Egypt Companies

# ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
# FOR
# EGYPTIAN OIL & GAS ACTIVITIES

SUBMITTED TO
OVERSEAS PRIVATE INVESTMENT CORPORATION (OPIC)

NOVEMBER 2005

CONTENTS

# Introduction

This report contains the environmental assessment of a number of activities that reflect Apache's oil and gas operations inside Egypt. Complete details are available in the individual EIA reports that Apache has prepared for each activity. These reports have been submitted, as a reference, to OPIC as part of a previous submittal.

It should be noted that in February 2004, Apache submitted an EIA to OPIC for it's Egyptian operations. Since that time five new concessions have been added as referenced in this report and one offshore concession has been dropped.

**Apache Overall Operations**

Egypt is one of Apache Corporation's most important international regions, and its estimated proved reserves in Egypt constitute 12.1 percent of Apache's total estimated proved reserves as of December 31, 2004. Through December 31, 2004, the investments of the Apache Egypt Companies in Egypt total approximately US $2.5 billion.

Apache and its affiliated companies ("Apache") have a significant operating presence in Egypt. As of December 31, 2004, Apache held interests in 14.3 million acres in Egypt and is the number one producer of oil/condensate and the number two producer of natural gas in the Western Desert. Apache's total production ranks number three for all of Egypt and accounts for 14% of Egypt's total production. In addition Apache is the most active driller with 26 drilling/completion rigs currently operating.

Apache owns a 75 percent interest in the Qarun Concession and a 100 percent interest in the Khalda/Khalda Offset Concession, located in the Western Desert of Egypt. The operating interest in Qarun was acquired from Phoenix Resources in 1996. In addition to the Qarun and Khalda/Khalda Offset Concessions, Apache holds interests in the East Beni Suef Concession to the south of the Qarun Concession, WD-19 Concession to the north of Qarun, and five other blocks in the Western Desert the Matruh Development Lease, the North East Abu Gharadig Concession (NEAG), the East Bahariya Concession, the onshore West Mediterranean Block I and El Diyur Concession.

In 2001, Apache acquired all of Repsol's interest in the Khalda Concession, the Ras Kanayes Concession, the Ras El Hekma Concession, the North East Abu Gharadig Concession and the portion of the West Mediterranean Concession onshore and offshore up to 100 meters water depth. Included in the transaction was Repsol's interest in the Umbarka Development Lease, and in the South Umbarka Concession. Apache has become operator of all these areas except North East Abu Gharadig.

During 2005, Apache announced that it divested the offshore portion of the West Mediterranean Block and that the transaction is expected to close in early 2006. Also during 2005, Apache was awarded 100% interests in five new concessions: West Kalabsha, West Kanyayes, North Tarek, Shushan (ABC), and North El Diyur Blocks. These new concessions are all exploratory blocks adjacent to existing Apache concessions.

Pursuant to the terms of the concession agreements, Qarun Petroleum Company (QPC) and Khalda Petroleum Company (KPC) have been formed as joint venture companies between the contractor (Apache and its partners, if any) and the Egyptian General Petroleum Corporation (EGPC) to conduct development activities in each concession. Additional joint venture companies exist under each concession where production has been established in name only and are actually managed by either QPC or KPC. It should be noted that the QPC is ISO 14001 certified.

## Egypt's Petroleum and Environmental Policy

The Ministry of Petroleum oversees almost all activities of the Egyptian petroleum sector concerning exploration, production, refining, marketing, distribution, and services. The petroleum sector is a significant source of government revenues (along with tourism and Suez Canal tariffs).

Egypt's stated reserves are 3.5 billion barrels of oil and 62 trillion cubic feet of natural gas, with an additional 80 to 100 trillion cubic feet yet to be discovered. Approximately

one quarter of Egypt's daily oil production and one third of daily gas production comes from the Western Desert.

With a youthful population of nearly 70 million, growth in the Egyptian economy is heavily dependent on oil and gas produced within Egypt as well as revenues derived from exports of refined products. Though Egypt is considered to be a net exporter of oil at the present time, continuing decline of the large, maturing Gulf of Suez oil fields may create a net import position within a decade, barring significant new field discoveries.

Egypt's energy policy is focused in the following areas:

- Increasing exports of oil and gas products while maintaining or increasing petroleum production to meet domestic requirements.
- Achieving self sufficiency in Natural Gas production while building infrastructure for significant exports of liquefied natural gas (LNG).
- Promoting industries that rely on natural gas as a raw material and fuel.
- Reducing dependency on petroleum imports of some products (e.g. gas and oil) that are used in power generation.
- Reducing environmental pollution through progressive conversion of power generation from oil to abundant, cleaner-burning natural gas and the conversion of gasoline vehicles to natural gas in urban areas, specifically Cairo.

Exploitation of its natural gas resources is the underpinning of Egypt's future economic development. Egypt expects that it will play a major role as an LNG exporter, and forecasts that it will be ranked No. 6 worldwide by 2006. With its strategic location within the Mediterranean basin Egypt has signed long-term gas sales agreements to supply European, American, and Near East markets. The government's target by 2010 is to:

- Produce 100 million tons annually of oil, gas, and petrochemicals of which 50% is natural gas,
- Export 30 million tons annually of natural gas,
- Displace imports and generate export sales of over $ 4 billion per year
- Directly and indirectly, create 100,000 new jobs.

Environmental protection has become one of the most important concerns vis-à-vis energy developments in Egypt. The impact of energy policies and activities on environmental quality must be regarded as an extremely significant consideration for petroleum companies operating in Egypt. .

# 1. Project Description

As mentioned in the previous section, Apache is a joint venture partner in the [1] Qarun and [2] Khalda Offset Concessions located in the Western Desert of Egypt. The operating interest in Qarun was acquired from Phoenix Resources in 1996. In addition, Apache holds interests in the [3] East Beni Suef Concession to the south of the Qarun Concession, [4] WD-19 Concession to the north of Qarun, and four other blocks in the Western Desert of Egypt:

- [5] Matruh Development Lease,
- [6] North East Abu Gharadig Concession,
- [7] East Bahariya Concession,
- [8] El Diyur Concession
- [9] West Mediterranean Block No. 1 (onshore).

Other Khalda Concessions such as [10] Ras Kanayes, [11] Ras El Hekma, [12] Umbarka Development Lease, [13] South Umbarka and the [9] West Mediterranean Concession (onshore) are also being operated by Apache.

During 2005, Apache announced that it divested the offshore portion of the West Mediterranean Block and that the transaction is expected to close in early 2006. Also during 2005, Apache was awarded 100% interests in five new concessions: [14] West Kalabsha, [15] West Kanyayes, [16] North Tarek, [17] Shushan (ABC), and [18] North El Diyur Blocks. All five concessions are adjacent to existing Apache concessions and infrastructure.

In this chapter, and due to the huge number of activities that are included in these areas, all operations will be mentioned in summarized forms relying mainly on tabular and graphical data that reflect clearly the status of each group of similar activities.

If more detail is required it is recommended to revert back to the appropriate individual EIA report, which is the main reference, or contact the company directly.

The main operations include activities related to drilling wells (exploratory & development), establishing onshore gas plants, pipelines (for wells tie-in) and seismic surveys.

# 1. APACHE Concessions

The following tables summarize the production/characterization data from fields operated by Apache YTD September 2005 and the Apache drilling program for the year 2006.

## 1.1 Production/ Characterization Data thru Apache Concessions

| Joint Venture | Concession Name | Daily Average Production (B/D & MMSCF/D | | | Total Cumulative Production (MBO & BCF) | | |
|---|---|---|---|---|---|---|---|
| | | Oil & Condensate | Gas | Water | Oil & Condensate | Gas (Asso + Feed) | Water |
| **K.P.C.** | Khalda/ Khalda Offset | 54000 | 370 | 60083 | 216994 | 67.2 + 467.6 | 172716 |
| | Umbaraka | 5500 | 0 | 12660 | 26672 | 36.9 + 1.1 | 18919 |
| | S. Umbarka | 8400 | 11 | 16342 | 20788 | 4.6 + 37.5 | 12549 |
| | Ras Kanyes | 153 | 2 | 0 | 619 | 0 + 7 | 0 |
| | Ras El Hekma | 1210 | 7.5 | 0 | 555 | 0 + 2.7 | 2 |
| | Matrouh | 2450 | 34.3 | 0 | 2679 | 0 + 28.7 | 0 |
| | W. Med | 4500 | 0 | N/A | N/A | N/A | N/A |
| **Q.P.C** | Qarun | 13180 | 3.0 | 45300 | 80702 | 23.3 | 64576 |
| | Beni Suef | 2900 | 0.3 | 10127 | 7341 | 0.9 | 6808 |
| | East Bahariya | 16700 | 0.8 | 8856 | 12397 | 0.6 | 3369 |
| | WD 19 | 0 | 0 | 0 | 477 | 0.1 | 408 |
| | El Diyur | 350 | 0.02 | 455 | 20.4 | 0.001 | 28.7 |
| **NON_OP** | N.E.A.G. | 4250 | 28.5 | | 2902 | 8.3 | |

| | Concession Name | Oil well | Gas well | Injection | Water source | Disposal | Inactive |
|---|---|---|---|---|---|---|---|
| **KPC** | Khalda | 175 | 25 | 99 | 7 | | |
| | Umbaraka | 34 | 0 | 13 | 2 | | |
| | S. Umbarka | 29 | 2 | 8 | 2 | | |
| | Ras kanyes | 0 | 2 | 0 | 0 | | |
| | Ras El Hekma | 0 | 1 | 0 | 0 | | |
| | Matrouh | 3 | 4 | 0 | 0 | | |
| | W. Med | 2 | 0 | 0 | 0 | | |
| **Qarun** | Qarun | 37 | 0 | 3 | 0 | 3 | 7 |
| | Bani Suef | 8 | 0 | 0 | 3 | 0 | 1 |
| | East Bahariya | 49 | 0 | 11 | 1 | 3 | 12 |
| | WD 19 | 2 | 0 | 0 | 0 | 0 | 2 |
| | El Diyur | 4 | 0 | 0 | 0 | 0 | 0 |
| | North El Diyur | 2 | 0 | 0 | 0 | 0 | 0 |
| **Non_OP** | NEAG | 5 | 1 | 0 | 0 | 0 | 0 |

Note:

1. QPC Daily Production Rates and Cumulative volumes are as of Sep 2005.
2. QPC Well Status is as of Oct 2005.
3. KPC Cumulative Production data is as of June 2005.
4. KPC Well Status & Daily Average Rates are as of Nov. 2005
5. Cumulative Production includes all historical production since Joint venture companies' formation.
6. Associated gas volume indicated was not conserved. Total Cumulative gas production is the summation of the Associated and Feed (total gas plants inlet) volumes.

## 1.2 Apache Egypt Drilling Program 2006

| Egypt 2006 Drilling Plan | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Revised 10.25.2005 | | | | | | | | |
| | | **New** | | **#** | | | | |
| **Well/Prospect** | **Concession** | **PUD** | **WI** | **Wells** | **Primary Obj.** | **PTD** | **Spud Date** | **Date of First** |
| | | | **%** | | | | | **Production** |
| | | | | | | | | |
| ASALA W-1X | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 5,900 | JUL 2 2006 | **09/06** |
| ASALA-1X | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 5,900 | DEC 27 2006 | **03/06** |
| ASALA-2X | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 5,900 | FEB 21 2006 | **04/06** |
| HAMRA NE-2 (EB-37 ATTIC) | EAST BAHARIYA | New | 100 | 1 | A/R-G | 6,000 | OCT 16 2006 | **12/06** |
| I-BASHA-1 | EAST BAHARIYA | New | 100 | 1 | UB | 6,750 | JUN 18 2006 | **08/06** |
| I-FARASHA-1 | EAST BAHARIYA | New | 100 | 1 | A/R-G | 7,000 | JUL 8 2006 | **09/06** |
| I-HAMRA-1 | EAST BAHARIYA | New | 100 | 1 | A/R-G | 5,700 | AUG 1 2006 | **10/06** |
| I-K-4 (WIW) (WKSHOP INJ-2) | EAST BAHARIYA | New | 100 | 1 | A/R-G | 8,150 | APR 27 2006 | **07/06** |
| I-KNW-2 | EAST BAHARIYA | New | 100 | 1 | A/R-G | 6,500 | AUG 21 2006 | **11/06** |
| I-KNW-3 | EAST BAHARIYA | New | 100 | 1 | A/R-G | 6,500 | SEP 12 2006 | **11/06** |
| I-KSW-2 (WIW) (UB & A/R-G) | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 7,750 | MAY 27 2006 | **08/06** |
| I-KW-2 | EAST BAHARIYA | New | 100 | 1 | A/R-G | 6,500 | OCT 4 2006 | **12/06** |
| I-RABOWA-1 (WIW) | EAST BAHARIYA | New | 100 | 1 | A/R-G | 8,000 | OCT 25 2006 | **12/06** |
| I-YAMAMA 1 (WIW) | EAST BAHARIYA | New | 100 | 1 | A/R-G | 7,000 | 11/18/2006 | **01/07** |
| KARAMA-7 (WKSHOP P4) | EAST BAHARIYA | New | 100 | 1 | A/R-G | 8,150 | 01/31/2006 | **04/06** |
| KARAMA-8 (BET K & KSW) | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 7,900 | MAR 30 2006 | **06/06** |
| KNE-2 | EAST BAHARIYA | New | 100 | 1 | A/R-G | 8,300 | SEP 2 2006 | **11/06** |
| KW 3 | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 6,500 | 11/03/2006 | **01/07** |
| KW-2 | EAST BAHARIYA | New | 100 | 1 | A/R-G | 6,500 | MAR 8 2006 | **05/06** |
| SAMRA SW-1X | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 6,000 | JAN 16 2006 | **03/06** |
| SAMRA SW-2X | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 6,000 | JUL 17 2006 | **09/06** |
| SARA-2 | EAST BAHARIYA | New | 100 | 1 | A/R-G | 5,900 | AUG 1 2006 | **10/06** |
| SHAKRA NE 1 | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 6,500 | 11/25/2006 | **02/07** |
| SHAKRA-2 | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 7,200 | SEP 6 2006 | **11/06** |
| ZAINA-2 | EAST BAHARIYA | New | 100 | 1 | BAH , A/R-G | 7,350 | AUG 19 2006 | **10/06** |
| | | | | | | | | |
| **Total** | | | | **25** | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EB-38 X | EAST BAHARIYA EXT | New | 100 | 1 | BAH , A/R-G | 10,000 | AUG 1 2006 | **11/06** |
| EB-39 X | EAST BAHARIYA EXT | New | 100 | 1 | BAH , A/R-G | 12,000 | OCT 1 2006 | **01/07** |
| | | | | | | | | |
| **Total** | | | | **2** | | | | |
| | | | | | | | | |
| AZHAR-3B | EAST BENI SUEF | New | 50 | 1 | KHARITA | 8,400 | DEC 26 2005 | **03/06** |
| AZHAR-3C | EAST BENI SUEF | New | 50 | 1 | KHARITA | 8,400 | APR 7 2006 | **06/06** |
| AZHAR-4A | EAST BENI SUEF | New | 50 | 1 | KHARITA | 8,400 | FEB 15 2006 | **05/06** |
| AZHAR-4B | EAST BENI SUEF | New | 50 | 1 | KHARITA | 8,400 | MAR 13 2006 | **06/06** |
| BENI SUEF-13 | EAST BENI SUEF | New | 50 | 1 | A/R-A | 3,500 | MAY 30 2006 | **07/06** |
| BENI SUEF-3 (STK) | EAST BENI SUEF | New | 50 | 1 | A/R-A | 3000+ | JUN 14 2006 | **09/06** |
| YUSIF-3 | EAST BENI SUEF | New | 50 | 1 | KHARITA | 7,850 | JAN 20 2006 | **04/06** |
| YUSIF-4 | EAST BENI SUEF | New | 50 | 1 | KHARITA | 7,850 | MAY 3 2006 | **07/06** |
| | | | | | | | | |
| **Total** | | | | **8** | | | | |
| | | | | | | | | |
| EL DIYUR-12 (ED-2 OFFSET) | EL DIYUR | New | 47 | 1 | BAH , A/R-G | 6,750 | MAY 19 2006 | **08/06** |
| EL DIYUR-13 (ED-3 APPRAISAL) | EL DIYUR | New | 47 | 1 | BAH , A/R-G | 6,750 | APR 24 2006 | **06/06** |
| EL DIYUR-14 | EL DIYUR | New | 47 | 1 | BAH , A/R-G | 6,750 | JUN 10 2006 | **08/06** |
| EL DIYUR-9 | EL DIYUR | New | 47 | 1 | BAH , A/R-G | 6,750 | JAN 10 2006 | **03/06** |
| | | | | | | | | |
| **Total** | | | | **4** | | | | |
| | | | | | | | | |
| Atoun 2X | Khalda | New | 100 | 1 | AEB 3D, E, G | 12,000 | 2/1/2006 | **01/07** |
| Hyatt 45 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 11/4/2006 | **01/07** |
| Hyatt 46 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 11/17/2006 | **01/07** |
| Hyatt 47 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 11/30/2006 | **02/07** |
| Hyatt 48 WIW | Khalda | New | 100 | 1 | Bahariya | 6,200 | 12/13/2006 | **02/07** |
| Isis 7 | Khalda | PUD | 100 | 1 | Bahariya | 7,000 | 4/27/2006 | **07/06** |
| Isis 8 | Khalda | PUD | 100 | 1 | Bahariya | 7,000 | 5/14/2006 | **07/06** |
| Kah B-11 | Khalda | PUD | 100 | 1 | Bahariya | 6,900 | 12/30/2005 | **03/06** |
| Kah B-12 | Khalda | PUD | 100 | 1 | Bahariya | 6,900 | 1/12/2006 | **03/06** |
| Kah C-68 | Khalda | PUD | 100 | 1 | Bahariya | 6,900 | 3/7/2006 | **05/06** |
| Kah C-69 WIW | Khalda | PUD | 100 | 1 | Bahariya | 6,900 | 3/24/2006 | **05/06** |
| Kah C-70 WIW | Khalda | PUD | 100 | 1 | Bahariya | 6,900 | 4/10/2006 | **06/06** |
| Kah C-71 WIW | Khalda | PUD | 100 | 1 | Bahariya | 6,900 | 5/31/2006 | **07/06** |
| Kah C-72 | Khalda | PUD | 100 | 1 | Bahariya | 6,900 | 6/17/2006 | **08/06** |
| Kah C-73 WIW | Khalda | PUD | 100 | 1 | Bahariya | 6,900 | 7/6/2006 | **09/06** |
| Kah C-74 | Khalda | New | 100 | 1 | Bahariya | 6,900 | 7/23/2006 | **09/06** |
| Kah C-75 WIW | Khalda | New | 100 | 1 | Bahariya | 6,900 | 8/9/2006 | **10/06** |
| Kah C-76 | Khalda | New | 100 | 1 | Bahariya | 6,900 | 8/26/2006 | **11/06** |
| Kah C-77 WIW | Khalda | New | 100 | 1 | Bahariya | 6,900 | 9/12/2006 | **11/06** |
| Kah C-78 | Khalda | New | 100 | 1 | Bahariya | 6,900 | 9/29/2006 | **12/06** |
| Kah C-79 WIW | Khalda | New | 100 | 1 | Bahariya | 6,900 | 10/16/2006 | **12/06** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Kah C-80 | Khalda | New | 100 | 1 | Bahariya | 6,900 | 11/2/2006 | **01/07** |
| Kenz 31 WIW | Khalda | New | 100 | 1 | Bahariya | 6,500 | 11/19/2006 | **01/07** |
| Kenz-32 | Khalda | PUD | 100 | 1 | AEB, Unit 5 | 12,000 | 1/1/2006 | **01/07** |
| Kenz-34 | Khalda | New | 100 | 1 | AEB 3 | 10,500 | 3/1/2006 | **05/06** |
| Khalda 46 | Khalda | PUD | 100 | 1 | Bahariya | 6,500 | 7/21/2006 | **09/06** |
| Khalda 47 | Khalda | PUD | 100 | 1 | Bahariya | 6,500 | 8/4/2006 | **10/06** |
| Khalda 49 | Khalda | PUD | 100 | 1 | Kharita | 9,000 | 10/26/2006 | **01/07** |
| Muntaga 1X | Khalda | New | 100 | 1 | U & L Safa | 13,700 | 12/26/2005 | **08/06** |
| Nader-6 | Khalda | New | 100 | 1 | Bahariya | 9,000 | 12/7/2006 | **02/07** |
| Nakhaw-2 | Khalda | New | 100 | 1 | AEB 3 | 11,250 | 3/5/2006 | **06/06** |
| Ozoris-10 | Khalda | New | 100 | 1 | Bahariya | 7,500 | 4/20/2006 | **06/06** |
| Ozoris-11 WIW | Khalda | New | 100 | 1 | Bahariya | 7,500 | 5/7/2006 | **07/06** |
| Ozoris-12 | Khalda | New | 100 | 1 | Bahariya | 7,500 | 5/24/2006 | **08/06** |
| Ozoris-13 WIW | Khalda | New | 100 | 1 | Bahariya | 7,500 | 6/10/2006 | **08/06** |
| Ozoris-14 | Khalda | New | 100 | 1 | Bahariya | 7,500 | 6/27/2006 | **09/06** |
| Ozoris-6 | Khalda | New | 100 | 1 | AEB-3 | 14,000 | 12/5/2005 | **05/06** |
| Ozoris-7H (UBD) | Khalda | New | 100 | 1 | Al Dol | 11,000 | 5/23/2006 | **10/06** |
| Ozoris-8 | Khalda | New | 100 | 1 | AEB-3 | 12,200 | 10/3/2006 | **01/07** |
| Ozoris-9 | Khalda | New | 100 | 1 | Bahariya | 7,500 | 12/5/2006 | **02/07** |
| Phiops 1X | Khalda | New | 100 | 1 | Bah, Khar, Safa | 14,000 | 6/1/2006 | **01/07** |
| Pinot 4 | Khalda | New | 100 | 1 | Bahariya | 10,000 | 11/16/2006 | **01/07** |
| Qasr-13X | Khalda | New | 100 | 1 | AEB 3D/E | 12,000 | 3/19/2006 | **07/06** |
| Qasr-15 | Khalda | PUD | 100 | 1 | LSAF | 13,700 | 11/25/2005 | **01/07** |
| Qasr-18 | Khalda | New | 100 | 1 | AEB-3A | 12,500 | 2/17/2006 | **06/06** |
| Qasr-19 | Khalda | New | 100 | 1 | AEB-3A | 12,500 | 8/22/2006 | **12/06** |
| Qasr-20 | Khalda | PUD | 100 | 1 | LSAF | 13,700 | 5/23/2006 | **01/07** |
| Qasr-23 | Khalda | New | 100 | 1 | Bahariya | 7,500 | 5/6/2006 | **07/06** |
| Qasr-24 | Khalda | New | 100 | 1 | Bahariya | 7,500 | 3/17/2006 | **05/06** |
| Qasr-25 WIW | Khalda | New | 100 | 1 | Bahariya | 7,500 | 4/3/2006 | **06/06** |
| Renpet 11 WIW | Khalda | New | 100 | 1 | Bahariya | 7,000 | 2/25/2006 | **05/06** |
| Renpet 12 | Khalda | New | 100 | 1 | Bahariya | 10,500 | 5/6/2006 | **08/06** |
| Renpet 13 WIW | Khalda | New | 100 | 1 | Bahariya | 6,500 | 3/12/2006 | **05/06** |
| Renpet 14 WIW | Khalda | New | 100 | 1 | Bahariya | 6,500 | 3/25/2006 | **06/06** |
| Renpet 3 | Khalda | New | 100 | 1 | Bahariya | 7,000 | 1/25/2006 | **04/06** |
| Renpet 7 | Khalda | New | 100 | 1 | Bahariya | 7,000 | 2/10/2006 | **04/06** |
| Salam N-17 | Khalda | New | 100 | 1 | Bahariya | 6,500 | 12/4/2006 | **02/07** |
| Shams 1X ST (UBD) | Khalda | PUD | 100 | 1 | LSAF | 13,000 | 9/11/2006 | **01/07** |
| Shams 6 ST (UBD) | Khalda | New | 100 | 1 | Khatatba-2F | 13,000 | 10/18/2006 | **01/07** |
| Shrouk 10 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 6/12/2006 | **08/06** |
| Shrouk 11 WIW | Khalda | New | 100 | 1 | Bahariya | 6,200 | 6/25/2006 | **08/06** |
| Shrouk 12 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 7/8/2006 | **09/06** |
| Shrouk 13 WIW | Khalda | New | 100 | 1 | Bahariya | 6,200 | 8/17/2006 | **10/06** |
| Shrouk 14 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 8/30/2006 | **11/06** |
| Shrouk 15 WIW | Khalda | New | 100 | 1 | Bahariya | 6,200 | 9/12/2006 | **11/06** |
| Shrouk 16 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 9/25/2006 | **11/06** |
| Shrouk 17 WIW | Khalda | New | 100 | 1 | Bahariya | 6,200 | 10/8/2006 | **12/06** |
| Shrouk E-19 WIW | Khalda | New | 100 | 1 | Bahariya | 6,200 | 4/7/2006 | **06/06** |
| Shrouk E-20 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 4/21/2006 | **06/06** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Shrouk E-21 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 5/4/2006 | **07/06** |
| Shrouk E-22 WIW | Khalda | New | 100 | 1 | Bahariya | 6,200 | 5/17/2006 | **07/06** |
| Shrouk E-24 | Khalda | New | 100 | 1 | Bahariya | 6,200 | 5/30/2006 | **08/06** |
| Tayet 1 ( Deepening ) | Khalda-Ext | New | 100 | 1 | AEB, Unit 3 | 14,785 | 4/12/2006 | **01/07** |
| Tut 67 | Khalda | PUD | 100 | 1 | Khatatba | 12,700 | 9/2/2006 | **01/07** |
| Yasser 40 | Khalda | New | 100 | 1 | Bahariya | 6,500 | 1/6/2006 | **03/06** |
| Yasser 41 | Khalda | New | 100 | 1 | Bahariya | 6,500 | 1/19/2006 | **03/06** |
| Yasser 43 | Khalda | New | 100 | 1 | Bahariya | 6,500 | 2/1/2006 | **04/06** |
| | | | | | | | | |
| **Total** | | | | **77** | | | | |
| | | | | | | | | |
| Buchis Updip 3-X | Khalda-Ext | New | 100 | 1 | AEB 3A, Safa | 14,000 | 8/26/2006 | **02/07** |
| Hathor Deep 1X | Khalda-Ext | New | 100 | 1 | AEB 3D/E, 5, 6 | 14,000 | 5/19/2006 | **01/07** |
| | | | | | | | | |
| **Total** | | | | **2** | | | | |
| | | | | | | | | |
| Jade 1X (Matruh A) | Matruh | New | 100 | 1 | AEB 6,U&L Safa | 15,000 | 7/13/2006 | **01/07** |
| Karanis 1X | Matruh | New | 100 | 1 | U & L Safa | 15,500 | 12/23/2005 | **01/07** |
| Matruh-7 | Matruh | New | 100 | 1 | U & L Safa | 15,500 | 8/16/2006 | **01/07** |
| | | | | | | | | |
| **Total** | | | | **3** | | | | |
| | | | | | | | | |
| JD-4X | NEAG | New | 48 | 1 | Lower Safa | 16,000 | 4/1/2006 | **12/06** |
| Sheiba 18-6 | NEAG | PUD | 48 | 1 | Bahariya | 7,400 | 6/1/2006 | **10/06** |
| JG-7H | NEAG | PUD | 48 | 1 | L Safa B, A | 12,900 | 11/15/2005 | **06/06** |
| | | | | | | | | |
| **Total** | | | | **3** | | | | |
| | | | | | | | | |
| NEAG-3X | NEAG EXT | New | 48 | 1 | Jurassic | 14,000 | 8/1/2006 | **04/07** |
| NEAG-1X | NEAG-EXT | New | 48 | 1 | Bahariya | 7,500 | 4/1/2006 | **08/06** |
| NEAG-2X | NEAG-EXT | New | 48 | 1 | Bahariya | 8,000 | 6/1/2006 | **10/06** |
| | | | | | | | | |
| **Total** | | | | **3** | | | | |
| | | | | | | | | |
| N Harun 2 Deepening | QARUN | New | 75 | 1 | Bahariya | 10,100 | 10/28/2006 | **01/07** |
| NQ-9 (A/R-D) | QARUN | New | 75 | 1 | A/R-C & D | 700 | 3/3/2006 | **04/06** |
| SWQ 2ND HZ WELL | QARUN | New | 75 | 1 | KHARITA | 10200+ | 8/11/2006 | **12/06** |
| SWQ-8 HZ WELL | QARUN | New | 75 | 1 | KHARITA | 10200+ | 12/13/2005 | **04/06** |
| | | | | | | | | |
| **Total** | | | | **4** | | | | |
| | | | | | | | | |
| Ras Kanayes 7X | Ras Kanayes | New | 100 | 1 | U & L Safa | 16,000 | 3/29/2006 | **01/07** |
| West Kanayes-1X | West Kanayes | | 100 | 1 | Lower Safa | 16,000 | 6/1/2006 | **01/07** |
| | | | | | | | | |
| **Total** | | | | | | | | |
| | | | | | | | | |
| Khepri 13 | So Umbarka | New | 100 | 1 | Bahariya | 7,000 | 9/17/2006 | **11/06** |
| Khepri 19 | So Umbarka | New | 100 | 1 | Bahariya | 7,000 | 7/21/2006 | **09/06** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Khepri 21 | So Umbarka | New | 100 | 1 | Bahariya | 7,000 | 8/10/2006 | **10/06** |
| Khepri 23 | So Umbarka | New | 100 | 1 | Bahariya | 7,000 | 8/29/2006 | **11/06** |
| Khepri-17 | So Umbarka | New | 100 | 1 | Bahariya | 12,700 | 2/24/2006 | **07/06** |
| Khepri-18 | So Umbarka | New | 100 | 1 | Bahariya | 12,700 | 6/14/2006 | **10/06** |
| Selkit 11 | So Umbarka | New | 100 | 1 | AEB-3 | 13,700 | 3/1/2006 | **07/06** |
| Selkit-5 ST (UBD) | So Umbarka | New | 100 | 1 | AEB-3 | 12,700 | 4/17/2006 | **07/06** |
| Sethos-30 | So Umbarka | New | 100 | 1 | Bahariya | 10,000 | 12/6/2005 | **03/06** |
| Sethos-31 WIW | So Umbarka | New | 100 | 1 | Bahariya | 10,000 | 12/3/2005 | **02/06** |
| Sethos-32 | So. Umbarka | New | 100 | 1 | AEB, Unit 3 | 13,600 | 5/4/2006 | **01/07** |
| | | | | | | | | |
| **Total** | | | | **11** | | | | |
| | | | | | | | | |
| Aries 1X | Umbarka | New | 100 | 1 | AEB 3D | 11,500 | 4/4/2006 | **07/06** |
| Fereiha-2 | Umbarka | New | 100 | 1 | AEB-3 | 11,250 | 1/9/2006 | **04/06** |
| Kah UC-65 | Umbarka | PUD | 100 | 1 | Bahariya | 6,900 | 1/15/2006 | **03/06** |
| Kah UC-66 | Umbarka | PUD | 100 | 1 | Bahariya | 6,900 | 2/1/2006 | **04/06** |
| Kah UC-67 | Umbarka | PUD | 100 | 1 | Bahariya | 6,900 | 2/18/2006 | **04/06** |
| Umbarka-57 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 1/1/2006 | **03/06** |
| Umbarka-64 | Umbarka | New | 100 | 1 | Bahariya | 11,250 | 5/11/2006 | **09/06** |
| Umbarka-65 | Umbarka | New | 100 | 1 | Bahariya | 6,800 | 5/23/2006 | **10/06** |
| Umbarka-72 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 1/16/2006 | **03/06** |
| Umbarka-75 | Umbarka | New | 100 | 1 | AEB-3 | 11,250 | 7/8/2006 | **10/06** |
| Umbarka-76 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 1/31/2006 | **04/06** |
| Umbarka-77 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 2/15/2006 | **04/06** |
| Umbarka-78 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 3/2/2006 | **05/06** |
| Umbarka-79 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 7/14/2006 | **09/06** |
| Umbarka-80 | Umbarka | New | 100 | 1 | Bahariya | 6,800 | 7/30/2006 | **10/06** |
| Umbarka-81 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 8/14/2006 | **10/06** |
| Umbarka-82 | Umbarka | New | 100 | 1 | Bahariya | 6,800 | 8/28/2006 | **10/06** |
| Umbarka-83 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 9/11/2006 | **11/06** |
| Umbarka-84 | Umbarka | New | 100 | 1 | Bahariya | 6,800 | 9/25/2006 | **11/06** |
| Umbarka-85 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 10/9/2006 | **12/06** |
| Umbarka-86 | Umbarka | New | 100 | 1 | Bahariya | 6,800 | 10/23/2006 | **12/06** |
| Umbarka-87 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 11/6/2006 | **01/07** |
| Umbarka-88 | Umbarka | New | 100 | 1 | AEB-3 | 11,250 | 12/30/2005 | **04/06** |
| Umbarka-89 WIW | Umbarka | PUD | 100 | 1 | Bahariya | 6,800 | 11/20/2006 | **01/07** |
| Umbarka-90 | Umbarka | New | 100 | 1 | Bahariya | 6,800 | 12/4/2006 | **02/07** |
| | | | | | | | | |
| **Total** | | | | **25** | | | | |
| | | | | | | | | |
| *WADI RAYAN 11 | WADI RAYAN | New | 100 | 1 | BAH , A/R-G | 5,900 | JUN 30 2006 | **09/06** |
| *WADI RAYAN NW | WADI RAYAN | New | 100 | 1 | BAH , A/R-G | 5,900 | JUL 23 2006 | **10/06** |
| *WADI RAYAN SW (W/ SHEAR DATA FOR 3D) | WADI RAYAN | New | 100 | 1 | BAH , A/R-G | 5,900 | APR 2 2006 | **06/06** |
| | | | | | | | | |
| **Total** | | | | **3** | | | | |
| ***Note: Wadi Rayan wells are excluded from OPIC coverage.** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dahab 4X | West Med | New | 65 | 1 | Kah, Dah, Ala | 12,500 | 8/13/2006 | **01/07** |
| N Alamein 7 | West Med | New | 65 | 1 | AEB | 11,800 | 10/25/2006 | **02/07** |
| | | | | | | | | |
| **Total** | | | | **2** | | | | |
| | | | | | | | | |
| **Grand Total** | | | | 174 | | | | |

## Export Pipelines

Apache exports its total production via a number of different pipeline systems.

## Qarun Concession

**Oil** Qarun oil is pumped via a 16 inch pipeline that extends for 45 km to Dahshour (West of Cairo). At Dashour, oil is collected into two 350,000 BBL tanks. At this point the oil is transferred to non-Apache operated lines.

**Gas** Qarun gas is exported via a BP operated pipeline to the Dahshour gas plant also operated by BP (British Petroleum Company).

## Khalda Concession

**Oil** Khalda Oil is processed at the Salam oil treatment plant and pumped to the Meliha gathering station via a 35 km 16 inch line where it enters the main line owned and operated by IOEC. [See Map (1)]

**Gas**

## Northern Gas Pipeline

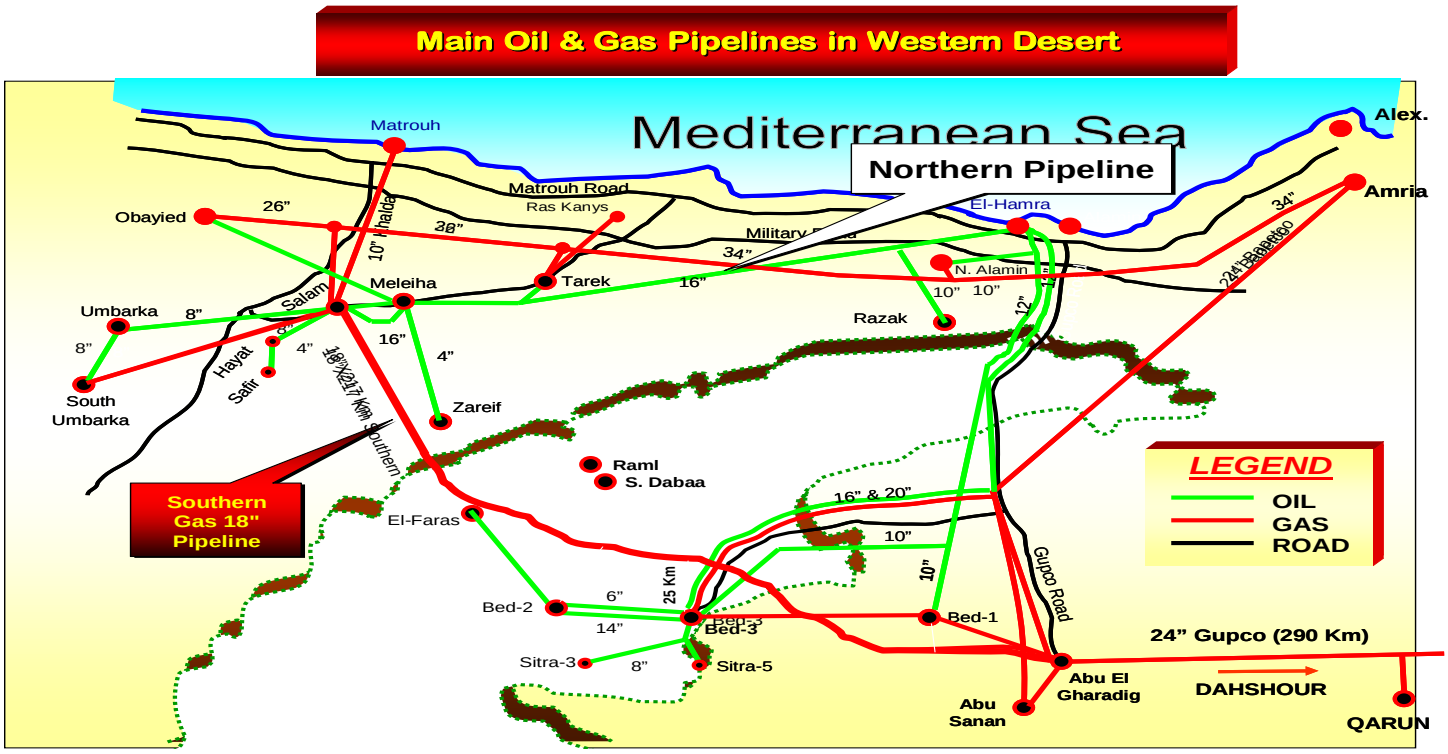
A 34 inch gas export line handles all of the gas exported from the Khalda concession, Martouh concession, Ras Kanayis concession, Ras El Hekma concession, Umbarka concession & South Umbarka concession. The line is jointly owned by Apache and Shell with Shell assuming operatorship of the line. [See Map (1)]

## Southern Gas Pipeline

This is an 18 inch line extending 217 km from Salam Base located in the Khalda concession to Abu Gharadig Gas Plant operated by GUPCO. This line could be used by Apache in the future but currently a portion of the southern end of the line is leased to another operator for oil gathering.

## Qasr Gas Field Evacuation Pipelines

During 2005, a 24 inch by 18 inch pipeline was completed that connects the Qasr gas field to the Obaiyed Gas Plant. The Obaiyed plant is owned and operated by Shell. The pipeline to reach Obaiyed is owned and operated by Apache. There are additional 18" pipeline segments under construction that will connect Qasr gas field to both the Salam and Tarek gas plants. Those pipeline segments and plants are owned and operated by Apache. Please refer to the sections below that more fully describe the Salam and Tarek gas plants.




## Umbarka & South Umbarka Concessions

**Oil** Crude oil & condensate are transported via pipeline to the Meliha gathering station to be mixed with Khalda concession oil and condensate.

# Oil and Gas Processing Facility Process Descriptions

## OIL PLANTS

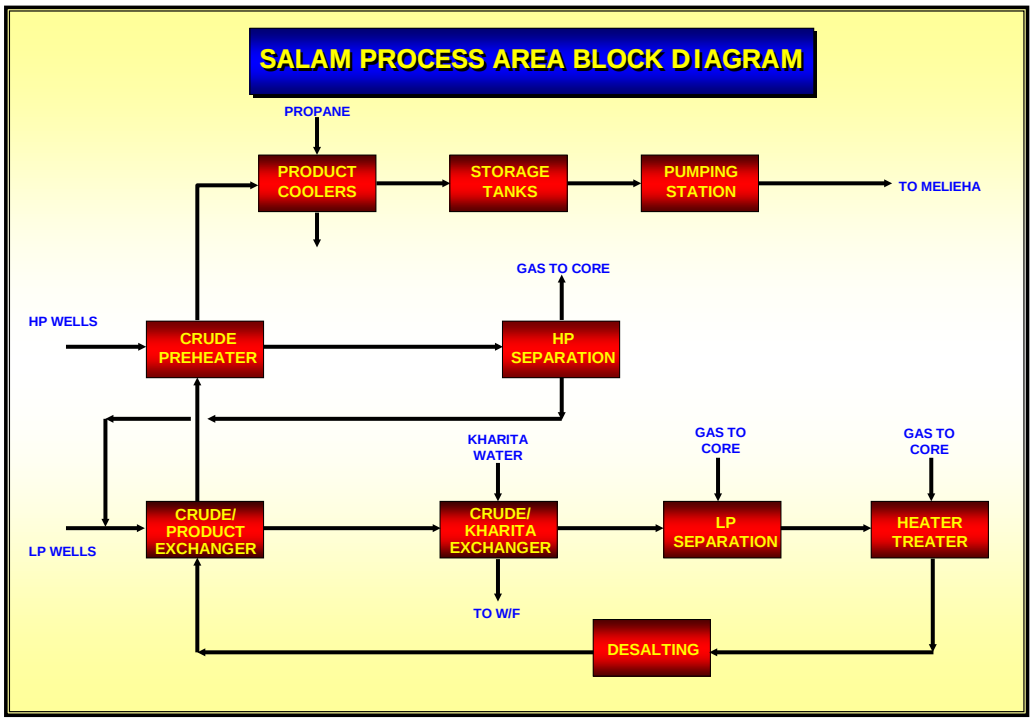
### Khalda Concession Oil Treating Facility

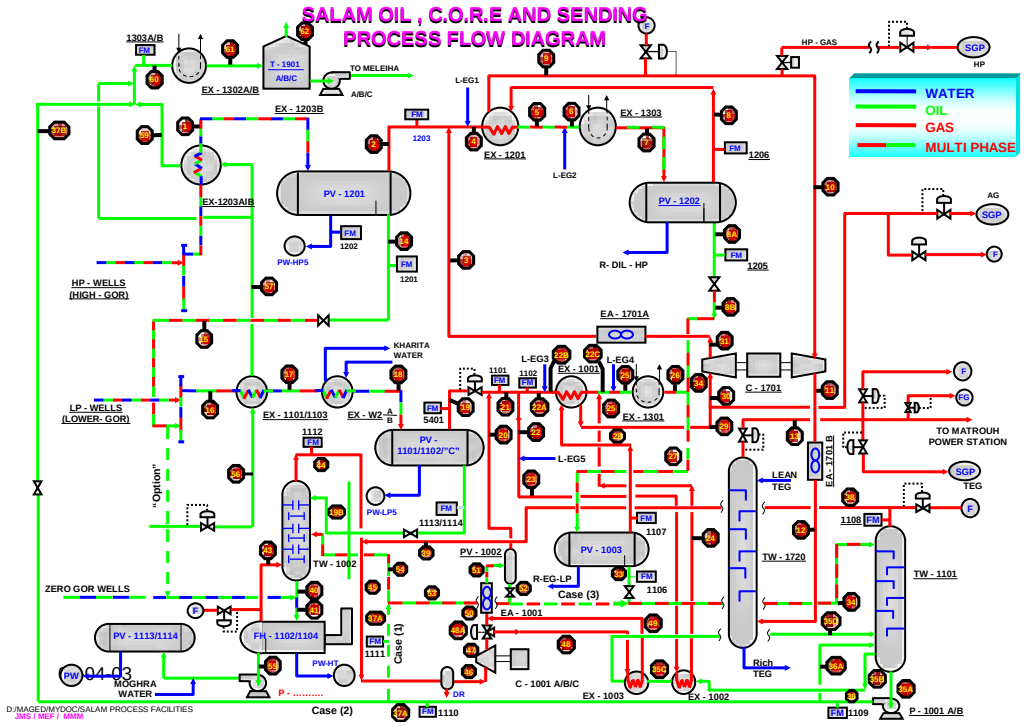
The processing system at the Khalda concession is referred to as the Salam oil treating facility consisting of oil, water, and gas separation. The oil conditioning consists of separators to separate the oil, gas, and water into three distinct phases. Oil goes to a heater treater to further reduce the entrained and free water concentration. Next it flows to a desalting vessel that conditions the oil further to meet the sales quality specification. Processed oil meeting the sales specification are stored in tanks. Shipping pumps deliver this oil the sales pipeline. This pipeline goes to the Meliha Gathering facility.

Separated water flows from the aforementioned vessels to an API separator to remove entrained oil from the continuous water phase.

The oil processed in this facility comes from wells that produce crude oil. This oil has a certain amount of gas associated with it. This gas is separated during the aforementioned processing scheme. This gas, referred to as “associated gas” is processed within this oil facility. Twenty (20) Million Standard Cubic Feet of gas can be processed within this oil facility on a daily basis. This rate is referred to as 20 MMSCFD. This associated gas has it pressure increased by compressors within the processing system. Some of the higher pressure gas is dehydrated and put in a sales line. The remaining gas flows to the Salam Gas Plant. This is physically a separate plant and is described in the gas plant section below.

The next two diagrams in this write up illustrate this description. The first one is a block diagram, depicting the major processing schemes as boxes, with arrows showing how flow proceeds through the plant. The second diagram is called a schematic. It shows all the actual components in the process, with “a schematic drawing” of each device. Flow arrows show how the flow proceeds through the plant.


SALAM PROCESS AREA BLOCK DIAGRAM
PROPANE
PRODUCT COOLERS
STORAGE TANKS
PUMPING STATION
TO MELIEHA
GAS TO CORE
HP WELLS
CRUDE PREHEATER
HP SEPARATION
KHARITA WATER
GAS TO CORE
GAS TO CORE
CRUDE/ PRODUCT EXCHANGER
CRUDE/ KHARITA EXCHANGER
LP SEPARATION
HEATER TREATER
LP WELLS
TO W/F
DESALTING


SALAM OIL , C.O.R.E AND SENDING
PROCESS FLOW DIAGRAM
WATER
OIL
GAS
MULTI PHASE
HP - WELLS (HIGH - GOR)
LP - WELLS (LOWER- GOR)
ZERO GOR WELLS
MOGHRA WATER
KHARITA WATER
TO MELEIHA
TO MATROUH POWER STATION
HP - GAS
LEAN TEG
Rich TEG
R- DIL - HP
PV - 1201
PV - 1202
PV - 1003
PV - 1002
PV - 1101/1102/"C"
PV - 1113/1114
FK - 1102/1104
EX - 1201
EX - 1303
EX - 1001
EX - 1301
EX - 1101/1103
EX - 1003
EX - 1002
C - 1701
C - 1001 A/B/C
TW - 1002
TW - 1720
TW - 1101
EA - 1701A
EA - 1001
R-EG-LP
Case (1)
Case (2)
Case (3)
"Option"
P - 1001 A/B
04-03

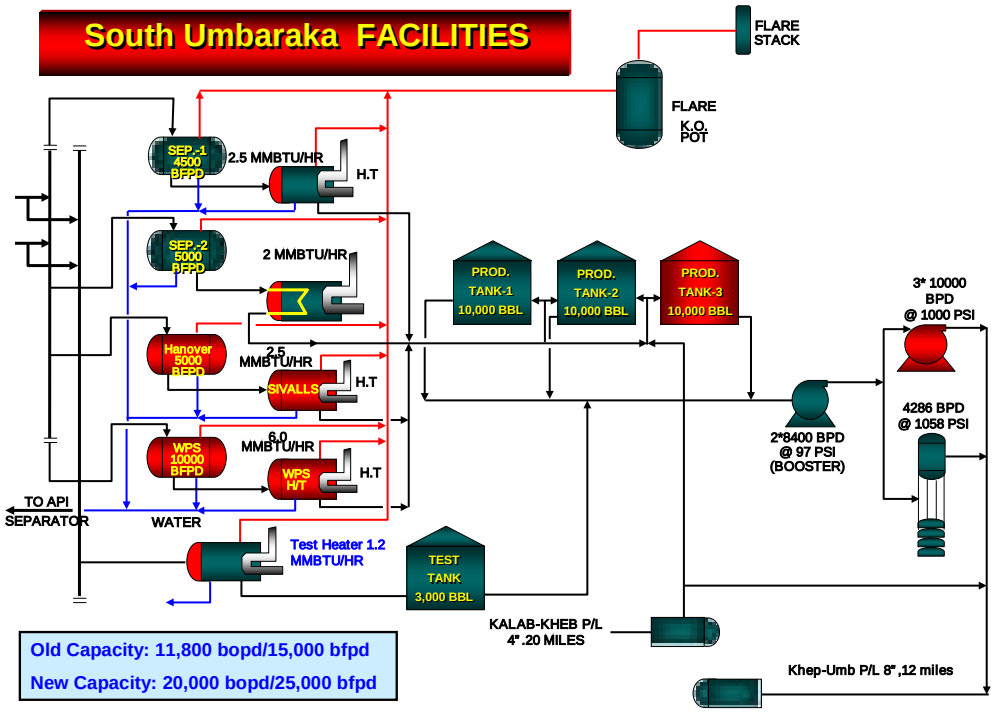
## South Umbarka Concession Oil Facility

The processing system at the South Umbarka concession consists of oil, water, and gas separation. Oil from the wells flows directly to fired heaters, where the oil, water, and gas mixture is heated to enhance three phase separation. The heated well stream then flows to a three phase separator. In these separators oil, gas, and, water are separated. Oil flows to a heater treater for further processing in order to meet sales quality specifications. Tanks store all the oil meeting the quality specification. Shipping pumps deliver the oil to a pipeline. This pipeline terminates at the storage tanks of the Umbarka Oil Facility described in the next section.

Water from the separators goes to an API separator to remove entrained oil that is carried over in the continuous water phase.

Separated gas is flared at a rate of approximately 0.350 MMCF/day.

The illustration below shows this facility in a schematic style.



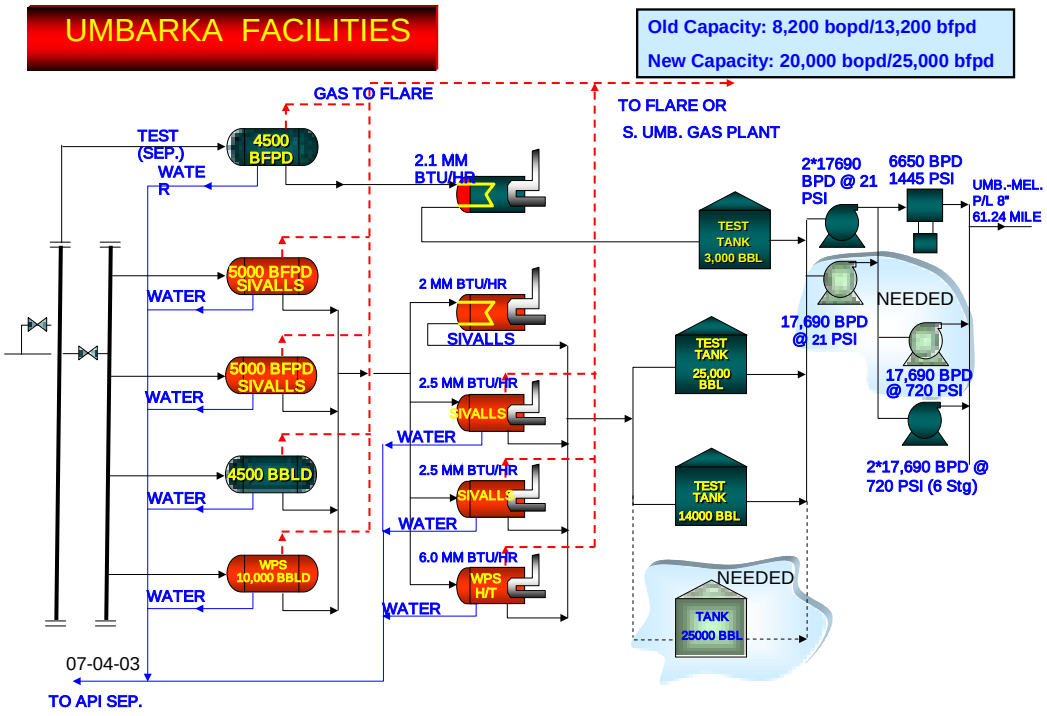
## Umbarka Concession Oil Facility

The process at the Umbarka oil treating facility consists of oil, water, and gas separation. The oil conditioning consists of separators and indirect heaters to help with the separation of the oil and water. The oil then goes to a heater treater to further reduce the water content in the oil. Tanks store all the oil meeting the quality specification. Shipping pumps deliver the oil to the sales pipeline. This sales pipeline goes to Meliha gathering facility.

The water from the separators goes to an API separator to remove the entrained oil that is carried over in the continuous water phase.

Separated gas is flared at a rate of approximately 0.600 MMCF/day.

The illustration below shows this facility in a schematic style.



## Qarun Concession Oil Treating Facility

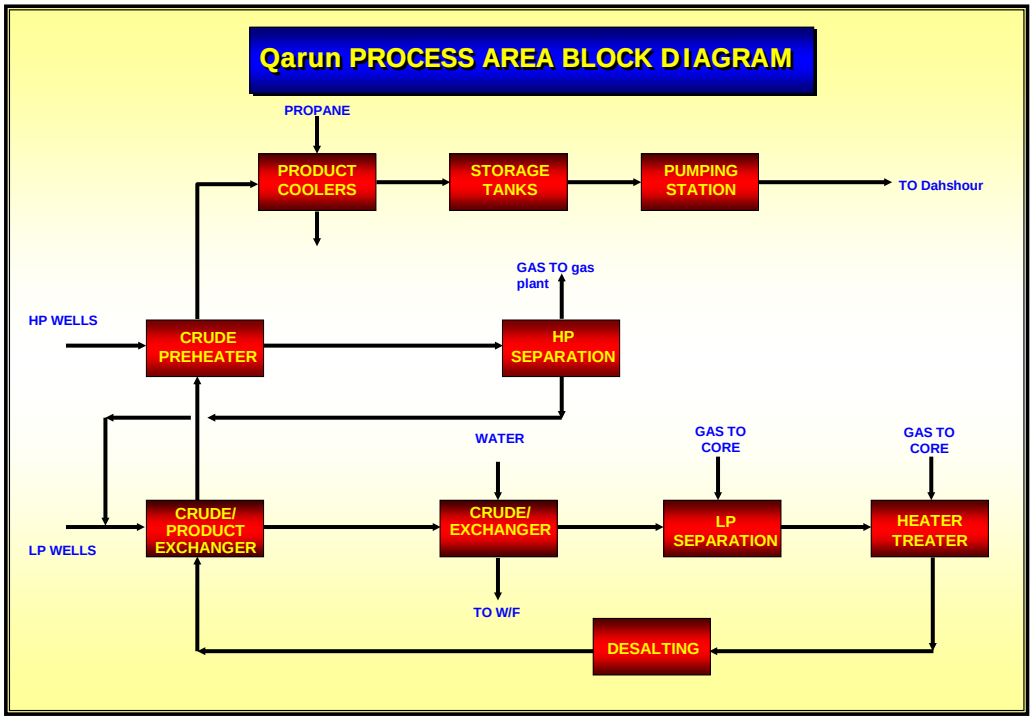
The processing system of Qarun consists of oil, water, and gas separation. The oil conditioning consists of separators to separate the oil, gas, and water into three distinct phases. Oil goes to a heater treater to further reduce the entrained and free water concentration. Next it flows to a desalting vessel that conditions the oil further to meet the sales quality specification. Processed oil meeting the sales specification are stored in tanks. Shipping pumps at the Qarun facility deliver this oil to a 16” pipeline owned and operated by Qarun. This pipeline terminates at place called Dahshour, 50 kilometers due east of the plant.

The oil at Dahshour is stored in two 350,000 BBL floating roof tanks. This oil can be pumped into the Suez Mediterranean Pipeline by pumps owned and operated by Qarun. Alternatively, Petroleum Pipeline Company can pump from these tanks. Oil flowing this route terminates at a Cairo refinery.

Separated water flows from the aforementioned vessels to an API separator to remove entrained oil from the continuous water phase.

The oil processed in this facility comes from wells that produce crude oil. This oil has a certain amount of gas associated with it. This gas is separated during the aforementioned processing scheme. This gas, referred to as “associated gas” is processed within this oil facility. Twelve (12) Million Standard Cubic Feet of gas can be processed within this oil facility on a daily basis. This rate is referred to as 12 MMSCFD. This associated gas has it pressure increased by compressors within the processing system. The gas is then dehydrated. All the hydrocarbon components heavier than C5+ (Pentane) are removed from the gas stream. These components are liquid mixed with the processed oil. The gas flows to a sales gas pipeline operated by British Petroleum Corporation.

The block diagram depicts this process.



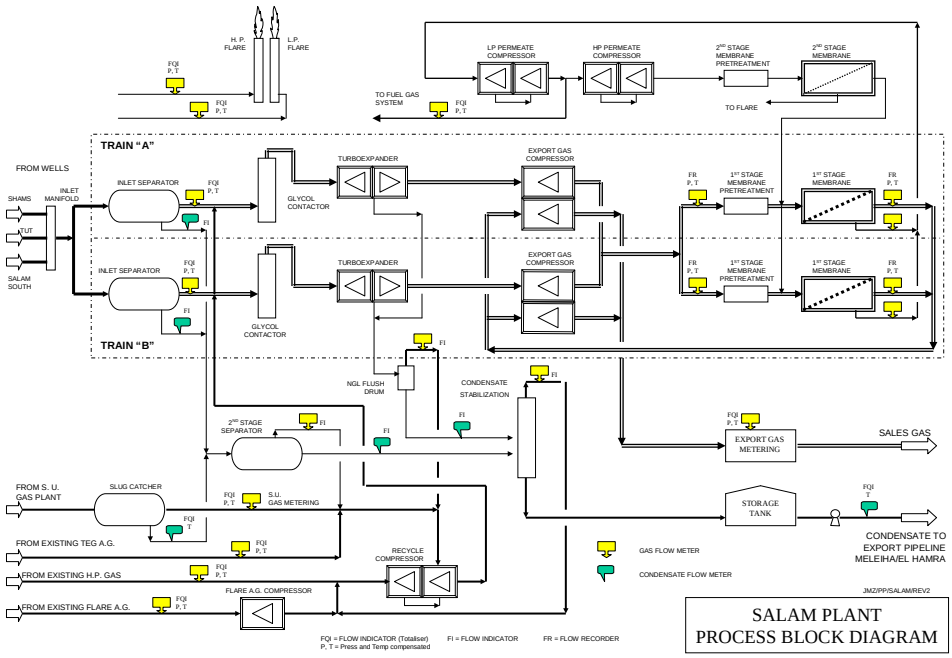

## GAS PLANTS

The Khalda Concession currently has two gas plants. The process description of each is described below.

**Salam Gas Plant** – is located adjacent to the Salam oil processing system. They share some utility systems. This plant processes gas from the Khalda Concession and dehydrated gas from the South Umbarka Concession.

The plant has a gas treatment system that includes membranes that reduce the Carbon Dioxide Concentration of the sales gas to less than 3 mole percent and a dehydration system that reduces the water concentration to less than 4 pounds per MMSCFD. The design flow rate is 200 MMSCFD. The gas is compressed, metered, and exported via, the Western Desert Gas Pipeline, also referred to as the Northern Gas Pipeline.

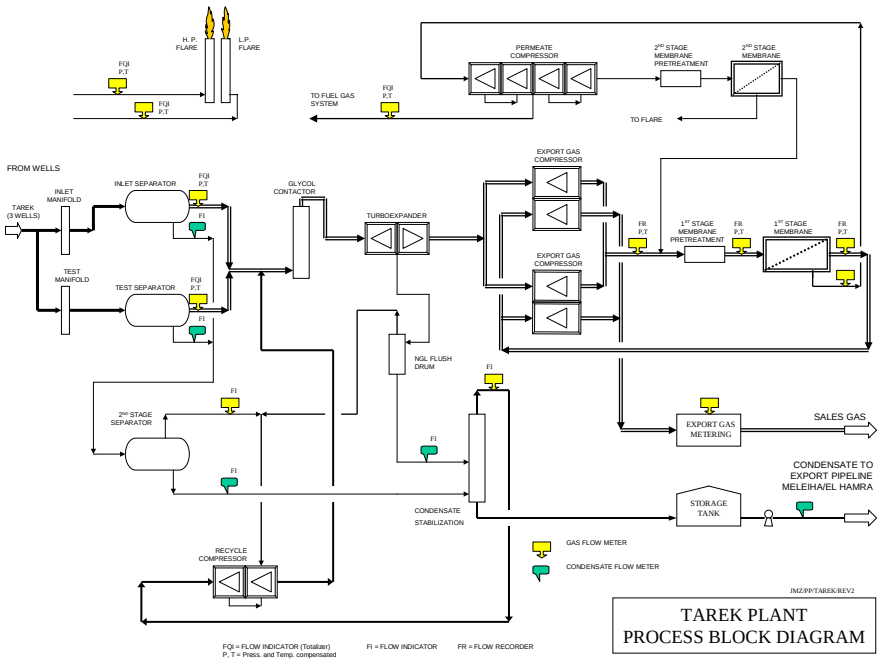
Condensate is received at the plant from the wells, and also as produced by the process. This condensate is stabilized to a Reid Vapor Pressure of 10 psi. It is then stored and pumped to the crude oil sales line flowing from the Salam Oil Plant, previously described.



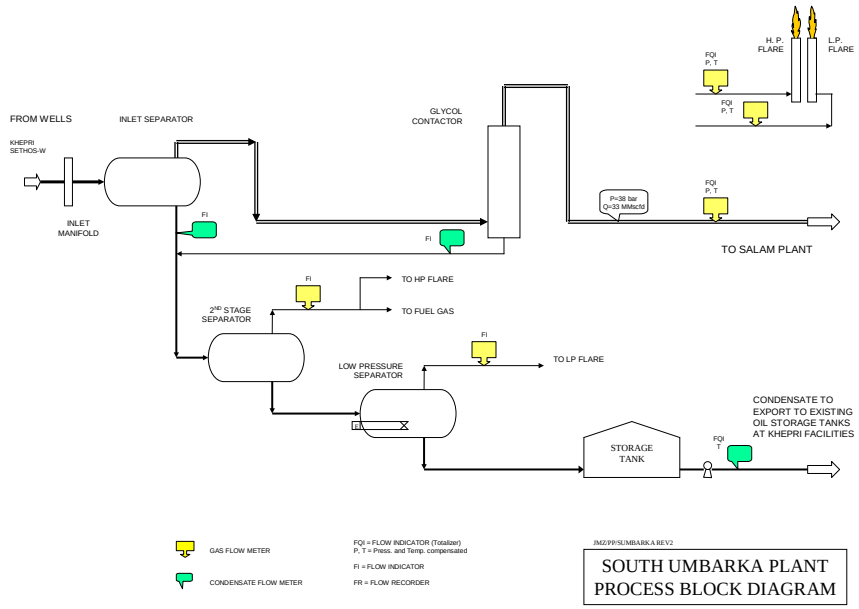

**Tarek Gas Plant** – Is located about 60 km NE of Salam Gas Plant. This plant processes Khalda Concession Gas and gas from the Ras Kanayes, Res El Hechma, and Matrouh concessions.

The plant has a gas treatment system that includes membranes that reduce the Carbon Dioxide Concentration of the sales gas to less than 3 mole percent and a dehydration system that reduces the water concentration to less than 4 pounds per MMSCFD. The design flow rate is 100 MMSCFD. The gas is compressed, metered, and exported via, the Western Desert Gas Pipeline, also referred to as the Northern Gas Pipeline.

Condensate is received at the plant from the wells, and also as produced by the process. This condensate is stabilized to a Reid Vapor Pressure of 10 psi. It is then stored and pumped from the Plant via 6" pipeline to a 16" crude oil line. This crude oil line runs from Meliha to El Hamra terminal. It is owned and operated by Agiba Oil Company.



**South Umbarka Plant** – is located about 60 km west of the Salam Gas Plant. The plant has a capacity of 33 MMSCFD. Gas is dehydrated and exported to the Salam Plant. Condensate is stabilized and then pumped into the South Umbarka Crude oil facility described previously. The oil and condensate mixture is then exported to the Umbarka concession, mixed, and evacuated to the Meliha Gathering Facility.



## Oil Analysis

The following table contains the oil analysis from the Qarun fields and are generally representative of Apache Egyptian operations.

# *Qarun Chemical Lab.*
# *Crude Oil Complete Analysis for all fields*

| *No.* | *Test* | *Method ASTM &IP No* | *Qarun* | *North Qarun* | *South West Qarun* | *SAKER* | *EWD* | *El-Ahram* | *Karama* | *Wadi Ryan* | *Beni suief* | *North Alamein* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1* | *Specific Gravity @60/60°F* | *D-1298* | *0.8241* | *0.845* | *0.846* | *0.8413* | *0.8960* | *0.8174* | *0.8137* | *0.8922* | *0.8128* | *0.8314* |
| *2* | *API Gravity @60°F* | *D-1298* | *40.2* | *36* | *35* | *36.7* | *26.4* | *41.6* | *42.4* | *27.1* | *42.6* | *38.7* |
| *6* | *Pour Point °C* | *D-97* | *24* | *15* | *15* | *21* | *Zero* | *27* | *24* | *0* | *36* | *0* |
| *7* | *Viscosity Kinematics @40°C cSt.* | *D-445* | *4.29* | *5.7* | *7* | *4.785* | *38.4* | *5.62* | *6.033* | *26.9* | *11* | *3.24* |
| *8* | *Conradson Carbon % Wt* | *IP 13/94* | *1.0994* | *2.8* | *2.94* | *1.04* | *10.2* | *1.48* | *1.166* | *8.9* | *1.7* | *2.5* |
| *9* | *Ash content % Wt* | *IP 4/94* | *0.001* | *0.03* | *0.013* | *0.0055* | *0.7* | *0.073* | *0.0206* | *0.015* | *0.089* | *0.0032* |
| *12* | *Sulfur Content % Wt* | *D-4294* | *0.0538* | *0.33* | *0.348* | *0.4591* | *1.5* | *0.0628* | *0.0489* | *1.385* | *0.37* | *0.64* |
| *13* | *Asphaltene Content % Wt* | *IP 143/57* | *0.3* | *0.97* | *1.16* | *0.66* | *6.6* | *0.4* | *0.6931* | *6.803* | *0.4* | *2.52* |

## Average Wellsite Foot print

A typical foot print for each well will be similar as that shown in Appendix C.

# 2. Baseline Environment

The Environmental Profile includes an inventory of the biotic and abiotic components of the environment and their interaction. The presented data will include physical, biological and ecological features of all areas that host Apache operations in Egypt.

An environmental profile is very useful for identifying main environmental effects, adverse and beneficial, likely to result from mentioned activities. Mitigation measures are applied in order to avoid environmental damage, and depletion of available natural resources that may result from the projects negative environmental impacts.

Most of the Apache concessions, as per maps in appendix A, belong to the Egyptian Western Desert and distributed among three separate areas as shown in maps included in Appendix A:

- **Area 1 -** including East Bahariya, Khalda, Matruh, Umbarka, South Umbarka, Ras El Hekma, Ras Kanayes, North East Abu Gharadig (NEAG), West Med Onshore, West Kalabsha, West Kanyayes, North Tarek, Shushan (ABC), El Diyur and N. El Diyur:
- **Area 2 -** including Qarun, Wadi Rayan Development Lease and WD 19 Blocks; and
- **Area 3 -** including East Beni Suef.

In this section, we will summarize the main features of the different environments that prevail in the Apache concession areas.

## 2.1 AREA 1

The last environmental survey for Area 1 was carried out on 18/10/2003 and soil samples were collected for environmental analysis.

Areas that are part of Area 1 and share the same general environmental features are the Qarun East Bahariya Concession and all of the Khalda Concessions.

### 2.1.1 Geological, Meteorological & Hydrological status

Area 1 as a whole lies approximately in the middle and Western section of the Western desert. This section is essentially a flat plateau with numerous closed-in depressions. According to Said (1962) the oasis of Farafra and East Bahariya are situated in the great plateau of Eocene limestone, which extends from about Lat. 25° N to about Lat. 29° N. This plateau rises, in places, over 500 m above sea level and forms the dominant feature of the major part of the western desert in Egypt. To the northeast of Bahariya, the plateau rises and forms Gebel Qatrani. While, to the northwest, this plateau slopes gradually towards Siwa and the great Qattara Depression where the ground descends below sea level (lowest site: 142 m). The site is characterized by its flat nature with the western side of the Area 1 bordered by a belt of sand dunes.

#### 2.1.1.1 Climate

According to Ayyad and Ghabbour (1986) with some modification: according to the system applied in the UNESCO map of the world distribution of arid regions (UNESCO, 1979), Area 1 is included in the hyperarid province which includes all the area between Lat. 22° and 30° N. The rain in this province is less than 30 mm/year and is occasional and unpredictable.

In the Western desert oasis the range of annual temperature variation ranges from a mean minimum of 4°C in the coldest months (Dec.-Feb.) to a mean maximum of 38°C in the hottest months (Jun.-Aug.)

#### 2.1.1.2 Meteorological Conditions of the Area

The closest weather station to Area 1 is North Qarun and Bahariya. The following data is compiled from Egyptian Meteorology Authority and summarized as follows:

2.1.1.2.1 Temperature

| Jan. | Feb. | Mar. | Apr. | May | June. | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12.99 | 12.21 | 14.75 | 18.67 | 24.70 | 26.66 | 28.20 | 28.39 | 27.38 | 21.92 | 18.63 | 13.24 |

**Table 2.1 Air Temperature**

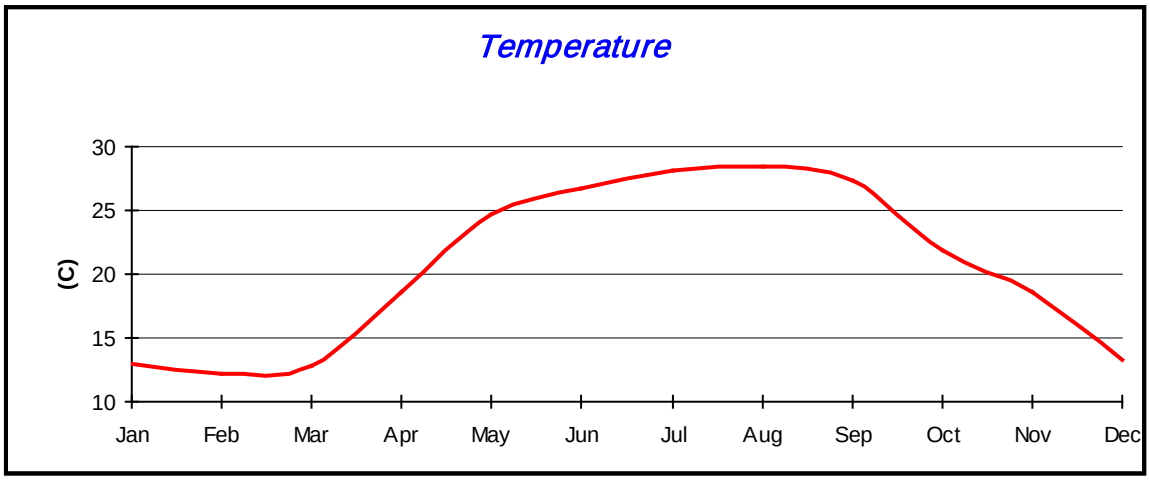



**Figure 2.1 Air Temperature Distributaries allover the Year**

2.1.1.2.2 Air Pressure

| Jan. | Feb. | Mar. | Apr. | May | June. | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1020.9 | 1019.1 | 1017.5 | 1017.1 | 1014.6 | 1014.2 | 1011.8 | 1012.2 | 1015.2 | 1019.3 | 1020.1 | 1022.2 |

**Table 2.2 Air Pressure**

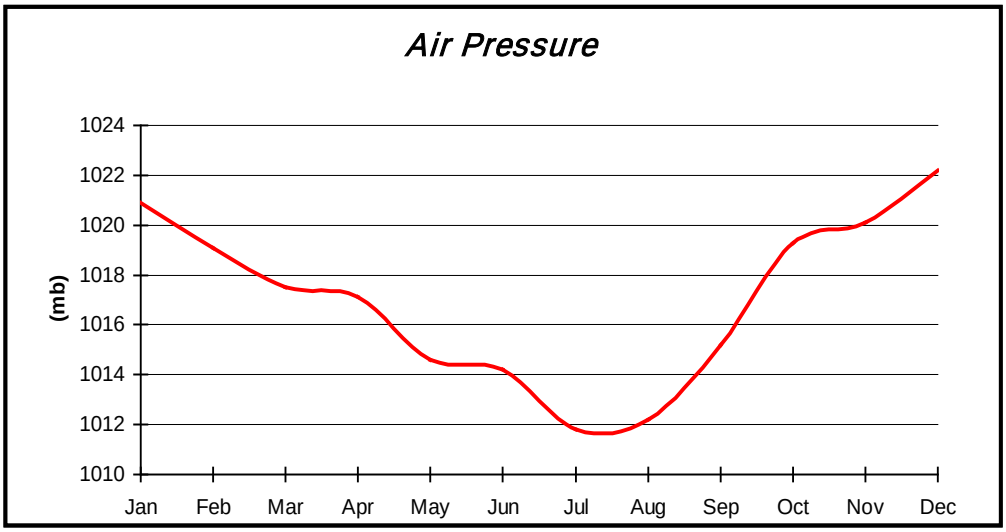



Figure 2.2 Air Pressure Curve

2.1.1.2.3 Wind Speed

| Jan. | Feb. | Mar. | Apr. | May | June. | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **2.60** | **3.99** | **3.59** | **4.64** | **4.82** | **5.40** | **4.69** | **5.31** | **4.78** | **4.88** | **4.99** | **2.11** |

**Table 2.3 Wind Speed**

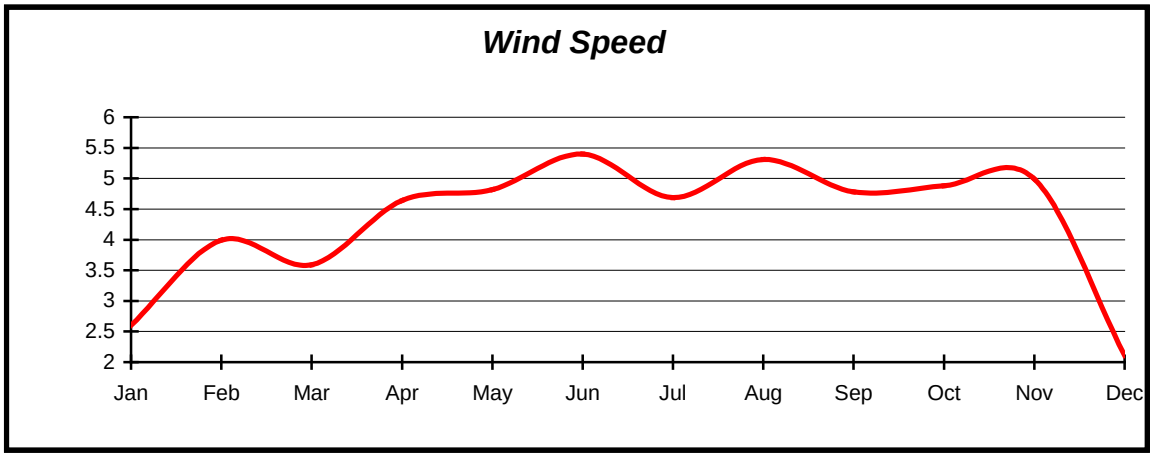



**Figure 2.3 Wind Speed**

2.1.1.2.4 Relative Humidity

| Jan. | Feb. | Mar. | Apr. | May | June. | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **56.22** | **48.35** | **48.06** | **40.31** | **38.23** | **36.82** | **40.34** | **43.19** | **45.36** | **47.79** | **57.66** | **55.11** |

**Table 2.4 Relative Humidity**

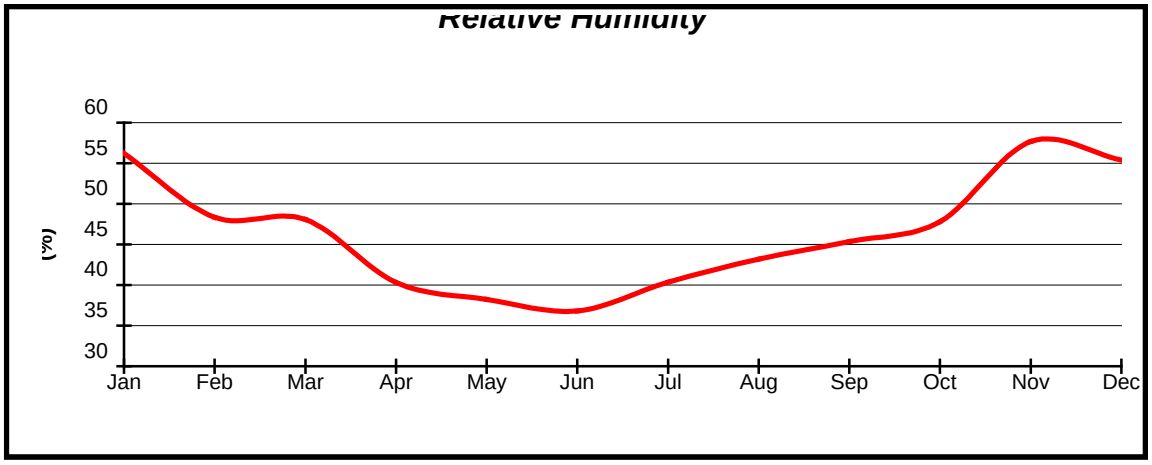



**Figure 2.4 Relative Humidity**

2.1.1.2.5 Evaporation

**Table 2.5 Evaporation**

| Jan. | Feb. | Mar. | Apr. | May | June. | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.78 | 5.03 | 5.91 | 12.66 | 20.37 | 25.35 | 23.60 | 25.67 | 20.25 | 14.67 | 9.60 | 3.18 |

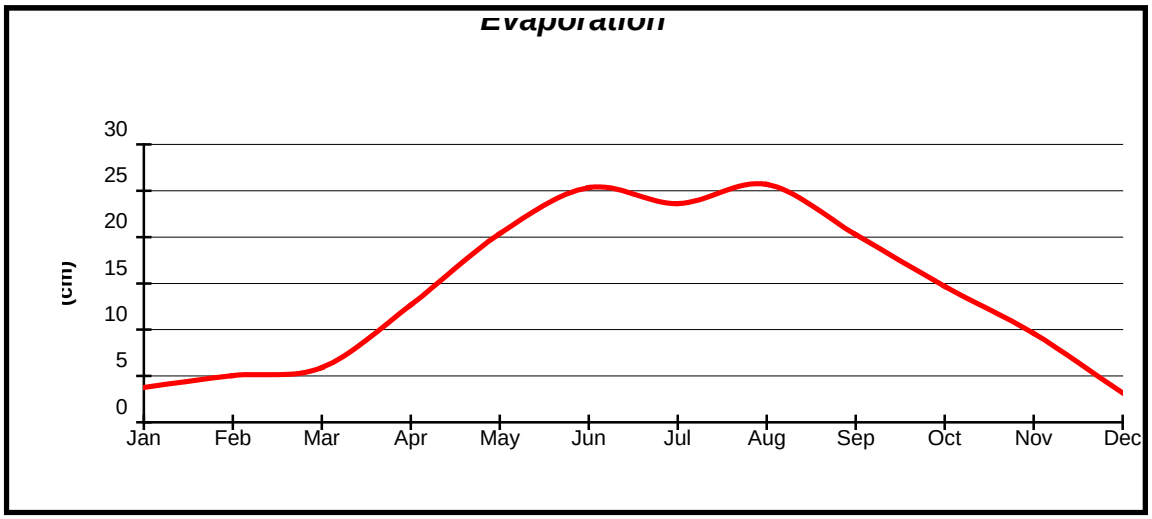



**Figure 2.5 Evaporation Rate**

### 2.1.1.3 Ground Water

The Western desert is divided into 3 principle sections: the southern section of Nubia sandstone plateau, the middle section of limestone plateau and the Miocene northern plateau. The Karama oasis is located within the middle limestone plateau. Abu Al-Izz (1971) reported that the oasis depressions of this plateau including Bahariya depend on ground water resources from Nubia sandstone aquifers. He added that the Western desert is generally conceived as a barren plain with an apparently internal drainage system. In the Southern Nubia sandstone, water layers are relatively shallow (60--100 m).

## 2.1.2 Survey of the topography and soil analysis

Area 1 site is characterized with its flat nature with some slight elevations. The western side of the area is limited by a belt of sand dunes. The surface soil is covered with gravel sand to sand. Numerous patches of silicified wood is scattered in the area.

### 2.1.2.1. Loss on Ignition

Loss on ignition data shows relatively low content of organic matter (Table 2.6).

**Table (2.6) Heat Treatment Results**

| SAMPLE LOCATION | Moisture as (%) | Loss on ignition as (%) | Ash (%) |
|---|---|---|---|
| Area 1 | **0.87** | **1.65** | **97.48** |

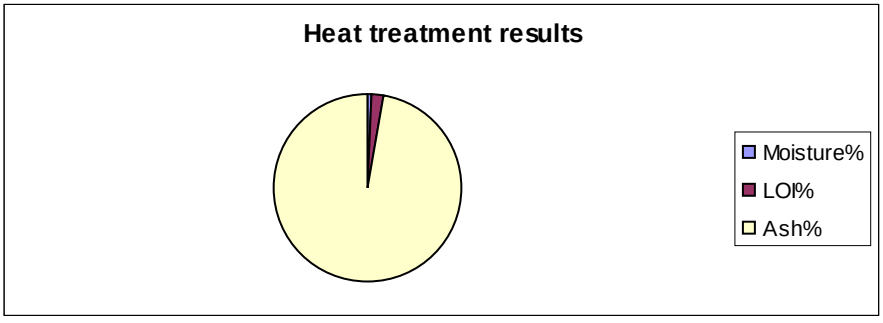



**Figure 2.6**
**Heat Treatment Results**

### 2.1.2.2. Grain Size Analysis

The sample from the area site showed unimodal distribution of grain size indicating moderate to high sorted sediment.

| Sieve No | Sieve Open (mm) | Passing% |
|---|---|---|
| 1 " | 25 | 100 |
| 3\4 | 19 | 87 |
| 1\2 | 12.5 | 85 |
| 3\8 | 9.5 | 82 |
| No 4 | 4.75 | 74 |
| 10 | 2 | 70 |
| 20 | 0.85 | 68 |
| 40 | 0.475 | 64 |
| 60 | 0.25 | 23 |
| 100 | 0.15 | 19 |
| 200 | 0.074 | 14 |

**Table (2.7) Percentage of Size Fractions**

| Visual & manual description | | Grain size parameters of soil | |
|---|---|---|---|
| Location | Area 1 | A S T M Classification | SM |
| Colour | Light brown | Uniformity coefficient ( C u ) | NA |
| Structure | Slightly cemented | Effective diameter in ( mm ) | NA |
| Name | Calcareous gravelly fine sand contains some silt | Uniformity curvature ( C z ) | NA |

**Table (2.8) Classification of Soil Sample**

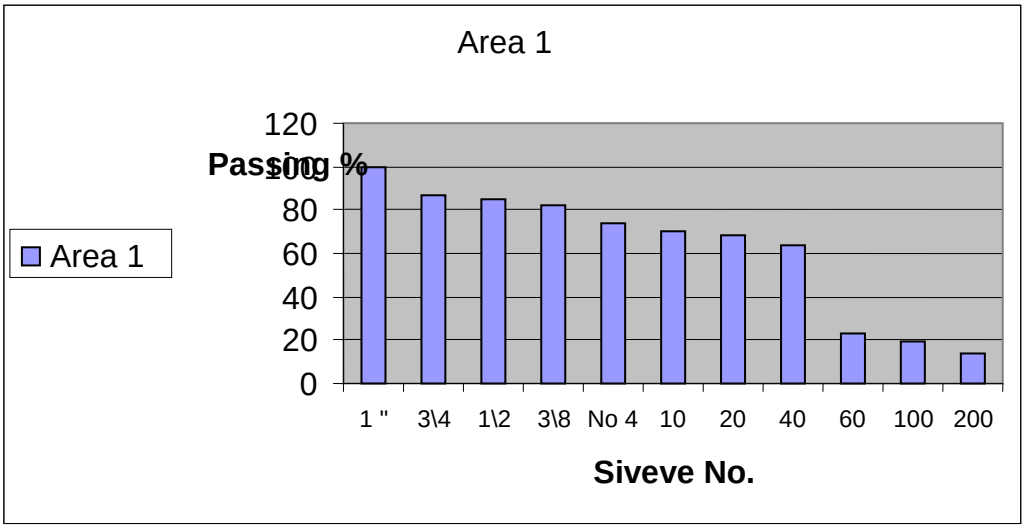


**Figure (2.7) Histogram Showing the Grain Size Distributions of Soil Sample**

## 2.1.2.3 SOIL CHEMICAL ANALYSIS

**Location: Area 1**

**I. SAMPLE DESCRIPTION :**

Colour : Light brown

Texture : Slightly cemented

Name : Calcareous gravelly fine sand contains some silt

**II. CHEMICAL ANALYSIS :**

| NO. | Chemical compound calculated as milligram me equivalent (m. equiv. ) | | Molecular formula | Result |
|---|---|---|---|---|
| 1 | Calcium | Cations | $Ca^{++}$ | 28.1 |
| 2 | Magnesium | | $Mg^{++}$ | 13.6 |
| 3 | Sodium | | $Na^{+}$ | 5.2 |
| 4 | Potassium | | $K^{+}$ | 1.7 |
| 5 | Carbonates | Anions | $CO_3^{--}$ | 1.50 |
| 6 | Bicarbonates | | $HCO_3^{-}$ | 5.65 |
| 7 | Sulphates | | $SO_4^{--}$ | 16.86 |
| 8 | Chlorides | | $Cl^{-}$ | 24.69 |
| 9 | Total mineral soluble salts as ppm | | Ionized salts | 2994 |
| 10 | p H value | | $\text{Log } \frac{1}{(H^{+})}$ | 7.4 |
| 11 | Conductivity at 25 $^{o}$ C on m. hos / cm | | E C | 4.40 |

**III. GENERAL NOTES :**

**1 :2 ratio soil sample : water extract was used in chemical analysis**

**Table 2.9 Chemical Soil Analysis**

### 2.1.3 Flora & Fauna

The fragile and unique ecosystems of the oasis are relatively far from the concession under investigation. The nearest inhabited oasis to the Apache concessions is Karama which is typically made of a number of settlements based on artesian springs or wells. The area of the concessions is generally poor in plant and animal life. The plant life is essentially ephemeral and depends on the chance occasion of cloud burst incidents that may happen once in several years (accidental type of vegetation) (Kass, 1966). A most noticeable and an important biotopographic unit for animals in this habitat type are the phytogenic mounds. These mounds which are usually formed around Nitraria retusa, Calligonum comosum or Tamarix sp. add greatly to the structural diversity of this habitat, thus creating more niches for animals including birds (Saleh et al., 1988). In different sites, around and close to the phytogenic mounds, some tracks of geckos and lizards were observed. There were also some excreta of medium sized mammal (probably wolf or fox). It is worthy to mention that the vicinity of Area 1 is considered as accidental habitats which occasionally have rich areas of ephermal pasture which are exploited by the wide ranging slender-horned Gazelle Gazalla leptoceros leptoceros (Saleh, 1993). The nature of the area as accidental habitat, because of lack of rainfall, is limiting the structural diversity of vegetation and also the vertebrate fauna. Therefore, the following table shows the vertebrate fauna that are likely to be supported in this habitat.

**Table (2.10): Vertebrate Fauna**

| Latin name of species | English name |
|---|---|
| **Geckos:** | |
| Stenodactylus stenodactylus stenodactylus | Elegant Gecko |
| **Lizards:** | |
| Acanthodactylus boskianus | Bosc's lizard |
| Acanthodactylus scutellatus scutellatus | Nidua lizard |
| Mesalina rubropunctata | Red spotted lizard |
| **Snakes:** | |
| Malpolon moilensis | Moila snake |
| Spalerosophis diadema cliffordi | Clifford's snake |
| Cerastes cerastes | Horned viper |
| Echis carinatus | Saw-scaled viper |

| | |
|---|---|
| **Rodents:** | Jird |
| Meriones libycus libycus | Egyptian fat-tailed Jird |
| Pachyuromys duprasi natronensis | |
| **Carnivores:** | Jackal or wolf |
| Canis aureus | Fox |
| Vulpes sp. | |

(Compiled from Saleh, 1997)

Except for the first gecko, the status of all these reptiles is Lower risk (least concern), which means that the taxa do not qualify for Conservation Dependent or Near Threatened.

*From the snakes found in the concession, two species are very dangerous. Antidotes should be available in case of emergency.*

### 2.1.4 Socio-Economic Features

Area 1, as mentioned, is located within the Western Desert in a hyper-arid area. The area is almost desert. High temperature, rare rainfall, extreme drought and lack of vegetation cover are the dominant characteristic conditions of this area. There is no population in this area. No Bedouins were observed, probably because of the lack of vegetation. Generally, the inhabitants of the Western Desert, Eastern Desert and Sinai Peninsula represent only 1.2% of the total population in Egypt with a rate of 1 person / 6 kilometers. Oil and gas activities usually attract labor to this area and consequently would offer jobs to many residents.

#### *Medical Services*

The nearest residential spot is 6th of October City, which is located before the East Bahariya site by about 140 kilometers. The Apache Base is well equipped and accommodated for human needs, and located a few kilometers from the site. Accordingly, good dependable medical services or first aid facilities are available in the area. Basic medical services are present ready to respond to any unexpected injuries to the workers.

***Archeology***

The concession has no archeological features and the surrounding area has no history of archeological services. However, if any evidence appears activities will be stopped and immediate notification will be made to the appropriate authorities (e.g. Archeology Authorities).

***Inter-Agency & Public Involvement***

Normal involvement such as obtaining acceptance of EGPC, EEAA, Local Governorate, and Ministry of Defense will be conducted as appropriate.

## 2.2 AREA 2

This area is representative of the conditions associated with the Wadi El-Rayan, Qarun and WD 19 concessions and lies in the Fayoum Governorate which is a natural Depression. The area of the Depression is about 12,000 $km^2$ surrounded by desert uplands. The climate is typically arid (low rainfall and bright sunshine throughout the year). However, the Depression is a very productive region agriculturally because of the use of Nile water. The Depression also contains a considerable area of surface water (Qarun Lake-saline- and Wadi El-Rayan Lakes-freshwater). The lakes cover an area of about 400 $km^2$.

### 2.2.1 Geology, Geomorphology and soil Analysis:

Fayoum Depression is 2-10 million years old and was formed by the action of the arid climate and strong winds on the predominantly fluvio-marine sediments that comprise the geology of the area. Soils of Fayoum Depression consist of heavy to light clays derived from Nile flood alluvium. Sandy patches occur towards the edges of the depression. On the upper slopes, the soils are well-drained, slightly saline clays while the lower basin soils are poorly drained and hence highly saline. The soil of the surrounding desert differs to those in the Depression and range from non-arable sands and gravels, commonly with high gypsum content, to deep loam sands.

### 2.2.1.1 Geological History

Geology and geological history, like climate, are basic building blocks of the environment of the area. In fact, the character of the rock types has directed the genesis of the present day landscape. Specific details of Fayoum's and Beni Suef's geological history are discussed below. With the coming and going of ancient seas and associated shifting coastlines, the marine sedimentary landscape has been built up over a period stretching from the late Cretaceous to the late Pliocene (70 to 2 million years ago). Through alternations of periods of uplift (and erosion) and with depositions, the landscape of the area began to evolve.

Land exposure from late Eocene to late Oligocene (40 to 30 million years ago) allowed the ancient “Libyan River” to begin eroding the thick Eocene sediments, and laid down some of Egypt’s most valuable fossil deposits of early mammal, primate, reptile and fish species. The late Miocene, through Pliocene, (10 to 1.8 million years ago) saw the coastline come and go, as well as the formation of the ancient Nile valley, and possibly the initiation of the Fayoum depression.

From Pleistocene to Holocene (1.8 million years to present) the Fayoum depression and Beni Suef were being formed. The beginning of the present arid climate (8000 B. C. onwards) and subsequent wind erosion carved out the then desert depression. Later, during the Pleistocene, the basin subsided relative to the Nile valley. Subsequent Nile floods allowed deposition of the present alluvial fan of sediments, and initiated the ancient Lake Qarun. By late Pleistocene the present day basin was formed and inhabited. The Neolithic (late stone age) peoples lived around the lake, that showed fluctuating levels between +5 and +18 m (asl) due to the annual inflow of Nile floodwaters. Geologically speaking, the formation of the Fayoum depression was made possible since thick bands of sandy and clay material were breaking up the continuous hard layer of Middle Eocene limestone. As a consequence of harder rock strata overlying the softer strata, the boundaries of the depression are often dramatically marked by escarpments and gebels. To the north and northwest the Gebel El Qatrani escarpment rises, with its highest point at

Gebel El-Qatrani 340 m (asl); this is the southern limit of an undulating desert plateau, stretching with little change in character to the Mediterranean Sea. To the south is an irregular cliff line, forming the boundary of Wadi El-Rayan and Wadi Muwellih; the vertical escarpment rises up to 184 m (asl) at Minqar El-Rayan. Beyond this cliff-line lies an almost unbroken limestone plateau, rising gradually to the south. To the southwest of the Fayoum, the floor of the depression merges with the desert plateau beyond.

The Wadi El-Rayan sub-depression is separated from the Fayoum to the north by a limestone ridge +34 to +60 m (asl). Its area is some 15 km wide, is largely enclosed within the +20 m contour, and has an average elevation of -43 m (asl). Its maximum depth falls to - 64 m (asl). Since the opening of the drainage water tunnel from the Fayoum depression in 1973, the lower areas of the Wadi El-Rayan depression have been progressively covered by two lakes. The first lake (Rayan I Lake) reached its maximum level -5 m (asl) in 1978, and covers the Wadi El Masakheet depression. From there the water flows through a (presently) shallow swampy area (-10 m asl) known as Rayan II Lake, from which it overflows and runs into the second and lowest depression, called Rayan III Lake. This lake is still in the process of filling. According to Wilson and Saleh (1991), the lake will be allowed to reach an elevation of -13 m (asl) before drainage water inflow will be reduced to balance with evaporation levels. The present elevation is estimated at -20 to -25 m (asl). Southwest and southeast of the lower Rayan lake are two smaller, shallower, depressions: Wadi Muwellih (20 to 50 m asl), and Oyun El-Rayan (0 to 25 m asl). The latter one lies below Minqar El Raiyn, and supports three natural springs; it is separated from El-Rayan depression by dune fields and rock terraces (up to 50 m asl). The dune fields separating all three basins are extensive, and consist mostly of Seif (longitudinal) dunes, varying from several hundred meters to 30 km in length and up to 30 m in height.

### 2.2.2 Fossiliferous Sites

The sediments of Fayoum depression range in age from the late Cretaceous (70 million years ago) to Pliocene (2 mya). Lake Qarun, Qasr El-Sagha and Gebel Qatrani formation deposited during the late Eocene (40 mya) to late

Oligocene (30 mya) contain a wide range of fossil deposits of early mammals, primates, reptiles and fishes. These represent some of the richest fossil deposits in Egypt and their discovery was of international importance.

### 2.2.3 Surface water quality

Lake Qarun is located about 100 km to the south-West of Cairo. It is a closed inland basin of 40 km in length and a mean width of 5.7 km. The lake area is about 255 km2. Maximum water depth is 12 m while the mean depth is 4.2 m. The level of the lake was rising and flooding the neighboring agricultural lands due to the feed of fresh water from two main drains, El-Bats and El-wadi. Since the mid seventies, 80% of the water of El-Wadi Drain was directed to Wadi El-Rayan Depression. Cutting off the input of the freshwater of El-Wadi Drain aggravated the old problem of increasing salinity in the lake (since 1901). Therefore, salinity of the Lake Qarun is now reaching 44 ppt in some regions.

### 2.2.4 Ground water

The known ground aquifers in Fayoum are contained in Pleistocene and Eocene limestones and are largely saline.

The Fayoum basin is embedded in Eocene limestone and marls; the only breach in the surrounding limestone allowing an inflow of ground water is that through the Hawara gap. A semi-confined Pleistocene groundwater aquifer connects to the Nile valley through the gap. An estimated amount of 70 l/sec of groundwater flows into Fayoum which can be considered a negligible source of basin water recharge if compared to the average irrigation water supplies of 72 m3/sec. The Oyun El-Rayan springs of the Wadi El-Rayan basin are reputed to originate from the Nubian sandstone aquifer, but since they yield brackish water (soluble salts, 2,620 - 4,700 ppm), at low flow rates (1.6, 4.8 and 14.4 l/min), they do not represent a substantial resource, but are considered as a life support source to the wildlife existing in the region. The Oyun El-Rayan was declared a natural park in 1982.

The Bahariya Oasis, which is found to the west of [Area 2]the concession, contains several wells tapping the Nubian sandstone.

### 2.2.5 Soil Analysis

**I. SAMPLE DESCRIPTION :**

**Colour :** **Very light brown**
**Texture :** **Fragments**
**Name :** **Calcareous sandy gravel ( limestone fragments ) contains some silt**

**II. CHEMICAL ANALYSIS :**

| SNO | Chemical compound calculated as milligramme equivalent ( m. equ. ) | | Molecular formula | Result |
|---|---|---|---|---|
| 1 | Calcium | Cations | $Ca^{++}$ | 32.6 |
| 2 | Magnesium | | $Mg^{++}$ | 17.5 |
| 3 | Sodium | | $Na^{+}$ | 10.9 |
| 4 | Potassium | | $K^{+}$ | 3.6 |
| 5 | Carbonates | Anions | $CO_3^{--}$ | 1.13 |
| 6 | Bicarbonates | | $HCO_3^{-}$ | 5.26 |
| 7 | Sulphates | | $SO_4^{--}$ | 29.98 |
| 8 | Chlorides | | $Cl^{-}$ | 28.33 |
| 9 | Total mineral soluble salts as ppm | | Ionised salts | 4060 |
| 10 | p H value | | $\text{Log } \frac{1}{(H^{+})}$ | 7.5 |
| 11 | Conductivity at 25 $^{o}$ C on m. hos / cm | | E C | 5.97 |

**II. GENERAL NOTES :**

**1 : 2 ratio soil sample : water extract was used in chemical analysis**

**Table 2.1 Chemical Soil Analysis**

### 2.2.5.1 Heat Treatment Results of Soil Sample

| SAMPLE LOCATION | Moisture as % | Loss on ignition as % | Ash % |
|---|---|---|---|
| Area 2 | 1.04 | 1.87 | 97.09 |

**Table 4.2 Heat Treatment Results of Soil Sample**

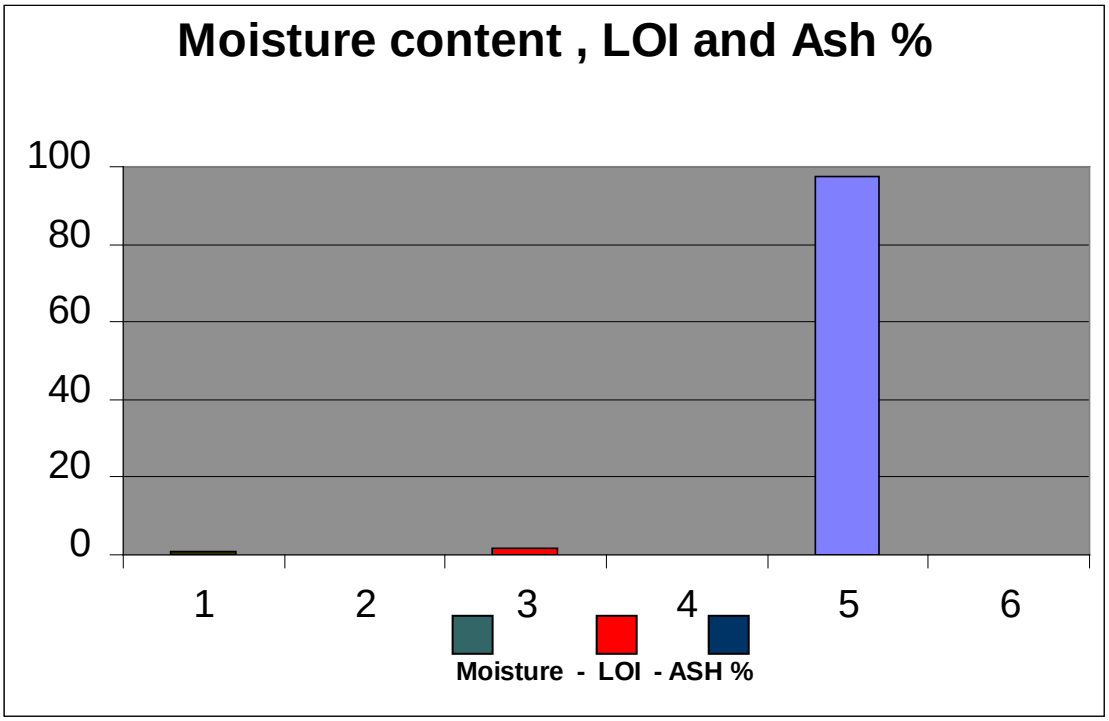



**Figure 2.8 Block Diagram showing Relative distribution of Moisture LOI & Ash Contents of Soil Sample**

### 2.2.5.2 Grain Size Analysis

| Sieve No | Sieve Open (mm) | Passing% |
|---|---|---|
| 1 " | 25 | 77 |
| 3\4 | 19 | 64 |
| 1\2 | 12.5 | 64 |
| 3\8 | 9.5 | 60 |
| 4 | 4.75 | 39 |
| 10 | 2 | 33 |
| 20 | 0.85 | 30 |
| 40 | 0.475 | 28 |
| 60 | 0.25 | 22 |
| 100 | 0.15 | 16 |
| 200 | 0.074 | 13 |

**Table 4.3: Percentage of Size Fractions**

| Visual & manual description | | Grain size parameters of soil | |
|---|---|---|---|
| Location | Area 2 | A S T M Classification | GM |
| Colour | Very Light brown | Uniformity coefficient ( C u ) | NA |
| Structure | Fragments | Effective diameter in ( mm ) | NA |
| Name | Calcareous sandy gravel (limestone fragments) contains some silt | Uniformity curvature ( C z ) | NA |

**Table 4.4 Classification of Soil Sample**

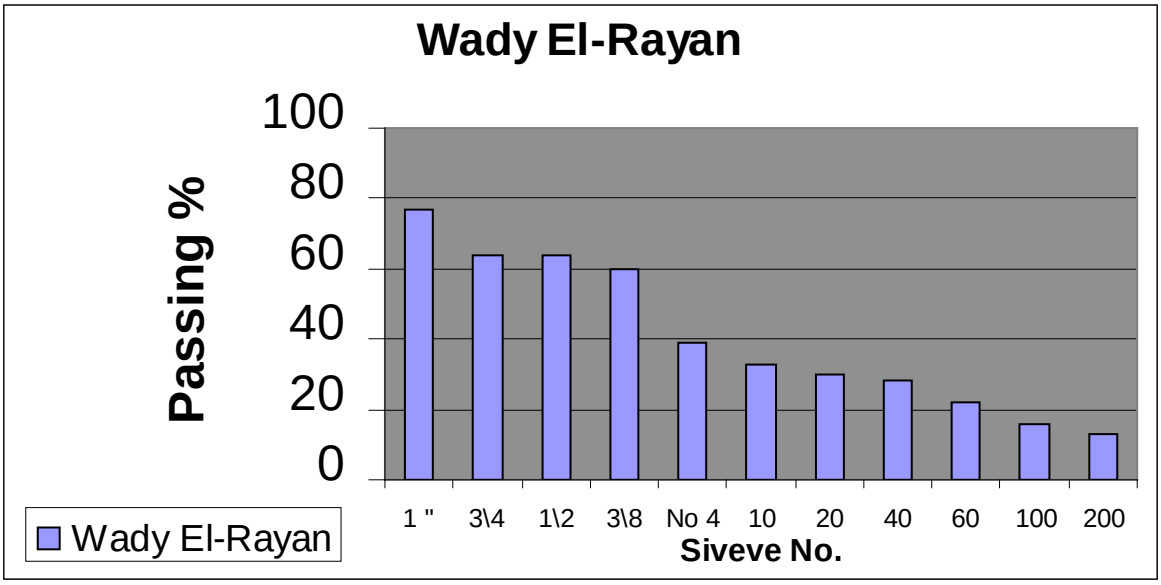



**Figure 2.9 Histogram Showing the Grain Size Distributions of Sample**

### 2.2.3 Meteorological Data

The area under consideration is located in a hot and dry environment with scanty winter rain and bright sunshine throughout the year. Its climate is a typical Saharan hyper-arid system with cold winter and hot summer. The climate of the region has a big influence on the fauna and flora existing in the region.

***Refer to Section 2.1 as the parameters are the same.***

### 2.2.4 Biological Environment

The biological characteristics of Area 2 may be considered highly variable as it belongs to three distinct ecosystems, namely the desert ecosystem, the agricultural ecosystem and the freshwater ecosystem.

#### 2.2.4.1 FLORA

Flora, with links to soil and land supports animal and human life, should be discussed.

Flora within Area 2 simply can be divided into:

a) Desert flora

b) Flora of the cultivated lands

**Desert Flora**

Beyond the reach of the system of irrigation canals, the borders of the fertile alluvial soils and the boundaries of man's farming activities, is where the Western Desert begins.

The upland desert areas to the north and north east of Fayoum, are predominantly rocky areas and eroded pavement that appear to carry no vegetation. Close observation, however, reveals that some vegetation does exist along the courses of the shallow wadis (flood channels). No detailed seasonal variation of the vegetation cover are available for these areas, but species identification and description are found for the desert areas of Fayoum, where the greatest part of Area 2 occurs, in the Flora of Egypt, from which the following table was adopted.

**Table (4.5) Listed Plant Species of the Desert Areas of Fayoum**

| **Family/Species** | **Family/Species** |
|---|---|
| Family Cruciferae<br>*Forsskalea tenacissima* | Family Urticacea<br>*Eremobium aegyptiacum*<br>*Farsetia aegyptia*<br>*Zilla spinosa* |
| Family Polygonacea<br>*Calligonum comosum* | Family Leguminosae<br>*Alhagi marorum*<br>*Trigonella laciniata* |
| Family Aizoaceae<br>*Mesembryanthenum forsskalei*<br>*Aizoon canariense*<br>*Aizoon hispanicum* | Family Zygophyllaceae<br>*Zygophyllum simplex*<br>*Zygophyllum album* |
| Family Caiyophyllaccae<br>*Spergularia diandra*<br>*Spergula fallax*<br>*Robbairea delileana* | Family Nitrariaceae<br>*Nitraria retusa* |
| Family Cehnopodiacea<br>*Bassia muricata*<br>*Salicornia herbacea*<br>*Salsola baryosma*<br>*Comulaca monacantha* | Family Tamaricaceae<br>*Tamarix aphylla (articulate)*<br>*T. passerinoides*<br>*T. passerinoides* |
| Family Solanaceae<br>*Hyoscyamus muticus* | Family Gramineae<br>*Cutandia memphitica*<br>*Aeluropus lagopoides* |
| Family ComDositae | Schismus barbatus |
| *Echinops spinosissimus*<br>*Francoeuria crispa*<br>*Cotula cinerea*<br>*Launaea capitala* | *Sporobolus spicatus*<br>*Stipagrostsis ciliate*<br>*Stipagrostis lanata*<br>*Cynodon dactylon*<br>*Panicum turgidum* |

Source: Tackholm(1974)/Tackholm and Drar 1973

Firm data on the desert flora of Wadi El-Rayan were gathered and published by Saleh et.al. in 1988 ("Development and Conservation of Wadi El-Rayan" study of the Foreign Relations Coordination Unit (FRCU) of the Egyptian Supreme Council of Universities). These survey data concerned the perennial plant species of the Oyun El-Rayan area; they are listed in Table 3. The vegetation was restricted around the springs, interdune areas and bases of large dunes, and comprised four main associations:

- the *Alhagi maurorum* community in the low lying interdune areas;

- the *Desmostachya bipinnata* community in the flat or gently undulating interdune areas,
- the *Tamarix - Nitraria - Calligonum* community, widely scattered on sandy hillocks over a large area of interdunes; and
- the salt marsh community in, or immediately surrounding pools of the springs.

**Table (4.6) Plants of the Area 2 Study Area.**

| Species | Dunes | Inter-dunes | Springs |
|---|---|---|---|
| **Trees/Shrubs** | | | |
| *Tamarix nilotica* | | + | + |
| *Nitraria retusa* | | ++ | |
| *Phoenix dactylifera* | ++ | | |
| **Sub-Shrubs** | | | |
| *Zygophyllum album* | + | ++ | |
| *Callogonum comosum* | | + | |
| *Alhagi maurorum* | | ++ | |
| **Sedges/Grasses** | | | |
| *Juncus rigidus* | | | ++ |
| *Cyperus laevigatus* | | | ++ |
| *Desmostachya bipinnata* | | ++ | |
| *Sporobolus spicatus* | ++ | | + |
| *Imperata cylindrical* | ++ | | + |
| *Phragmites australis* | | | |
| *Typha domingnesis* | | | ++ |

+ + = preferred area  + = other areas  Source: Saleh et.al. (1988).

Flora of the Cultivated Lands:

Systematic botanical survey data are also missing for the flora of the cultivated lands, but the assumption may be made that this flora is largely introduced as a result of man's activities, and equivalent to that of the adjacent areas of the Nile valley. An exception is some patches of saline marsh adjacent to Lake Qarun, where the vegetation can still be considered natural. A review of the Flora's of Egypt (Tackholm, 1974; Tackholm and Drar, 1973. and Boulos and Hadidi, 1967), lead to compilation of a list of plant species that are reported to occur in the Fayoum, with a classification in plants

of cultivated lands, plants of waste lands and roadsides, plants along the verges of canals and drains, and plants of marshy lands.

**Table (4.7) Flora of the Cultivated Land**

| **Family**/*species* | **L** | **W** | **C** | **M** | **Family**/*species* | **L** | **W** | **C** | **M** |
|---|---|---|---|---|---|---|---|---|---|
| **Family Amaranthaceae** | | | | | **Family Cyperaceae** | | | | |
| *Alternanthera sessilis* | + | | + | | *Cyperus alopecuroides* | + | | + | + |
| *Amaranthus graccizans* | + | + | | | *C. articulatus* | | | + | + |
| *A. hybridus* | + | + | | | *C. difformis* | + | | + | |
| *A. lividus* | + | + | | | *C. lacvigatus* | | | + | + |
| | | | | | *C. rotundus* | + | | | + |
| **Family Asclepiadaceae** | | | | | *Scirptis tuberosus* | + | | + | + |
| *Oxystelma alpine* | | | + | | | | | | |
| | | | | | **Family Euphorbia** | | | | |
| **Family Boraginaceae** | | | | | *Euphorbia arguta* | + | | | |
| *Heliotropium europaeum* | + | + | | | *E. forsskalii* | + | + | | |
| *H. supinurn* | | | + | | *E. geniculata* | + | + | | |
| | | | | | *E. granulata* | + | | | |
| **Family Caryophyllacea** | | | | | *E. helioscopia* | + | | | |
| *Silene conoidea* | + | | | | *E. peplis* | + | | | |
| *S. nocturna* | + | | | | | | | | |
| *S. rubella* | + | | + | | **Family Gramineae** | | | | |
| *Spergularia marina* | | | | + | *Agrostis viridis* | + | | + | |
| *Stellaria pallida* | + | | | | *Avena sp* | + | | | |
| *Vaccaria pyramidata* | + | | | | *Brachiaria eruciformis* | + | | | |
| | | | | | *Bromus wildenowii* | + | + | | |
| **Family Chenopodiaceae** | | | | | *Cynodon dactylon* | + | + | + | |
| *Beta vulgaris* | + | + | | | *Dactyloctenium aegyptium* | + | + | | + |
| *Chenopodium album* | + | + | | | *Desmostachya bipinnata* | | + | + | |
| *C. ambrosioides* | | | | + | *Digitaria sanguinalis* | + | + | | |
| | | | | | *Dinebra retroflexa* | + | | | |
| **Family Compositae** | | | | | *Echinochloa colonum* | + | | + | |
| *Ageraturm conyzoides* | | | + | | *E. crus-galli* | + | | + | |
| *Ambrosia maritime* | | | + | + | *Eleusine indica* | + | | | |
| *Anthemis pseudocotula* | + | + | | | *Imperata cylindrica* | + | + | + | |
| **Family Compositae (cont)** | | | | | **Family Gramineae (cont.)** | | | | |
| *Aster squamatus* | + | + | + | | *Lolium sp.* | + | | + | |
| *Calendula arvensis* | + | + | | | *Lolium temulentum* | + | | | |
| *Chamomilla recutila* | + | + | | | *Panicum repens* | + | | + | |
| *Cichorium endivia* | + | + | | | *Papspalidium geminatum* | | | + | + |
| *Conyza aegyptiaca* | + | + | | | *Paspalum paspaloides* | + | | + | + |
| *Erigeron bonariensis* | | + | | + | *Phalaris minor* | + | + | | |
| *Eclipta prostrata* | | + | + | + | *Poa annua* | + | | + | + |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Lactuca serriola* | | + | | | *Setaria glauca* | + | + | + | |
| *Senecio aegyptius* | + | | | | *S. verticillata* | + | | + | |
| *S. flavus* | + | + | + | | *S. viridis* | + | | | |
| *Silybuin mariarum* | | + | | + | *Phragmites australis* | | + | + | + |
| *Sonchus sp.* | + | + | + | | *Sorghum virgatum* | + | | + | |
| *Xanthium sp.* | + | | + | + | | | | | |
| | | | | | Family Juncacaceae | | | | |
| Family Convolvulaceae | | | | | *Juncus rigidus* | | | + | + |
| *Convolvulus arvensis* | + | + | | | *J. acutus* | | | | + |
| *Cuscuta arabica* | + | | | | | | | | |
| | | | | | Family Labiatae | | | | |
| Family Cruciferae | | | | | *Mentha longifolia* | + | | + | |
| *Brassica nigra* | + | | | | | | | | |
| *Capsella bursa-pastoris* | + | + | | | Family Leguminosae | | | | |
| *Coronopus niloticus* | | | | + | *Alhagi maurorum* | | + | + | + |
| *Lepidium sativum* | + | + | | | *Lathyrus hirsutus* | + | | | |
| *Sisymbrium irio* | + | + | + | | *Lotus arabicus* | + | | + | |
| *Medicago polymorpha* | + | + | + | | | | | | |
| *Melilotus indicia* | + | + | + | | Family Poligonaceae | | | | |
| *Trifolium resupinatum* | + | | + | | *Emex spinosus* | + | + | + | |
| *Trigonella hamosa* | + | | + | | *Polygonum salicifolium* | | | + | |
| *Vicia monantha* | + | | | | *P. senegalense* | | | + | |
| | | | | | *Rumex dentatus* | + | | + | + |
| Family Malvaceae | | | | | | | | | |
| *Hibiscus trionum* | + | | + | | Family Portulacaceae | | | | |
| *Malva parviflora* | + | + | + | | *Portulaca oleracea* | + | + | | |
| | | | | | | | | | |
| Family Onagraceae | | | | | Family Primulaceae | | | | |
| *Jussiaea repens* | | + | + | + | *Anagallis arvensi* | + | | | |
| Family Orobanchaceae | | | | | Family Solanaceae | | | | |
| *Orobanche crenata* | + | | | | *Datura sp.* | + | + | | |
| *O. ramosa L* | + | + | | | *Solanum nigrum* | + | + | + | |
| *O. muteli v. spissa* | + | | | | | | | | |
| Family Oxalidaceae | | | | | Family Tiliaceae | | | | |
| *Oxalis corniculata* | + | | + | | Corchorus olitorius | + | + | | |
| | | | | | | | | | |
| Family Plantaginaceae | | | | | Family Umbelliferae | | | | |
| Plantago sp. | + | | + | + | Ammi majus | + | + | + | |
| | | | | | A. visnaga | + | | + | |
| | | | | | | | | | |
| | | | | | Family Utricaceae | | | | |
| | | | | | Utrica utens | | + | + | |

**L = cultivated lands; W = waste lands and road sides; C = verges of canals and drains; M = marshy lands.**

In general cultivated crops in Area 2 are oriented to the needs of the surrounding population and the Greater Cairo population. Vegetables (legumes), cotton, corn, sun-flower, palm dates, lime and lemon, etc. are major crops found in the cultivated part of the Area 2. In a few locations, near the water resources, rice and other crops that need large amounts of water are cultivated.

### 2.2.4.2 FAUNA

#### Zoogeographics

Of the seven main bio-geographic regions in the world, Egypt falls within the Palaearctic region, which ranges from the Atlantic coast of Europe to the Pacific coast of the Soviet Union, with its southern border being formed by the Sahara desert. The Fayoum - West Beni Suef fauna is also influenced by two other biographic regions, with representatives of the Oriental realm (e. g. pied kingfisher) and of the Ethiopian realm (e. g. gazelles and the wolf snake). In the past, during the warmer inter-glacial epochs, borders of the Ethiopian realm shifted to the north and true African species such as the wolf snake (*Lycophidium capensis*) could settle. To date, this species in Egypt is confined solely to the Fayoum area.

#### Mammals

Of the 170 land mammals recorded in Egypt, 27 are known in the Fayoum - West Beni Suef Area. The Flower's Shrew (endemic to Egypt) has not recently been recorded and is believed to have become locally extinct. The Dorcas Gazelle and the Slender Horned Gazelle are considered vulnerable species (IUCN, 1988). The occurrence of the latter species (*Gazella leptoceros*), discovered in 1984 at Oyun El Rayan, is of global conservation importance as it may well represent the only surviving population of this subspecies in the world (Saleh, 1987). This genuine desert species is thought to be restricted to the sand dune area southwest of the lower El Rayan lake; realistic estimates of population and distribution range are absent. The main factor for the ongoing decline in the populations of predators is considered to

be the large scale application of rodenticides. Other negative factors include the destruction, or deterioration, of habitats (marsh, treed areas), use of agro-chemicals, and hunting of the more common mammalian species, the rodents are well represented with 12 species recorded, including the extremely wide-spread pest species house mouse and field rat. Of the predators, the jackal is recorded throughout the Fayoum. Being often referred to as "wolf", it is severely hunted by farmers for its said raids on poultry, goats and sheep, although the species undoubtedly preys mainly on rodents and some fish from shallow depressions.

Mammal (and other animal) activities are concentrated in gardens, farmlands and vegetation along the Fayoum lakes. A relatively small number of animals frequent settlements of the vegetated desert. Only a few species are well adapted to the extreme conditions of the real desert. An example is the fennec fox that escapes the intense heat by its nocturnal behavior, obtains most of its water from its natural food, and whose feet show hair-growth that allows fast movement in loose sand. The same adaptations are found in the desert rodents, silky gird and lesser gerbil. The mongoose is probably the only wild mammal that is active during day time.

Chiroptera (bats) are well represented in Egypt but information on their occurrence in the area is scanty. Recorded species include the Egyptian fruit-bat (*Rousettus aegyptica*), larger rat-tailed bat (*Rhinopoma microphyllum*), lesser rat-tailed bat (*R. hardwicki*), the ban bat (*Nycteris thebaica*), and the very rare *Eptesicus innesi*. Representatives of the Vespertilionidae, or Typical Bats, include Kuhl's pipistrelle (*Pipistrellus kuhli*), *Eptesicus innesi*, and the gray long-eared bat (*Plecotus austriacus*).

**Table (4.8) Mammals usually found in the Area 2.**

| Scientific name | English name | status | Behaviour |
|---|---|---|---|
| *Hemiechinus auritus aegypticus* | Long eared hedgehog | C | D/N |
| *Crocidura flavescens deltae* | Giant musk shrew | C | D/N |
| *Crocidura floweri* | Flower's shrew | VR | D/N |
| *Lepus capensis rothschildi* | Hare | VR | N |
| *Gerbillus pyramidum pyramidum* | Greater gerbil | C | N |
| *Gerbillus andersoni andersoni* | Anderson's gerbil | R | N |
| *Gerbillus gerbillus gerbillus* | Lesser gerbil | C | N |
| *Dipodillus amoenus arnoenus* | Charming dipodil | C | D/N |
| *Meriones crassus perpallidus* | Silky jird | C | D/N |
| *Meriones libycus libycus* | Libyan jird | C | D/N |
| *Arvicanthis niloticus niloticus* | Field rat/Kusu | C | D/N |
| *Rattus rattus* | House rat | C | N |
| *Rattus norvegicus* | Brown rat | C | N |
| *Mus musculus praetextus* | House mouse | C | N |
| *Nesokia indica suilla* | Bandicoot rat | C | N |
| *Jaculus jaculius jaculus* | Lesser jerboa | R | N |
| *Canis aureus lupaster* | Jackal | R | N |
| *Vulpes vulpes aegyptiaca* | Nile fox | R | N/D |
| *Vulpes ruepeili ruepelli* | Rucpell's sand fox | R | N/D |
| *Fennecus zerda* | Fennec fox | R | N |
| *Mustela nivalis subpalmata* | Weasal | C | N |
| *Herpestes ichneumon ichneumon* | Egyptian mongoose | C | D |
| *Hyaena hyaena dubbah* | Stripped hyena | VR | N |
| *Felis chaus nilotica* | Jungle cat | C | D/N |
| *Felis sylvestris libya* | Wild cat | C | N |
| *Gazella leptoceros leptoceros* | Slender-horned gazelle | VR | D/N |
| *Gazella dorcas dorcas* | Dorcas gazelle | VR | D/N |

C = Common R = Rare VR = Very rare
D = Day N = Night

## Birds

The wetlands provide important habitat for passing and wintering migratory waterbirds; their most important feeding areas are the Wadi El- Rayan lakes, the shallow waters in the western and eastern ends of Lake Qarun, and along the entire northern shore of Lake Qarun. The southern shore of Lake Qarun is little used by the majority of the wintering species, due to human disturbance.

Exceptions are the fish and salt ponds of Abuksah bay, which are frequented by black-necked grebe, waders and gulls.

Common resident breeding species in cultivated areas are the spur-winged plover, crested lark, cattle egret and hoopoe. Other characteristic residents are little owl, black-shouldered kite, and Senegal coucal. A number of bird species have only recently invaded the area. They include some Afro-tropical species such as common bulbul and the avadavat, and also the blackbird which is now a common breeding resident in gardens. Characteristic species of the arid desert are hoopoe lark, cream-coloured courser, and the desert and mourning wheaters.

**Reptiles and Amphibians**

Egypt has thirty-three species of snakes, the majority of which also occur in the area. Common snakes include the diced water-snake ( *Natrix tessellate*), green flying snake (*Coluber rodorhachis*), flowered snake (*Coluber florulentis*), and egg-eating snake (*Dasypeltis scaber*). Other common reptiles and amphibians of the area include the common tortoise (*Testudo graecae*), skinks (*Chalcides ocellatus*, *Mabuya quinquetaemata* and *Scincus scincus*), gecko (*Hemidactylus turcicus*), cameleon (*Chamaeleo chamaeleon*), and toads (*Bufo regularis*, *B. viridis* and *B. vittalus*).

## 2.3 AREA 3

Area 3, which includes the Beni Suef Concession is located on the Eastern and Western sides of the Nile River; most of its terrain is a limestone plateau. However, the area of the blocks is covered with a layer of silt and clay. The eastern bank of the river is about 1.5 m above the present water level, while the western bank is about 4 m above it.

## 4.2 GEOLOGICAL FORMATION

It is obvious that the area under consideration has two geological characteristics. The Eastern Desert of Egypt is part of the cultivated land and

has been developed for urban uses. Generally, the Eastern Desert of Egypt consists essentially of a backbone of high and rugged igneous mountains running parallel to the Red Sea Coast. The mountains do not form a continuous range, but rather a series of mountain groups with some detached masses and peaks flanked to the north and west by intensively dissected sedimentary limestone plateaus. The study area is one of these formations. The formation of these limestone plateaus mainly Upper Eocene (Bartonian) and Middle Eocene (Lutetiam). The former includes a series of sands, clays and marly limestone, which are separated; more easily eroded and contain larger amounts of gypsiferous and ochreous materials. The Middle Eocene formation includes various types of limestone, which are more solid and contain hard dolomite bands. The most pronounced geo-morphological feature of the whole Eastern Desert of Egypt is its dissection by independent valleys and ravines. Between the highlands and the banks of the River Nile a gentle slope can be observed. It is divided into salt marshes with sandy hillocks and flats of calcareous silt, and an inland desert plain covered with coarse boulders, which become less coarse further away from the hills. The River Nile north of the Aswan High Dam runs for about 900 km through a valley that consists of a level-floored groove on a limestone plateau, averaging 18 km width. Upstream Cairo and for almost 300 km, including the Beni Suef area, the Nile River shows a strong tendency to hug the eastern edge of the valley floor in a way that rendered the greater part of the cultivated land found on the western bank of the river. The River Nile Valley itself went through numerous changes after the construction of the High Dam, but as a general feature it consists of the River Nile Channel surrounded by a flood plain of alluvium material that gradually increases in width from Aswan until it reaches its maximum at Beni- Suef (+ 12 km). The flood plain is elaborately cultivated through a well-established irrigation system and a slowly developing drainage system.

## 4.3 Climates and Meteorology

The bioclimatic provinces in Egypt are defined by Ayyad and Gabbour (1986) with some modification according to the system applied in the UNESCO map of the world distribution of arid regions (UNESCO, 1979). This system is based on the aridity index P/ETP (where ETP is potential evapotranspiration) and is calculated according to Penman's formula. Two classes are recognized: *hyperarid* (P/ETP< 0.03), and *arid* (P/ETP= 0.03-0.20). These classes are, in turn, subdivided according to the mean temperature of the coldest month and that of the year. Consideration is also given to the time of the rainy period relative to the temperature regime. Accordingly, the area of concern is included in the hyperarid province, which includes all the area between Lat. 22° and 30° N. The rain in this province is less than 30 mm/year and is occasional and unpredictable. In the Western Desert, the range of annual temperature variation ranges from a mean minimum of 4° C in the coldest months (Dec.-Feb.) to a mean maximum of 38° C in the hottest months (Jun.-Aug.). The closest meteorological station to the site is north Qarun and Al-Bahariya. The following data is compiled from the Egyptian Meteorology Authority and other relevant literatures.

### 4.3.1 Wind

Three permanent high-pressure belts control the wind circulation over Egypt: the *Azores*, the *Indian Subtropical*, and the *South Atlantic Subtropical*. Besides these, a permanent low-pressure belt, the *doldrums*, crosses the African continent in the vicinity of the equator. Seasonal high and low-pressure systems also alternate over the continental mass, the Red Sea, the Mediterranean and the Arabian Peninsula. During winter, a semi-permanent low-pressure area known as the Cyprus Low is usually located over the eastern Mediterranean. These months are the windiest, with dominant winds from northwest and west-northwest, less frequently from north and northeast. From November to March-April, cyclonic storms, associated with moving depressions, appear regularly. Low-pressure centers generally move along the northern side of the eastern Mediterranean. Such storms are responsible

for the generation of the highest waves on the Egyptian northern shores. Weaker storms between Crete and the Nile Delta usually last for two days; they are less frequent, shorter duration and have shorter fetches. Thunderstorms occasionally affect the Egyptian coast, accompanied by sustained winds of 43 to 60 knots for short periods and instantaneous wind gusts in the range of 70 to 90 knots. These thunderstorms occur particularly between October and May, less frequently in the summer and early autumn. During the spring months (April to May) a gradual weakening of the Cyprus Low coincides with development of a high-pressure ridge over the Mediterranean and a low-pressure zone over the Arabian Peninsula and the north-central Sahara. These weaker pressure features result in a decrease of the average wind speeds over the Mediterranean. When the depressions are counteracted by strong blasts of polar air, the southwest and south hot and dry winds (Khamasin, Ghibli) become violent, raise ground temperatures, lower the relative humidity, and transport sand and dust. In the summer June to September the high-pressure ridge that runs east-west across the central and eastern Mediterranean and the low-pressure area over the north-central Sahara reach their maximum development. Consequently average wind speeds during summer are greater in July and the dominant winds are from the west-northwest. From mid-September, the Arabian-Persian depression disappears progressively, and high-pressure belts from southeast Europe and North Africa extend over the central part of the eastern Mediterranean, producing very calm weather in October. Wind prevails from the north, northeast or northwest, at mild speeds averaging 2.1 m/s only the hot south westerly Khamaseen gales (March to May) and the cold northerly gales of February - March provide marked variation. Table (4.1) and figure (4.1) reflects the values of wind speed year round.

Table (4.1)- Mean **Monthly Wind Speed km/h**

| **Months** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Wind Speed km/h** | 3.6 | 3.9 | 4.2 | 5.0 | 5.3 | 5.2 | 4.8 | 4.7 | 4.9 | 4.6 | 4.3 | 4 |

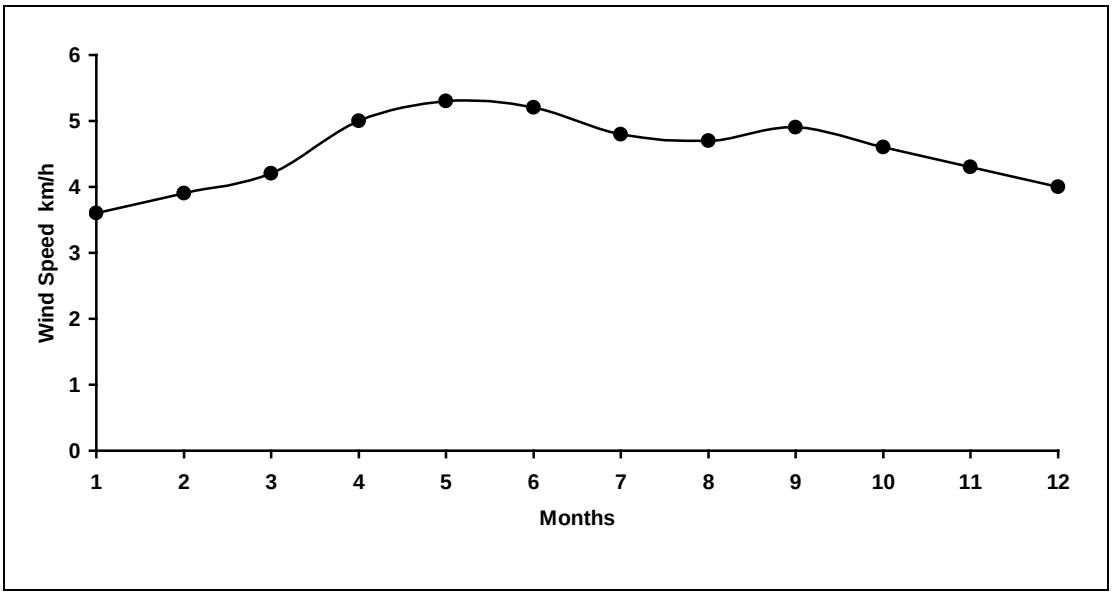



Figure (4.1) **Mean wind speed**

### 4.3.2 Air Temperature

Temperatures in northern Egypt vary considerably with season as well as diurnally. Mean maximum temperatures range from 23-27$^{o}$C, and mean minimum temperatures vary between 14.2 and 19.5$^{o}$C. Temperature extremes range usually from below 6$^{o}$C to above 38$^{o}$C. The area under consideration is located in a hot and dry environment with scanty winter rain and bright sunshine throughout the year. Its climate is a typical Saharan hyper-arid system with cold winters and hot summers. The climate of the region has a big influence on the fauna and flora occurrence in the area. It is quite apparent that the average air temperature around the Area 3 reaches its minimum values during January and its maximum values during July. The large differences between the minimum and maximum values reveal its hyper-aridity characteristics, though large areas of the region are already reclaimed to be agricultural land.

Table (4.2)- **Mean Monthly Temperature Variation**

| Months | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Max** | 30.3 | 32.0 | 40.0 | 42.7 | 46.7 | 48.7 | 46.7 | 42.8 | 40.7 | 40.0 | 37.5 | 32.7 |
| **Min** | -1.2 | -0.5 | 2.7 | 6.8 | 9.1 | 14.0 | 17.3 | 19.7 | 13.3 | 10.5 | 4.1 | 1.0 |
| **Mean** | 12.5 | 14.7 | 18.7 | 22.7 | 26.0 | 28.3 | 29.5 | 28.5 | 25.9 | 22.9 | 18.5 | 14.7 |

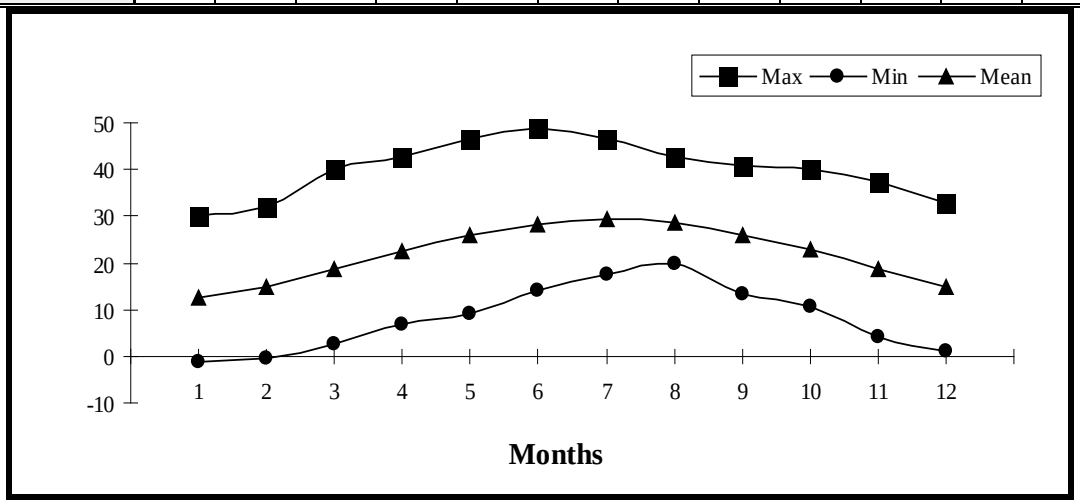



Figure (4.2) - **Average Air Temperature $^{O}$C.**

### 4.3.3 Relative Humidity

The relative humidity in Egypt is affected mainly by the relative proximity to the Mediterranean and the Red Sea. The lowest records are those of inland locations of the arid and hyper-arid provinces and the highest are those of locations closer to the Mediterranean coast and in the Nile Delta within the arid province. The lowest records of relative humidity are generally those of late spring where as the highest records are those of late autumn and early winter. From May to August, it is entirely dry over the Middle East. Humidity, however, is high in the coastal regions with frequent nocturnal condensation (dew), which decreases sharply as we proceed to the south. Relating to the area of concern, it was found that the minimum value (36.82%) is in June while the maximum (57.6%) is recorded in November. Figure (4.3) shows average relative humidity values all the year round.

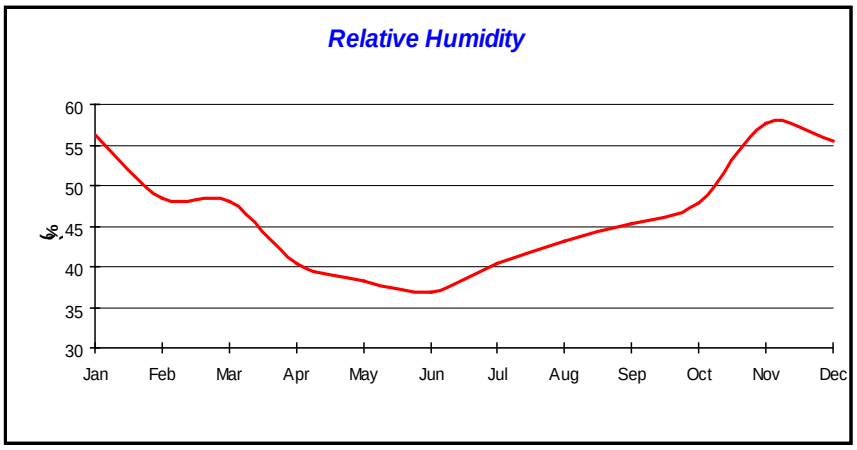



Figure (4.3) - **Average Relative humidity values all aver a year**

### 4.3.4 Rainfall

In general three rainfall belts may be characterized in Egypt:

- *The Mediterranean Coastal Belt;*
- *Middle Egypt, with latitude 290 N as its southern boundary; and*
- *Upper Egypt*

The first and second belts have a winter rainfall (Mediterranean regime) whose rainy season extends from November to April, though mainly concentrated in December and January. These belts correspond roughly to the attenuated and accentuated arid provinces of northern Egypt, where the average annual rainfall ranges from 100 to 150 mm in the attenuated arid province; and from 20 to 100 mm in the accentuated arid province. One of the major features of rainfall in arid and semiarid regions, other than being scanty, is its great temporal variability. The area of concern is within the Middle Egypt belt. The rainfall is exceedingly irregular in space and duration. The evaporative power of the air in the arid province of Egypt as measured by the Piche evaporimeter indicates that the annual potential evapotranspiration is in general lower in the arid province than in hyper arid provinces. The first rains may appear at the end of Sep. Annual rainfall, which varies considerably locally, falls mainly between early October and March. Significant precipitation is limited to the coastal belt, especially in the Northwest.

### 4.3.5 Evaporation

The minimum rate of evaporation recorded (3.18 cm) is measured in December while the maximum (25.67 cm) was measured in August. The annual of evaporation is in order of 170.7 cm. Figure (4.4) shows average evaporation values all year round at the Bahariya and North Qarun stations.

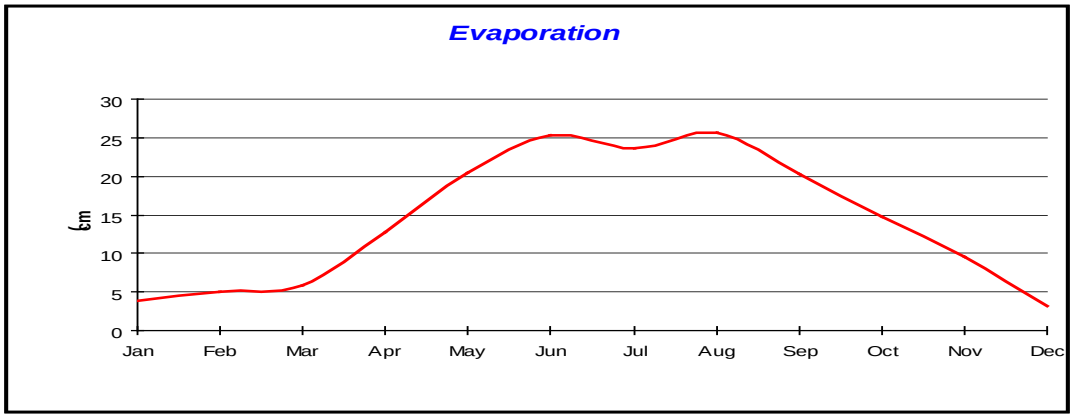



Figure (4.4) **Average Evaporation values (mb) all over a year**

### 4.3.6 Atmospheric Pressure

The atmosphere pressure is a good indicator of the weather. The minimum air pressure (1011.8 mb) lies in July, while the maximum one (1022.2 mb) is in December. Figure (4.5) shows average atmospheric pressure values all year round at the concerned area.

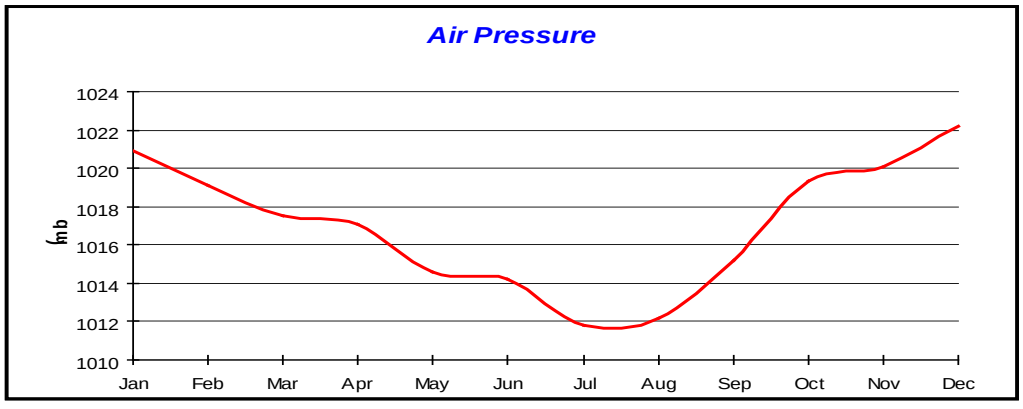



Figure (4. 5) - **Average Atmospheric Pressure values all over a year**

## 4.4 SOIL ANALYSIS

### 4.4.1 SOIL CHEMICAL ANALYSIS

**I. SAMPLE DESCRIPTION**

**Location** **Area 3**

**Colour** **Light grayish brown**

**Texture** **Cemented disintegrated**

**Name** **Calcareous clayey silt contains some sand**

**II. CHEMICAL ANALYSIS:**

| NO. | Chemical compound calculated as milligrams equivalent (m. equiv.) | | Molecular formula | Result |
|---|---|---|---|---|
| 1 | Calcium | Cations | $Ca^{++}$ | 56.0 |
| 2 | Magnesium | | $Mg^{++}$ | 19.2 |
| 3 | Sodium | | $Na^{+}$ | 15.7 |
| 4 | Potassium | | $K^{+}$ | 5.2 |
| 5 | Carbonates | Anions | $CO_3^{--}$ | 1.10 |
| 6 | Bicarbonates | | $HCO_3^{-}$ | 7.80 |
| 7 | Sulphates | | $SO_4^{--}$ | 27.27 |
| 8 | Chlorides | | $Cl^{-}$ | 60.03 |
| 9 | Total mineral soluble salts as ppm | | Ionised salts | 5872 |
| 10 | p H value | | $\text{Log} \frac{1}{(H^{+})}$ | 7.2 |
| 11 | Conductivity at 25 $^{o}$ C on m. hos / cm | | E C | 8.63 |

**III. GENERAL NOTES:**

**1 : 2 ratio soil sample : water extract was used in chemical analysis**

**Table 4.3 Soil Chemical Analysis**

### 4.4.2 LOSS ON IGNITION (LOI) Heat Treatment Results

***Table (4.4) Heat Treatment Results***

| SAMPLE LOCATION | Moisture as % | Loss on ignition as % | Ash % |
|---|---|---|---|
| Area 3 | 1.60 | 2.65 | 95.75 |

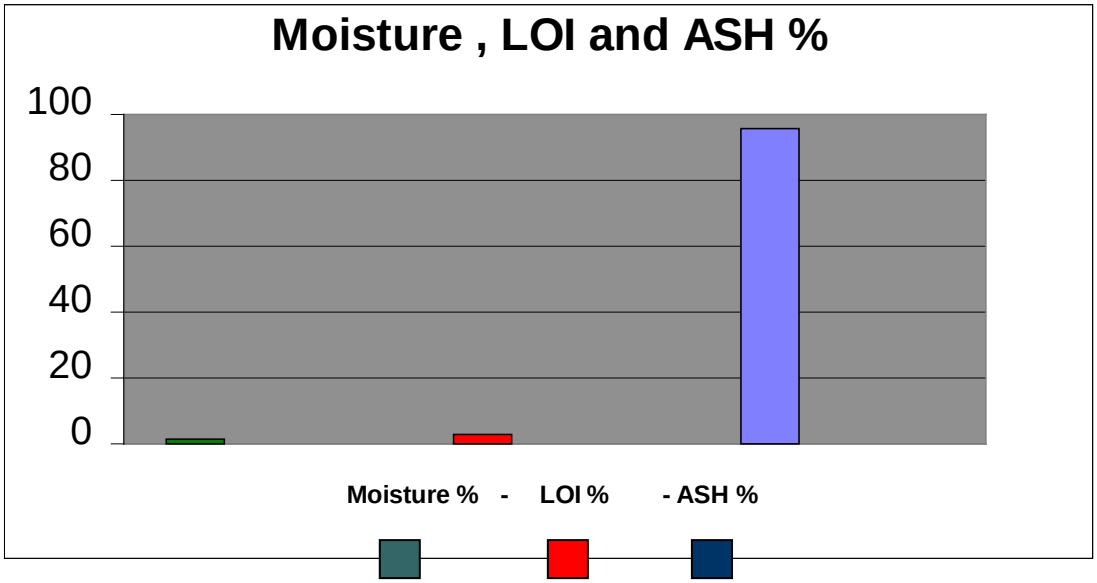



**Figure 4.6 Heat Treatment Results**

### 4.4.3 Grain Size Analysis

The sample at Area 3 showed unimodal distribution of grain size indicating moderate to high sorted sediment.

| Passing% | Sieve No |
|---|---|
| 100 | 4 |
| 95 | 10 |
| 91 | 20 |
| 88 | 40 |
| 85 | 60 |
| 83 | 100 |
| 82 | 200 |
| 77 | 0.064 |
| 69.3 | 0.053 |
| 63 | 0.041 |

| | |
|---|---|
| **51.7** | **0.03** |
| **44** | **0.02** |
| **34.9** | **0.015** |
| **28.2** | **0.009** |
| **23.1** | **0.0063** |
| **21.4** | **0.0037** |
| **18.5** | **0.0019** |

**Table (4.5) Percentage of Size Fractions**

| Visual & manual description | | Grain size parameters of soil | |
|---|---|---|---|
| Location | Beni Suef | A S T M Classification | MH |
| Colour | Light grayish brown | Uniformity coefficient ( C u ) | NA |
| Structure | Cemented disintegrated | Effective diameter in ( mm ) | NA |
| Name | Calcareous clayey silt contains some sand | Uniformity curvature ( C z ) | NA |

**Table (4.6) Classification of Soil Sample**

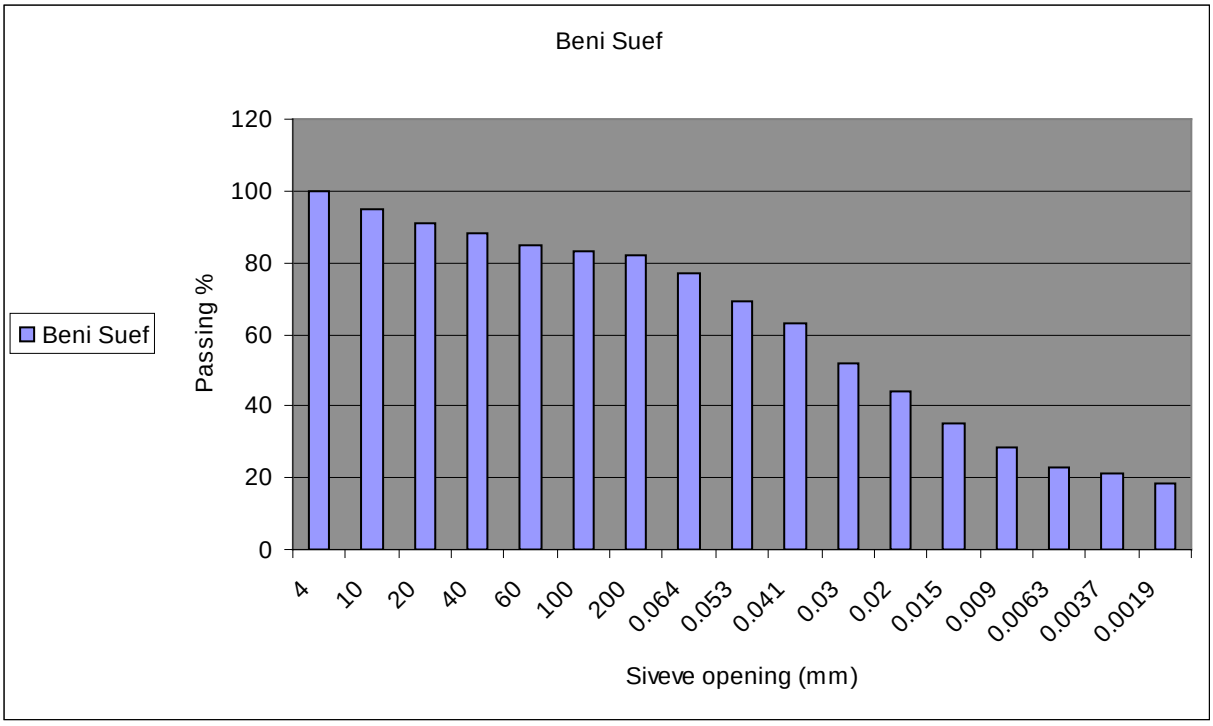



**Figure (4.7) Histogram Showing the Grain Size Distributions of Soil Sample**

## 4.5 Existing Environment:

### 4.5.1 TERRESTRIAL HABITAT

New Beni Suef on the eastern side of the River is originally a part of the Eastern Desert. This arid desert is mainly composed of limestone, sparse population, vegetation and animal representatives. Living organisms of economic or environmental value do not exist, most probably because of the heavy traffic on the highway. The newly cultivated land in this area is bordered by the River Nile on the west side and by the Highway Cairo-Aswan from the east. The area is covered with clay silt and mud. Farmers in this area produce some sugarcane, corn, wheat and other field crops. A very gentle slope to the River characterizes the area. The bank of the River in this site is about 1.5 m above the water surface. New residential areas are scattered within the cultivated lands. Apparently, only domestic and farm animals exist.

### 4.5.2 FLORA

A well-adapted wildlife flora exists in the lowlands and valleys. A mixture of xerophytes and halophytes exists such as Zygophyllum spp. And Lmonium spp. Systematic botanical survey data is not yet made for the flora of the cultivated lands and the newly reclaimed land, but the assumption may be made that this flora is largely introduced as a result of man's activities, and equivalent to that of the adjacent areas of the Nile valley where the vegetation can still be considered natural. A review of the Flora's of Egypt (Tackholm, 1974; Tackholm and Drar, 1973. and Boulos and Hadidi, 1967), leads to a compilation list of plant species that are reported to occur in the region with a classification in plants of cultivated lands, plants of waste lands and roadsides and plants on verges of canals and drains.

## Table (4.7) Flora of the cultivated Land

| Family/species | L | W | C | Family/species | L | W | C |
|---|---|---|---|---|---|---|---|
| Family Amaranthaceae | | | | Family Cyperaceae | | | |
| Alternanthera sessilis | + | | + | Cyperus alopecuroides | + | | + |
| Amaranthus graccizans | + | + | | C. Articulatus | | | + |
| A. Hybridus | + | + | | C. Difformis | + | | + |
| A. Lividus | + | + | | C. Lacvigatus | | | + |
| | | | | C. Rotundus | + | | |
| Family Asclepiadaceae | | | | Scirptis tuberosus | + | | + |
| Oxystelma alpine | | | + | | | | |
| | | | | Family Euphorbia | | | |
| Family Boraginaceae | | | | Euphorbia arguta | + | | |
| Heliotropium europaeum | + | + | | E. Forsskalii | + | + | |
| H. Supinurn | | | + | E. Geniculata | + | + | |
| | | | | E. Granulata | + | | |
| Family Caryophyllacea | | | | E. Helioscopia | + | | |
| Silene conoidea | + | | | E. peplis | + | | |
| Family/species | L | W | C | Family/species | L | W | C |
| Family Caryophyllacea | | | | | | | |
| S. Nocturna | + | | | | | | |
| S. rubella | + | | + | Family Gramineae | | | |
| Stellaria pallida | + | | | Agrostis viridis | + | | + |
| Vaccaria pyramidata | + | | | Avena sp | + | | |
| | | | | Brachiaria eruciformis | + | | |
| Family Chenopodiaceae | | | | Bromus wildenowii | + | + | |
| Beta vulgaris | + | + | | Cynodon dactylon | + | + | + |
| Chenopodium album | + | + | | Dactyloctenium aegyptium | + | + | |
| | | | | Desmostachya bipinnata | | + | + |
| Family Compositae | | | | Digitaria sanguinalis | + | + | |
| Ageraturm conyzoides | | | + | Dinebra retroflexa | + | | |
| Ambrosia maritime | | | + | Echinochloa colonum | + | | + |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Anthemis pseudocotula | + | + | | E. crus-galli | + | | + |
| Aster squamatus | + | + | + | Eleusine indica | + | | |
| Calendula arvensis | + | + | | Imperata cylindrica | + | + | + |
| Chamomilla recutila | + | + | | Lolium sp. | + | | + |
| Cichorium endivia | + | + | | Lolium temulentum | + | | |
| Conyza aegyptiaca | + | + | | Panicum repens | + | | + |
| Erigeron bonariensis | | + | | Papspalidium geminatum | | | + |
| Eclipta prostrate | | + | + | Paspalum paspaloides | + | | + |
| Family Compositae (cont) | | | | Family Gramineae (cont.) | | | |
| Lactuca serriola | | + | | Phalaris minor | + | + | |
| Senecio aegyptius | + | | | Poa annua | + | | + |
| S. flavus | + | + | + | Setaria glauca | + | + | + |
| Silybuin mariarum | | + | | S. verticillata | + | | + |
| Sonchus sp. | + | + | + | S. viridis | + | | |
| Xanthium sp. | + | | + | Phragmites australis | | + | + |
| | | | | Sorghum virgatum | + | | + |
| Family Convolvulaceae | | | | | | | |
| Convolvulus arvensis | + | + | | Family Juncacaceae | | | |
| Cuscuta arabica | + | | | Juncus rigidus | | | + |
| Family Cruciferae | | | | Family Labiatae | | | |
| Brassica nigra | + | | | Mentha longifolia | + | | + |
| Capsella bursa-pastoris | + | + | | | | | |
| Lepidium sativum | + | + | | Family Leguminosae | | | |
| Sisymbrium irio | + | + | + | Alhagi maurorum | | + | + |
| Medicago polymorpha | + | + | + | Lathyrus hirsutus | + | | |
| Melilotus indicia | + | + | + | Lotus arabicus | + | | + |
| Trifolium resupinatum | + | | + | | | | |
| Family Cruciferae | | | | | | | |
| Trigonella hamosa | + | | + | Family Poligonaceae | | | |
| Vicia monantha | + | | | Emex spinosus | + | + | + |
| | | | | Polygonum salicifolium | | | + |
| Family Malvaceae | | | | P. senegalense | | | + |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hibiscus trionum | + | | + | Rumex dentatus | + | | + |
| Malva parviflora | + | + | + | | | | |
| | | | | Family Portulacaceae | | | |
| Family Onagraceae | | | | Portulaca oleracea | + | + | |
| Jussiaea repens | | + | + | | | | |
| Family Orobanchaceae | | | | Family Primulaceae | | | |
| Orobanche crenata | + | | | Anagallis arvensi | + | | |
| O. ramosa L | + | + | | Family Solanaceae | | | |
| O. muteli v. spissa | + | | | Datura sp. | + | + | |
| Family Oxalidaceae | | | | Solanum nigrum | + | + | + |
| Oxalis corniculata | + | | + | | | | |
| | | | | Family Tiliaceae | | | |
| Family Plantaginaceae | | | | Corchorus olitorius | | | |
| Plantago sp. | + | | + | | + | + | |
| | | | | Family Umbelliferae | | | |
| Family Utricaceae | | | | Ammi majus | + | + | + |
| Utrica utens | | + | + | A. visnaga | + | | + |

L = cultivated lands; W = waste lands and roadsides; C = verges of canals and drains.

In general, cultivated crops in the area are oriented to the needs of the surrounding population especially those in the Greater Cairo, Beni-Suef, Minia, etc. They include vegetables (legumes), cotton, corn, sunflower, palm dates, lime and lemon, etc. are major crops found in the cultivated areas.

### 4.5.3 TERRESTRIAL FAUNA

Generally speaking, the fauna of the Northern part of the Eastern Desert, where the New Beni-Suef City is located, is related to that of Sinai, Palestine, the Arabian Peninsula and Western Asia. The mammals known to exist in this part of the dessert are Cape Hare (Lepus capensis), Gerbillus gerbillus, Dpodillus henleyi, Mus musculus, Jaculus jaculus, Ruppel's Fox (Vulpes rueppelli). Camels, sheep, wild donkeys and goats are frequent mammals

observed in the region. Reptiles are spread over the area, five genera of lizards and three different genera of snakes were reported, and they include the small spotted lizard, the gecko lizard and the shockari sand snake. Birds are also seen within the area. They include the sand partridge, the Egyptian vulture, the Egyptian eagle, the Raven, the Ranner Falcon, etc. Presently, after the man made alteration to the natural habitat, only domestic and farm animals can be observed. But original populations may exist in undisturbed areas surrounding the New Beni-Suef Area.

### 4.5.4 AQUATIC HABITAT

The aquatic habitats in Area 3 exist in 4 different locations, namely; the two banks of The River Nile, the submerged Island in the middle of the River, and The Ibrahimiya Canal.

#### 4.5.4.1 Water Regime

The nature of the inflow of the River Nile entering Egypt differs greatly before and after the High Dam. Before the High Dam Table (4.8), the amount of water entering Egypt was 83.9 X $10^9$ $m^3$ / year reaching its maximum during August/September and its minimal values during January/February. After the High Dam, and due to the water requirement policy and International Convention regulating the use of the water of the River Nile, the water released to the Egyptian channel of the River Nile was fixed to be around 57.2 X $10^9$ $m^3$. Its minimum value was during January and its maximum one during July. This year (1998) and due to exceptional successive high floods, the inflow of the river was greatly altered to lower the water level upstream of the dam for safety reasons. The magnitude of discharge is not yet known.

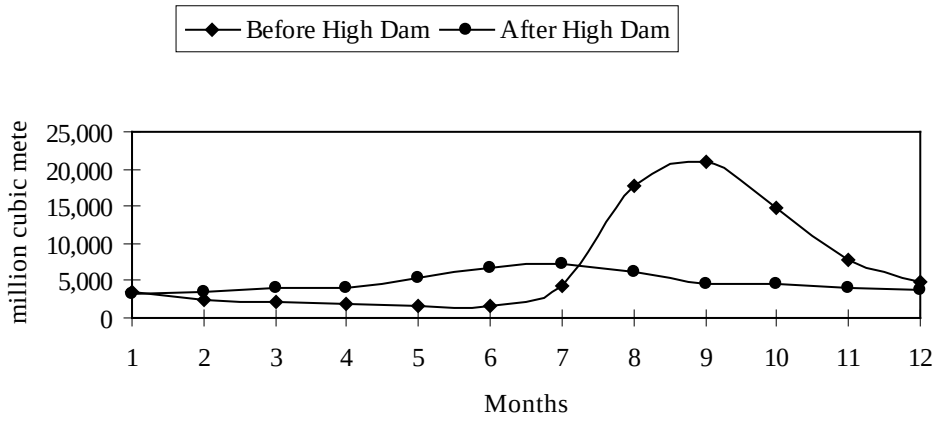
Table (4.8) - **Average Inflow*of the River Nile Before and after the High Dam**

(Data adopted from official statistics)

| Month | Before High Dam 1912 - 1957 | After High Dam 1970 – 1990 |
|---|---|---|
| **January** | 3,620 | 3,140 |
| **February** | 2,500 | 3,430 |
| **March** | 2,170 | 4,075 |
| **April** | 1,800 | 3,950 |
| **May** | 1,670 | 5,445 |
| **June** | 1,740 | 6,700 |
| **July** | 4,300 | 7,180 |
| **August** | 17,700 | 6,285 |
| **September** | 21,000 | 4,650 |
| **October** | 14,800 | 4,440 |
| **November** | 7,720 | 4,150 |
| **December** | 4,900 | 3,730 |
| **Total** | 83,920 | 57,175 |

- Million meter cube.

Figure (4.8) - **Discharge of the River Nile**



The indices of water quality within Area 3 indicate a high quality water with a water temperature ranging between 4.7 and 36.2 $^{o}$ C, a pH around 8, a dissolved oxygen over 7 ppm, a total phosphorus of 0.08 mg-P/l and a nitrate-Nof 0.21 mg-N/l.

### 4.6 Socio-economic Features

Area 3, as mentioned, is located within the Western Desert in a hyper-arid area. The area is almost deserted. High temperature, rare rainfall, extreme drought and lack of vegetation cover are the dominant characteristic conditions of this area. Thus, there is no population in this area. No Bedouins were observed, probably because of the lack of vegetation in the area. Generally, the inhabitants of the Western Desert, Eastern Desert and Sinai Peninsula represent only 1.2% of the total population in Egypt with rate of 1 person / 6 kilometers.

# 3. Environmental Impacts

## 3.1 IMPACTS FROM ONSHORE DRILLING ACTIVITIES

### 3.1.1 Waste Discharge

### 3.1.1 Waste Discharge – Well Sites

*Solid wastes*

The amount of solid waste is about 500 kg daily per well during drilling operations when OBM is not in used. This non-drilling waste consists of domestic items which are processed and disposed of by the supplier/contractor on locations through incineration and filtering processes. Drill cuttings of a non toxic nature are stored in earthen lined pits and OBM cuttings are dried on location and transported in containers to EIA approved processing facilities which utilizes the DSD 5/2 Soil Decontamination system. There is no significant waste produced when the wells are not being drilled or serviced.

***The Apache Egypt Environmental Monitoring and Waste Management Plans are located in Appendix D.***

Non-drilling waste consists of domestic items in addition to some metal items (e.g. used spare parts and bits) which are segregated and stored temporarily before sending back to the supplier/contractor.

*Wastewater*

Amount of wastewater averages around 150 $m^3$ per well, but varies per well depending on the reservoir characteristics.

All wastewater discharged is stored in a pit that is lined with PVC sheets to avoid leakage. Produced water can contain high levels of suspended solids, biocides, .hydrogen sulfide scavengers in addition to oil and heavy metals reflective of the reservoir characteristics. The residual liquid remaining upon completion of each well service operation is tested using API standards, these volumes are used in future operations. The unrecoverable portion that are tested to have no negative environmental impact are and only the unrecoverable portion, is properly covered to reinstate the soil quality after thorough verification that no adverse environmental impact occurs by conducting API field testing. Any fluids failing API recognized testing and shown to have

an adverse impact to the environment are treated using the same process as OBM and sent in enclosed containers to a treatment and disposal facility utilizing the incineration method and approved by local authorities.

*Gas emissions*

Sources of air emissions include fired equipment (e.g., generators), vents and flares. Typical gas emissions from diesel generators are expected to be very small and negligible. Flaring is conducted at controlled rates and monitored closely by supervisory personal and frequent sampling is performed to mitigate any environmental impact.

*Hazardous wastes*

Mud chemical additives that are considered toxic or hazardous are used, stored, handled, and disposed of according to instructions provided on the MSDS to assure the maximum level of safety and environmental protection. Oil base mud and cuttings are also considered hazardous wastes/substances in the event they are used during the drilling process.

### 3.1.2 Significant Environmental Impacts & Mitigation Measures

Apache utilizes an Environmental, Health & Safety Management System ("System") for all of its international locations. This ensures consistent and effective management of environmental, health and safety (EH&S) matters throughout Apache's international operations. The System promotes continuous improvement by ongoing measurement and evaluation of performance against established standards. It provides an effective EH&S management interface with partners and contractors, and ensures that EH&S issues are assessed and managed in accordance with the requirements of the Safety and Environmental Policy Statements. While the Egyptian Joint Venture partnerships vary in structure from the rest of Apache's worldwide operations, the System is still the basis by which we operate from an EH&S perspective. Included in the system among other topics are:

- Waste Management
- Industrial Hygiene
- Environmental Impact Evaluation
- Hazard / Risk Assessment and Control
- Emergency Response Program

- Others

**A System overview brochure and CD ROM of the complete System are located in Appendix D.**

*Impacts on Air Quality*

The air quality of the concessions area can be affected by the movement of heavy equipment and the operation of generators at the drilling site, leading to slight changes in the surrounding air quality.

The following table summarizes the main changes in air quality:

| Nature of Impact | Pollutants |
|---|---|
| Air emissions | Expected emissions originating from the machines and equipment (CO, $CO_X$, $NO_X$, $SO_X$). Particulate matter may also arise related to the movement of vehicles. However, it is not expected that these emissions have a long-term impact to the atmosphere due to the short duration of the project activities. NO Mitigation measures needed. |

**Typical Quantities of Emissions (by Volume)**

| **Fuel used** | **DIESEL OIL** | | | **NATURAL GAS** | | |
|---|---|---|---|---|---|---|
| Contaminant | 38 % | 29 % | Difference | 38 % | 29 % | Difference |
| CO2(kg./ton eq.) | 3370 | 2570 | 800 | 2300 | 1750 | 550 |
| NOx (kg/ton eq.) | 3 | 2.3 | 0.7 | 2 | 1.5 | 0.5 |
| SOx (kg/ton eq.) | 17 | 13 | 4 | 0 | 0 | 0 |

*Flaring*

Flaring may be conducted during drilling/completion operations as part of flow testing the well. Whenever possible, existing flowlines/pipelines are utilized to capture test gas rather than burning it at the flare. Flare/well test volumes are dependent on the flow rate of the individual wells being tested. The duration of any flaring is usually of short duration with minimal impact to the environment.

*Impacts on water quality*

No significant impacts have been recorded to surface and/or underground water due to the desert nature of the concessions area. All wastewater discharged is stored in a pit that is lined with PVC sheets to avoid leakage. All stored and decanted water is reused. The unrecoverable portion having no negative environmental impact is properly covered to reinstate the soil quality after thorough verification that no adverse environmental impact occurs by conducting API field testing. Any fluids failing API recognized testing and shown to have adverse impact to the environment are treated using the same process as OBM and sent in enclosed containers to a treatment and disposal facility utilizing the incineration method and approved by local authorities.

*Impacts on soil quality*

Best efforts have and will be conducted to restore the topographic features of the soil. This may include preserving excavated soil and using it as backfill for the excavated areas.

*From Solid Wastes*

| Source of Impacts | Mitigation Measures |
|---|---|
| Drill Cuttings | Mitigation measures in place for the treatment of drill cuttings are conducted using API testing methods for water based cuttings then determining the appropriate disposal method. OBM drill cuttings are transported in enclosed containers to a treatment and disposal (incineration) facility approved by local EIA authorities.<br><br>Waste Management<br><br>CONTRACTOR shall operate a waste management system in accordance with APACHE's requirements and as directed by APACHE's drilling supervisors.<br><br>Wastes shall be stored in designated containers, which shall be demonstrated to be suitable for the waste being stored.<br><br>Incompatible wastes shall be physically separated; in particular, hazardous wastes shall not be mixed.<br><br>Appropriate storage areas shall be provided for waste containers prior to transfer to disposal facilities. Storage areas |

| | |
|---|---|
| | should be defined and marked on a site plan.<br>All waste containers shall be labeled.<br>Manual handling of waste containers shall be minimized, and wherever practicable, waste shall be transported on pallets.<br>A transfer shall be completed for all waste loads leaving the CONTRACTOR's premises. The CONTRACTOR should keep copies of the transfer note, and records kept for a minimum of 2 years. A second copy shall accompany the waste if it is to be transported to an APACHE operated facility and handed to the APACHE person responsible for receiving such wastes. A third copy shall be sent to APACHE's Drilling Manager.<br>CONTRACTOR shall transport waste in an appropriate vehicle to the specified disposal sites.<br>APACHE will audit CONTRACTOR'S waste Management System from time to time.<br>OBM Mud Cuttings are transported in enclosed containers and transported to a treatment and decontamination facility approved by local EIA authorities through incineration processes to ensure emissions to atmosphere are colorless, odorless and below set European emission standards. |
| Garbage | Garbage and other solid wastes (wires, metal drums, scrap metal, plastic … etc.) are collected and disposed of in an authorized disposal site selected by the local authority. |

*From Liquid Wastes*

| Source of Impacts | Mitigation Measures |
|---|---|
| Drill Fluids | Water-based drilling mud is reused and only the unrecoverable portion is properly covered to reinstate the soil quality after thorough verification that no adverse environmental impact occurs by conducting API field testing.<br>OBM drilling fluid is sold back to approved vendor for processing and reuse with all non used residues being sent in enclosed containers to a treatment and disposal (incineration) facility approved by local EIA authorities. |
| Domestic Sewage | Domestic sewage is collected in closed tanks and transported to the nearest public sewer for discharge. |
| Accidental spills of fuels | Response procedures will be implemented. They include, but |

| | |
|---|---|
| and lubricants | are not limited to, the following:<br>- Barriers and dikes will be used around the contaminated area to prevent the spread of the spill.<br>- Contaminated topsoil will be removed and placed in specific containers.<br>- Raising the awareness of the on site staff site to manage fuel or lubricant spills properly if they occur. |

*From movement of heavy equipment, accessibility & camping*

| Source of Impact | Mitigation Measures |
|---|---|
| Mobilization of Heavy Equipment & Accessibility | For the new access roads, reinstatement procedures will take place after the rig demobilization. Best efforts will be done so as to restore the topographic features of the soil.<br>Upgraded existing roads will be left for local use. It is a positive impact.<br><br>During rig mobilization, the contractor will follow, as much as possible; the existing tracks to maintain the fragile micro-surface layers.<br><br>Moving inside the proposed area with cars, trucks and other means of transportation will be done as slowly as possible. |
| Camping | Pre-installed camps are used at the site. Minimal impacts would be caused to the soil |

*<u>Noise</u>*

| Source of Impact | Mitigation Measures |
|---|---|
| Noise from drilling activities. | No measurable mitigation measures are implemented. Best efforts are usually done to complete all the operations in a timely manner to minimize the disturbance by noise.<br><br>All well locations are far from any residential areas due to the nature of the concessions area.<br><br>It is a temporary effect and will cease by the end of the project.<br><br>Also, personal protective hearing equipment will be provided to the workers at the site area. |

*Health Hazards*

The contractor's workers may be subject to health hazards such as the exposure to high noise and vibration levels and exposure to emitted hydrocarbons. All workers must have proper awareness of the health risks associated with the prolonged exposure to these hazards. Health hazards emanating from contact with chemicals used in the drilling operations are another means of hazardous exposure. Workers must have access to any needed medical care in due time.

*Measures Undertaken to Protect the Health & Safety of Workers*

It is expected that all contractors are properly trained and that all proper P.P.E (e.g. ear plugs, helmets, and safety shoes) are utilized inside areas were they are required. All chemicals should be stored, handled, used and disposed of according to their MSDS.

*Hazard/Risk Assessment and Control*

Purpose

This document establishes a process for the management of existing worksite hazards and ensures that the process is communicated to all affected personnel. Hazard /Risk Assessment and Control is an ongoing process and is composed of different elements.

Scope

It is the practice to undertake formal workplace hazard/risk assessments in a manner which effectively prevent injuries. These elements consist of, but are not confined to, the following:

Pre-Event Planning

- Use of JSAs
- Pre-Job Safety Meetings
- Hot Work Permit System

Hazard Recognition/Resolution

- Near Miss Reports

Audits/Assessments

- Walkthroughs

- Checklists

Management of Change

- Complete the MOC process as needed.

Pre-Startup Review

- Conduct Pre-Startup Review Process.

**Responsibilities**

**Line Management** is responsible for:

- Providing leadership and guidance and to hold personnel accountable for implementation of procedures.
- Following appropriate Hazard Control Procedures outlined in this program.
- Auditing compliance.
- Providing information to affected personnel.

**Employees and Contractors** are responsible for:

- Maintaining integrity and carrying out procedures as defined by the scope of the Hazard Control Procedures.
- Develop and assist in Pre-Event Planning
- Evaluate and update JSAs
    - Pre-Job Safety Meetings
    - Hazard Recognition/Resolution
    - Use of Near Miss Reports
    - Conduct Audits and Assessments
    - EH&S Walkthroughs
    - Checklists
    - Management of Change
    - Follow MOC Process and report the need of MOC to immediate supervisor if process changes require a MOC.
    - Pre-Startup Review
    - Follow pre-start review procedures.

The elements of Hazard/Risk Assessment and Control, although separate entities, are to be used as a whole, distinct process. The use of JSAs, Near Miss Reports, the

Permitting Process, and Safety Checklists are all to be viewed as integral parts in the prevention of accidents/injuries.

*Impacts of Oil-Based Drilling Fluids & Cuttings*

In addition to the well-known contamination effects to soil, ground water and marine life (in the case of offshore drilling), human skin exposure to diesel fuel and gas oil (main constituents of OBM) will remove natural fat from the skin. Repeated or prolonged exposure can result in drying and cracking, irritation and dermatitis. Some individuals may be especially susceptible to these effects. Excessive exposure under conditions of poor personal hygiene may lead to oil acne and folliculitis.

A serious potential health hazard related to diesel fuel utilization concerns the possible risk of skin cancer under conditions of prolonged and repeated skin contact and poor personal hygiene. No epidemiological evidence exists for humans, but it has been demonstrated with mice that skin cancer can result in paint tests with light diesel oil and gas oils irrespective of the percentage of PACs present. This effect is due to (chronic) irritation of the skin. The diesel fuels/gas oils that contain cracked components may also be genotoxic in their own right because of high proportions of 3-7 ring PACs and their carcinogenicity may be much greater. Diesel fuels may contain 10 %(w) or more PACs.

**OBM Cuttings Treatment**

The Apache methodology for treating OBM Cuttings can be described by the following actions:

- Collecting the cuttings in an appropriate closed metallic boxes (approx. 20 per well)
- Transporting the boxes to treatment containers sent by the OBM Cuttings Treatment Contractor.
- Monitoring the treatment process which will take place at the company approved location.

***INCINERATION TREATMENT PROCESS***

General Description

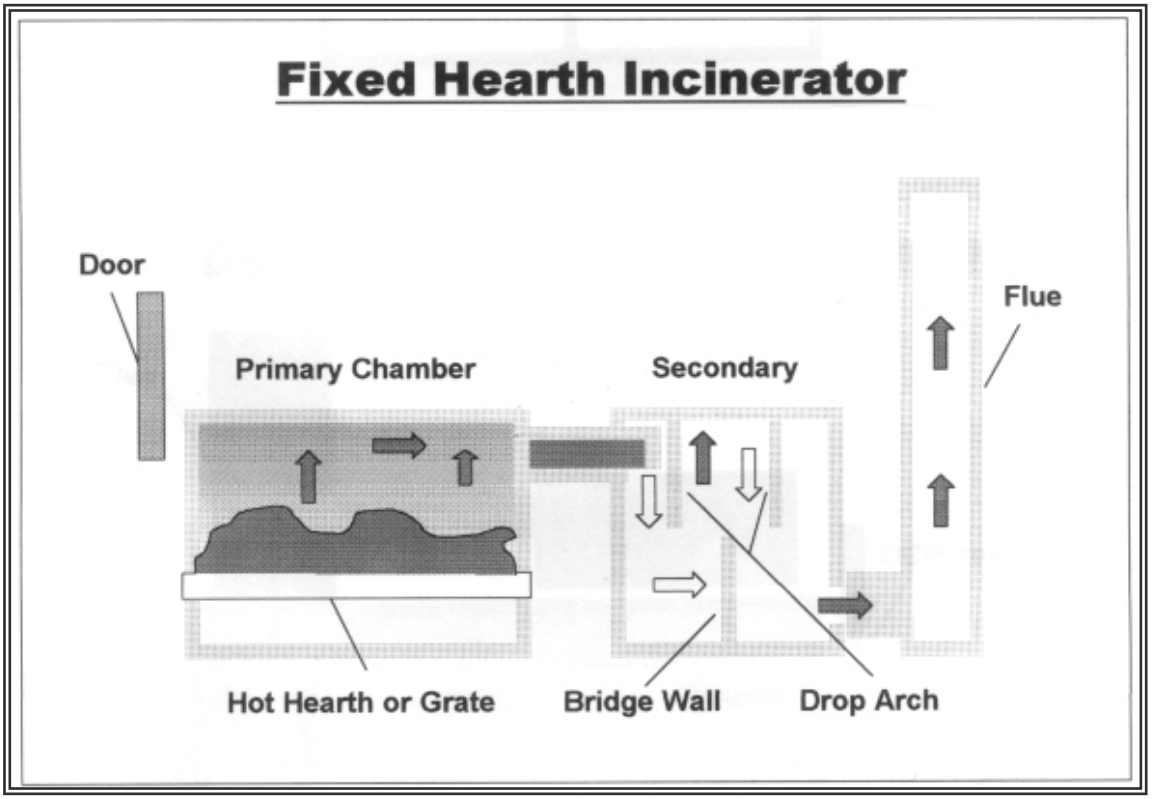
This process is widely used to treat contaminated oil based mud cuttings, sludge and contaminated soils. The treated material has been shown to contain essentially zero

hydrocarbon content, and has been used as a packer in brick and block making, and as a material for road construction. Although no oil is recovered during the decontamination process, an energy balance is achieved by using the hydrocarbon content of the material to be treated as a fuel source.

Process Description

The system is of a unique design incorporating a high efficiency heat source that can be oil or gas fired, and a feeding, mixing and emptying system incorporating variable speed drives.

The decontamination chamber operates under a negative pressure thus all the products of combustion are drawn through to a secondary treatment chamber prior to being released into the atmosphere via a stack. The contaminated product residue is reduced in volume by approximately 11% of its original weight and is rendered inert and sterile enabling it to meet stringent international criteria for unlicensed landfills. Releases to atmosphere are odorless and colorless and meet set environmental standards.




**Unit Schematic**

### 3.1.3 Well Testing

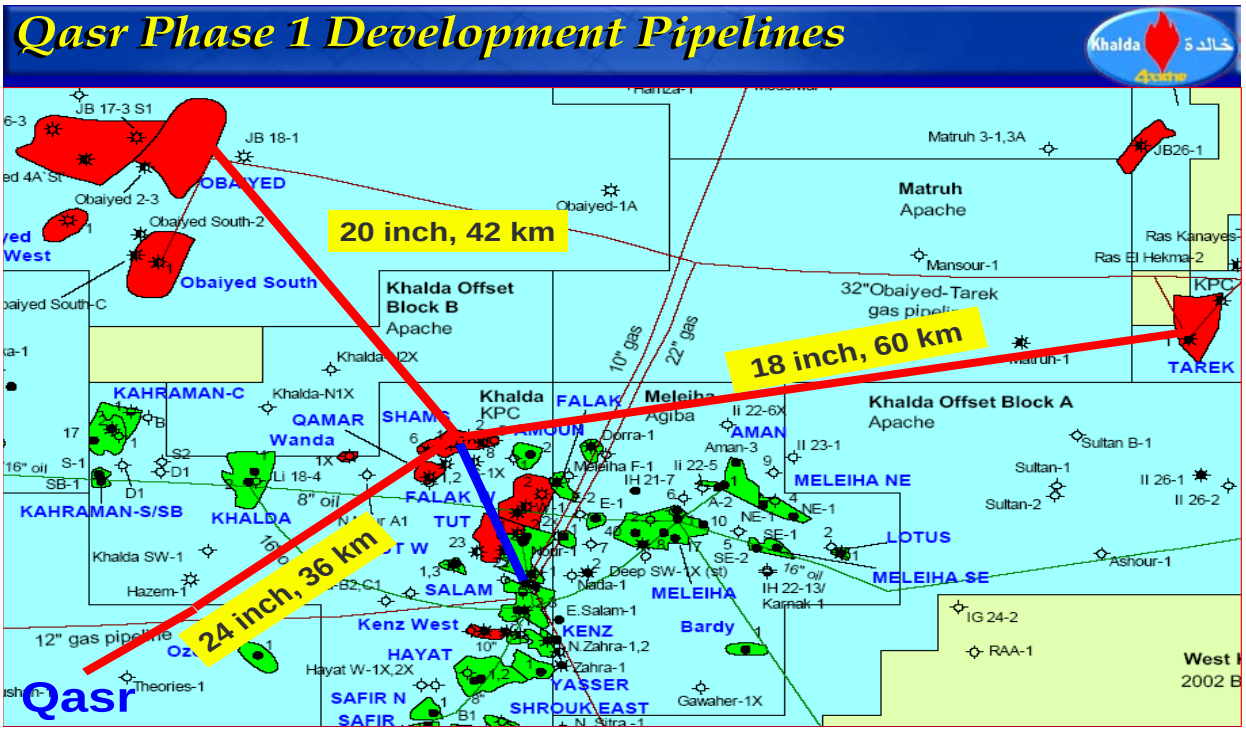
APACHE has specified a high efficiency flare/burner with sufficient capacity to handle the maximum anticipated well test hydrocarbons. The environmental advantages include reduction in the by-products of incomplete combustion such as carbon monoxide, hydrocarbon slippage and aldehydes, and reduced smoke and luminosity. As with any combustion process, during the first few minutes of start-up smoke will be emitted until the system stabilizes. Water from the well completion fluids may enter the flare, causing intermittent smoke, but this problem will only occur shortly after start-up, if at all. Proper setting of the flare will minimize smoke emissions and thus a persistent plume will be avoided.

## 3.2 IMPACTS FROM PIPELINE INSTALLATION

There are current plans to construct two major oil pipelines and one major gas and condensate pipeline. The first oil pipeline which is currently under construction is an 8” oil pipeline that parallels an existing 8” oil pipeline for added capacity. This line will be from the Umbarka Concession to the Meliha oil gathering facilities.

The second major oil pipeline will tie the E. Bahariya concession to the Qarun Concession. This oil is currently being trucked.

The Major Gas/Condensate pipeline is located on the Khalda concession. This line will tie in the Qasr development area located on the Khalda Offset concession to the Khalda concession that will be tied into the Shell operated concession (Obaiyed) for gas processing. Part of this project will also include tying in the Salam and Tarek gas plants together. (See Map)




### 3.1.4 Contractors' Responsibilities

*Drilling Contractor*

Contractors are responsible for drilling activities and mud logging will be requested to offer the best available technical safety for the equipment operators. In addition, they will secure mobilization of the rig to the nominated well location. To minimize environmental impacts, the drilling contractor should undertake measures to reduce the volume of generated drill cuttings and mud wastes. This could be done through the adoption of a drilling technique which will minimize the cost of the drilling operation; mainly by saving in the cost of handling solids, use of chemicals, use of energy, and labor work time. All contractors will have the necessary contingency plans to address recognized potential hazards associated with the project in order to minimize risks to their staff before initiating drilling operations.

Contractors will be responsible for training their working staff on environmental obligations during all phases of the project in order to reduce the environmental impacts they leave behind during their work at the site.

*Rig Contractor*

Rig contractor will offer safe residential facilities. The contractor staff will do its best to monitor the noise and vibration levels and maintain them below 80 dB. In case of higher noise levels, the contractor will provide the workers with noise protection equipment such as ear plugs.

The contractors will also understand that it is part of their responsibility to monitor for bottom subsidence and take corrective measures for it during planning, operation and phasing out stages.

*Mud Contractor*

To prevent environmental impact, the mud contractor completely eliminates all unused chemicals or abandoned containers **as well as oil-base mud (OBM) cuttings** and will not discharge them into the surrounding environment.

As previously mentioned, OBM Cuttings are sent to the authorized treatment facilities according to the contract between APACHE and the approved treatment contractor.

Trucking facilities are also available to haul all hazardous chemicals, containers of used chemicals, as well as domestic solid wastes. The nearest on shore solid dump site can be used for domestic organic waste disposal.

**All contractors will observe the environmental rule stating that any polluter will be forced to pay the cost of clean up by others. This rule applies to food suppliers; chemical suppliers, medical treatment and site care contractors while handling infectious and hazardous human wastes.**

## 3.2 IMPACTS FROM PIPELINE INSTALLATION

### 3.2.1 During Construction

Although this project has its impacts, they are all temporary and their duration is small compared to the life cycle of the project. The activities during this phase will include:

1. Pipe-laying.
2. Trenching and backfilling.
3. Construction activities.
4. Commissioning.

*1. Pipeline Laying, Trenching & Backfilling*

The basic environmental impacts associated with the process of pipe-laying, trenching, & backfilling include the following:

- Noise and vibration due to the engines of heavy equipment and cranes.
- Exhaust emissions due to engines of:

    - Vehicles.
    - Heavy equipment.
    - Cranes.

- Potential dust generated from the proposed pipe-laying activities.
- Temporary occupation of pipe-laying, fabrication and storage areas which may result in the following impacts:

    - Temporary disturbance to existing land use.
    - Severance to agricultural land.
    - Temporary loss or disturbance of ecological population.
    - Visual presence.
    - Wastes generated from the trenching materials.

- Potential land use loss, as the working area width will be approximately 10 meters.
- Potential runoff and sedimentation which may lower the water quality in rivers and streams.
- Temporary interruption to traffic.
- Temporary top soil removal during trenching which may result in changes in surface and ground water regime.

*2. <u>Construction & Commissioning Activities</u>*

The general construction activities such as periodic piling, generators, material handling and storage can generate the following environmental impacts:

- Noise and vibration impacts to local community due to engines of heavy equipment and cranes.
- Exhaust emissions in air due to engines of:

- Vehicles.
- Heavy equipment.
- Cranes.

- Potential dust generated from the proposed construction activities.
- General effects on people's perception of the area caused by:

  - Levels of activity.
  - Lighting.
  - On-site vehicle movement.

- Damage to ground water conditions by vehicle movements.
- Potential contamination of soil and water by spillage of chemicals, etc.
- Direct carry-out onto local roads.
- Potential impacts on available local resources caused by the supply of materials and other resources.
- Potential wastes generated from the proposed construction activities.
- Potential corrosion arising in areas adjacent to overhead electric power lines.

### 3.2.2 During Operation

As previously mentioned, operational impacts could only arise through pipeline accidents. Gas pipeline leakage or rupture can result in the potential contamination of air. The significance of this contamination is dependent on the type and size of the leak, and the degree to which the natural resource is affected. Also it may cause explosions or fires. In developed areas, such accidents pose significant human health risk.

*Risk Analysis*

Based on the statistical data, the main causes of pipeline accidents causing product release are:

- Defective pipe:
  - Flow in pipe material.
  - Construction defect.
- Corrosion:
  - Internal.
  - External

- Mechanical Impact:
  - Unintentional.
  - Malicious.
- Environmental Loading:
  - Subsidence.
  - Scour.
  - Earthquake.
- Operational Overloads:
  - Surge over pressure.
  - High temperature.

### 3.2.3 Positive Impacts

In many cases, oil and gas pipelines may be viewed as contributing to environmental quality by making cleaner fuels more available (e.g., low sulfur gas versus high sulfur coal) for energy production and/or industrial purposes. In offshore areas, unburied pipelines create habitat for marine organisms attracted to the new “artificial reef”.

In addition, huge numbers of employment opportunities will be created (i.e. positive socio-economic impact)

## 3.3 IMPACTS FROM Oil & GAS PLANT CONSTRUCTION & OPERATION

### 3.3.1 Construction Phase

It is worth mentioning that the construction phase of the project will impair both positive and negative impacts on the environment

The positive impacts of this phase on the surrounding environment, lies in the fact that it will open a new employment market for the surrounding resident workers, and a plus in the national economy.

As for the negative impacts on the environment it can be designated according to either the construction period generally or to the various activities incorporated during the construction period.

Regarding the construction period, main impacts are as follows:

a) One of the most visible current environmental issues and one with much public awareness is the matter of $CO_2$, dust emissions and pollution from cars and trucks.
b) The powerful lighting needed for sites to operate safely outside daylight hours can cause considerable nuisance, even preventing sleep, and waste of energy if the lighting remains on all night for security reasons.
c) The traffic generated by site operations can provide the largest impact of the construction phase on the surrounding area and communities and as a result needs active planning and management. The traffic movement causes dust suspension in the air, noise, and vibration problems.

Regarding the various activities incorporated during the construction period, the impacts are related specifically to the activity, and are as follows:

*Ground Works*

a) Run-off erosion from unprotected excavated areas resulting in excessive soil erosion and the encouragement of dust production.
b) Slewing and consequent degradation of the soil structure
c) The production of excess soil
d) De-watered fluid disposal

*Foundations, Structural Work, and Civil Activities*

a) $CO_2$ emissions
b) Waste production (empty packs, domestic wastes, scrap,etc.)
c) The use of hazardous materials

## Summary of Main Impacts and Their Nature

| # | Action | Impact | Nature of Impact (During the phase) |
|---|---|---|---|
| 1 | **During Construction** | | |
| a | Installation of early production facility | 1. Soil contamination;<br>2. Temporarily change in air quality;<br>3. Noise levels' increase. | Temporarily<br>Temporarily<br>Temporarily |
| b | Installations of oil/gas pipelines | 1. Erosion & alter the stability of the soil in the vicinity of the pipeline;<br>2. Affect access roads during equipment mobilization;<br>3. Leaks and waste generated during construction can cause potential threat to economic & environmental resources.<br>4. Oil/Gas pipeline leakage or rupture may cause explosion or fire. | Temporarily<br>Temporarily<br>Temporarily<br>Not likely to happen during construction phase. May cause continuous threat during trial period. |

| | | | |
|---|---|---|---|
| 2 | **During Operation** | | |
| a | Operating the production facility | 1. Change in air quality;<br>2. Soil contamination;<br>3. Occupational health & safety | Temporarily<br>Temporarily<br>Temporarily, but highly dangerous. |
| b | Operating oil/gas pipeline | 1. Erosion & alteration of the stability of the soil in the vicinity of the pipeline if not properly monitored;<br>2. Leaks can cause potential threat to economic & environmental resources.<br>3. Oil/Gas pipeline leakage or rupture may cause explosion or fire. | Temporarily<br>Temporarily, but highly dangerous.<br>Temporarily, but highly dangerous. |

### 3.3.2 Operation Phase

Most of the Oil/Gas plants are similar from the point of creating environmental impacts during operation. The following section describes typical emissions, effluents, and wastes during normal operating conditions, as well as emergency cases.

*Air Pollution*

Most of the activities include oil/gas processing and transferring streams. Hence, gaseous emissions are expected to be the major source for potential impacts. These emissions can be classified as follows:

- Heaters flue gases.
- Discharges from process.
- Emergency releases.
- Maintenance and other services.
- Volatile organic compounds (VOC's).
- Fugitive emissions.

The above mentioned sources of emissions include the following gases:

- $CO_2$
- $NO_x$
- Methane
- $H_2O$ Vapours
- CO
- $O_2$
- Hydrocarbons
- $N_2$

The use of natural gas in heating operations will minimize the pollutant emissions and maximize the combustion efficiency.

**Typical Emissions Quantities**

| **Fuel used** | **NATURAL GAS** | | |
|---|---|---|---|
| Contaminant | 38 % | 29 % | Difference |
| CO2(kg./ton eq.) | 2300 | 1750 | 550 |
| NOx (kg/ton eq.) | 2 | 1.5 | 0.5 |
| SOx (kg/ton eq.) | 0 | 0 | 0 |

*Surface Water Pollution*

Due to the fact that this type of project deals with oil/gases in different processes, the chance of surface water pollution is somewhat limited and surface water contamination can occur only as a result of an accidental oil/condensate release from the API separator or storage tanks to the nearest water body which is not a factor with respect to our desert locations. Containment structures, pursuant to API guidelines, are constructed to prevent contamination of surface water resulting from an accidental oil/condensate spill.

*Ground Water Pollution*

The chance of groundwater contamination can occur only due to leakage oils used during operations, spills and tank/vessel failure or leaks. As covered in Section 2 – Baseline Environmental, the chance of contaminating or encountering groundwater in this environment is minimal.

### 3.3.3 Other Impacts

*Routine Atmospheric Emissions*

Operation emissions, vehicles, emergency generators, emergency fire pumps, etc. are:

- $NO_x$
- $SO_2$
- CO
- $CO_2$
- Particulates

*Noise*

Sources of noise from facility utilities include pumps, air compressors, heaters, etc. In most cases the impact of noise from this equipment is limited and localized to the project site.

*Associated Wastes*

Associated wastes which are generated from gas plant activities include:

- Sewage
  Sewage is generated from proposed project operation staff (350 Persons + casuals). Approximately 0.2$m^3$ of sewage is generated per man/day shift.

- Garbage
  The garbage generated includes:
  a) scrap paper b) food remains
  c) periodical civil maintenance d) other different garbage items.

- Waste Lube Oil
  Used lube oil generated from machinery and equipment represent another source of wastes associated with the project related activities.

### 3.3.4 Environmental Management for Oil/Gas Plants

Environmental management plan is an essential element in the reduction and minimization of the environmental impact of petroleum production and pipelines projects.

This section describes a framework for the field environmental management procedures which will be adopted to minimize the environmental impact. It covers training, contracts, monitoring, audits and reporting. Apache will generate a detailed environmental management plan for the day to day operations including a waste management plan drafted for the commencement of operations.

## 2. TRAINING

### 2.1 Environmental Awareness Training

All staff and contractors will receive induction training on safety and environmental issues.

Environmental management is now an integral part of business management activities. There is now a wealth of information available on environmental issues such as global warming, acid rain and the ozone layer depletion. Although these environmental issues are of concern to the oil and gas industry, there are a number of other issues which are specifically concerned with production and pipeline projects.

The information on these subjects has tended be very technical and aimed at environmental specialists, and until recently there were no training packages available which cover these environmental issues in non-specialist terms. Special training programs will be available to Apache to train personnel to work with greater awareness and to help to minimize the environmental impact of operations.

The objective of the training series is to provide information on environmental issues of particular relevance to the oil and gas industry. It is aimed at all staff working in exploration and production.

The training program should include the following modules:

Recycling Waste
Drilling
Chemical Water
Oil and Chemical Spills
Atmospherics emissions
Drainage
Physical Presence of Installations
Overview

**2.2 Oil Spill Response Training**

The oil spill response plan identifies the oil spill response strategy and routine precautionary procedures. Regular training in the development, use and maintenance of all oil spill equipment is essential.

Key personnel identified in the oil spill plan will receive formal training, supplemented with regular practical exercises and tests of incident management procedures.

A log of personnel training and exercises will be maintained.

## 3. Contracts

All Apache contracts contain detailed health, safety and environmental clauses. These are to ensure that contractors and sub-contractors are aware of the Company's concern to protect the environment and the cost consequences to them of non-compliance. They provide a mechanism by which Apache can both select and monitor the performance of its contractors.

These clauses include the following requirements that apply to all contractors and their sub-contractors:

- Cooperate fully with the proper authorities, police, local coast guard, environmental, safety and fire authorities and the company.
- Inform the company of any potential situation which may put the environment at unnecessary risk or not comply with the law.
- Use products, equipment and materials which minimize the environmental impact and have a low environmental toxicity, wherever possible.
- Minimize waste, and ensure waste management practices do not cause harm to the environment.

## 4. Monitoring

Monitoring should begin before construction to determine baseline conditions.

Construction and operational monitoring will determine the degree and significance of impacts that will occur during these phases of the project. Normally a year of preconstruction monitoring will be sufficient to characterize the environmental resources potentially affected by the project. The length of construction and operation monitoring will depend on the environmental resource that is being affected and the expected duration of the impact. For example, if a continuous cooling produced water discharge is planned, then weekly or daily water quality monitoring may be needed for the life of the facility. Specific monitoring programs will be required depending on the type of process and the type of resources predicted to be affected.

**5. Chemical and Fuel Inventory**

A record of all proprietary chemicals imported and stored at the facility, including fuel, paints and process chemicals will be maintained. The pathways for use and disposal will be identified. Fuel consumption will be used as an indicator of the efficiency of the power plant.

**6. Waste Management plan**

The waste management methodologies will be developed according to the plan mentioned in Apache EH&S Management System in Appendix D.

**7. Air Emissions**

All emissions will be discretely monitored during operation, and the frequency of subsequent monitoring determined by the results.

**8. Reporting**

***Routine Reporting***

Environmental matters will be routinely reported at the regular safety and environment meetings,

***Environmental Incidents Reporting***

Environmental incidents are defined as any planned or unplanned discharges or releases over permitted limits. Any other actions resulting in adverse environmental effects are also defined as environmental incidents. The cause of any incident will be identified and the management system reviewed to prevent a recurrence.

**9. Audit**

Internal and external environmental audits should be commissioned on a regular basis to ensure that operations comply with Egyptian Environmental regulations and the Company's environmental policy. Audit reports will highlight positive and negative indicators of environmental performance and identify priorities for improvement to be considered by Apache.

Internal audits of environmental performance should be carried out regularly during different stages of the operation. The audit team will be identified by the Company's Environmental, Health and Safety Manager.

### 3.3.4 Environmental Management for Oil/Gas Plant Specific Activities

Apache usually identifies four major sources of air emissions from these plants. These emissions are identified and discussed below.

*Flare*

The flare burns continuously and in order to prevent air from entering and to maintain a continuous flame a certain purge rate of natural gas is required. This rate has been established and verified by the flare stack manufacturers and the American Petroleum Institute.

For example, a 30 inch diameter flare stack the amount of gas burned just for purging will be approximately a 300,000 SCFD. The combustion process of gas will transform the hydrocarbons to carbon dioxide and water.

*Exhaust gases from the turbine driving the plant power generation units*

The amount of power generation required is determined during the Front End Engineering and Design (FEED) study and verified during the detailed design portion of the project.

Apache operates several plants in Egypt's western desert where Mars Power Turbines are used. These units are rated at 8 MW each at site conditions (40 $^{o}$C ambient air temperature).

NOTE: All other mechanical drive units in the plant are electric motor type. Thus the only exhaust pollutants to contend with will be in the power generation plant.

It is well known that the pollutants from any Gas Turbine exhaust consist of NOx (NO + NO2), Carbon Monoxide, and unburned hydrocarbons.

Either of these machines can burn the sales gas or the inlet gas from the separators. The Solar turbine and the General Electric Turbine can be equipped with low NOx

emission combustors. This will minimize air emissions. The combustor type is selected to minimize the emission rate of the other two pollutants as well.

It is not possible now to determine the air emission rate of any pollutant as this is an extremely complicated function of fuel gas, load, and ambient temperature. It can however, be stated unequivocally that Apache selects, purchases, and installs the power generation gas turbine driver equipped with the best available control technology (BACT) for minimizing exhaust of pollutants from the gas turbines driving the generator.

It is planned that all other power drivers in all gas plants will be electric motor type. Thus the only exhaust pollutants to contend with will be within the power generation plant.

*Hot oil fired heaters*

Hot oil is required by the dehydration system and the condensate stabilization system. This hot oil will be obtained using indirect fired heaters. The heat for these indirect fired heaters will be obtained by burning inlet separator or sales gas. The exhaust gas will contain NOx (NO + NO2), carbon monoxide, and unburned hydrocarbons. This amount will be determined and minimized during the detailed engineering process.

*Compressor seals*

All centrifugal compressors used throughout the plant for large flow applications, such as the booster compressor and export compressors will be centrifugal type. These compressors have the ability to be provided with dry gas seals. These dry gas seals do not require oil. As such they are environmentally friendly. They will leak continuously at the design condition about 10 SCFM per seal. This leakage is vented through a flare system for burning. Thus if we have 10 compressors each with 2 seals the gas flowing to flare under design conditions will be approximately 200 SCFM or about 300,000 SCFD.

When the seals fail, gas leaks directly to atmosphere in the vicinity of the compressor. This is an unsafe condition and when this occurs, gas detectors shutdown the compressor and the seals are changed.

*Means of treating process water*

All separated water throughout the Gas Plants will contain a large amount of methanol, injected at the wells to prevent hydrate formation. The methanol and water have very similar specific gravities; therefore, gravity separation must not be the primary process for separation. During the FEED study the optimum process to separate these liquids will be determined. Presently it can be acknowledged that the system for doing this has been allotted space within the plant's plot area, as well as power for movement of the two streams.

All water separated from condensate and methanol will flow to two produced water storage tanks. The two tanks will operate in parallel. The tanks will separate the hydrocarbon from the water using gravity separation, i.e. Stokes Law. The hydrocarbons will rise to the top where they are skimmed off to a hydrocarbon collection tank. From this collection tank the hydrocarbons will be pumped to condensate stabilization system for reprocessing. Hydrocarbon concentration in the water leaving these tanks is approximately between 50 and 100 ppm.

The water from these tanks is pumped to a coalescing plate interceptor or a flotation cell. Either of devices is able to further reduce the hydrocarbon concentration level to approximately 30 ppm. Separated hydrocarbon will flow to the aforementioned oil collection tank and de-oiled treated process water will flow to an evaporation pond.

The Oil Plants utilize three phase separation where the oil, gas and water are separated and processed accordingly. Details of these processes are outlined in Section 1 – Introduction. In most cases the separated produced water flows to an API separator that removes any entrained oil and is then either injected downhole or discharged to an evaporation pit.

## Attachments – Gas, Condensate & Oil MSDS's

# MATERIAL SAFETY DATA SHEET

**2000 Post Oak Blvd., Suite #100**
**Houston, TX 77056-4400**
**24 Hour Hotline (800) 874-3262**
**Canutec: (613) 996-6666**

| | |
|---|---|
| **Product:** | CRUDE OIL |
| **Synonyms:** | PETROLEUM, PETROLEUM OIL, CRUDE, ROCK OIL, SOUR CRUDE OIL, CONDENSATE, SOUR CONDENSATE |
| **Chemical Name:** | CRUDE OIL |
| **Chemical Family:** | HYDROCARBON |
| **NFPA Classification:** | Health: 1- 3 Fire: 2- 4 Reactivity: 0 Special: |

**PRODUCT/INGREDIENT**

| Composition | CAS Number | % | OSHA PEL | ACGIH TLV | Carcinogen* |
|---|---|---|---|---|---|
| Crude Oil<br>May contain variable amounts of : | 8002-05-9 | 100 | | 100 ppm suggested | |
| Hydrogen Sulfide ($H_2S$) | 7783-06-4 | 0 - 3 | 20 ppm | 10 ppm | |
| Natural Gas | 8006-14-2 | | | | |
| Benzene | 71-43-2 | .1-.99 | 1 ppm | | OSHA,NTP, IARC |
| N-Hexane | 110-54-3 | | 500 ppm | 50 ppm | |

* The source that indicates carcinogenicity

**ACUTE HAZARD DATA**

Possible IDLH levels of poisonous $H_2S$ Gas; Probably flammable to extremely flammable liquid; Benzene, a minor constituent is a known carcinogen (leukemia); Vapors can be simple asphyxiant/anesthetic; Ingestion of liquids may be harmful or fatal; Skin and eye irritant.

**PHYSICAL DATA**

| | | |
|---|---|---|
| **Boiling Point** (° F): Approx. 30 - 1000 | **Specific Gravity** ($H_2O$ = 1)**:** 0.7 - 1.1 | **Vapor Pressure** (mm Hg @ 20°C)**:** < 1823 |
| **Melting Point** (°F): ¯76 to ¯4 | **Solubility** (In Water)**:** <15 | **Vapor Density** (Air = 1)**:** >1 |
| **Evaporation Rate** (N-Butyl acetate = 1)**:** >1 | | **Auto ignition Temperature** (°F): >500 |

| |
|---|
| **Appearance/Odor:** |
| Viscous clear, yellow, brown or greenish black liquid, strong hydrocarbon and sulfur (rotten egg) odor when containing $H_2S$. Do not use odor as an indicator of $H_2S$ concentration. |

**HEALTH INFORMATION**

| | |
|---|---|
| **Eye Contact:** | Based on the presence of light hydrocarbons, crude oil is presumed to be mildly irritating to the eyes. |
| **Skin Irritation:** | Crude oil and some of its fractions have been shown to cause skin irritation when applied directly and repeatedly to the skin. Hot oil can cause burns. Prolonged and repeated contact may cause various skin disorders such as dermatitis, folliculitis, oil acne or skin tumors. Contact with compressed material may cause freezing burns. |
| **Skin Absorption:** | This product contains polycyclic aromatic hydrocarbons (PAHs) which, under conditions of poor personal hygiene and prolonged, repeated contact, some PAHs have been suspected as a cause of skin cancer in humans. |
| **Ingestion:** | Not a likely route of entry, but may cause burning of mouth, nausea, vomiting |
| **Inhalation:** | ***Warning:*** Hydrogen sulfide ($H_2S$), Natural gas and other hazardous vapors may evolve and collect in the headspace of storage tanks or other enclosed vessels. $H_2S$ gas is heavier than air and will collect in low places and is an extremely flammable, toxic gas. Exposure to greater than 300 ppm $H_2S$ is Immediately Dangerous to Life or Health. Natural gas is extremely flammable and a simple asphyxiant. Inhalation of other light hydrocarbons may cause pulmonary irritation, nausea, vomiting and result in CNS depression. OSHA has concluded that benzene can cause leukemia in humans and has established TWA of 1 ppm and a STEL of 5 ppm. Prolonged, repeated exposure may have leukemogenic effects if air concentrations of 1 ppm are exceeded. |

**FIRE AND EXPLOSION HAZARDS**

| | |
|---|---|
| **Flash Point and Method** (°F)**:**<br>> 1 ASTM D-56 | **Flammable Limits** (% by Volume in Air):<br>**Lower**: .6 **Upper**: 12.5 |
| **Extinguishing Media:** | Use water fog, foam, dry chemical or $CO_2$. Do not use a direct stream of water. Product will float and can be re-ignited on surface of water. |
| **Special Fire Fighting Procedures and Precautions:**<br><br>* Should be attempted only to extent of training. | *Stop flow of fuel if possible, prior to extinguishing.* Clear fire area of unprotected personnel. Do not enter confined fire space without full bunker gear (helmet with face shield, bunker coats, gloves and rubber boots), including a positive pressure NIOSH approved self-contained breathing apparatus. Water may not be effective for fire, but water should be used to keep fire-exposed containers cool. *Caution should be used in storage tank fires due to potential for boil-over of water at bottom of tank.* If a leak or spill has not ignited, use water spray to disperse the vapors and to protect personnel attempting to stop leak. Water spray may be used to flush spills away from exposures. Prevent runoff from fire control or dilution from entering streams, sewers (possibly explosive), or drinking water supply. |
| **Unusual Fire and Explosion Hazards:** | Sulfur oxides and hydrogen sulfide, both of which are toxic, may be released upon combustion. Vapor accumulation could flash and/or explode if ignited. Vapors from crude oil can be heavier than air and may travel some distance to ignition sources. Immediately withdraw from fire if vessel-venting noise increases or the container becomes discolored. |

**REACTIVITY**

| | |
|---|---|
| **Stability:** Stable | **Hazardous Polymerization:** Will not occur |
| **Conditions and Materials to Avoid:** | Heat, sparks, flame, contact with strong oxidizing agents, and build up of static electricity. |
| **Hazardous Decomposition Products:** | Thermal decomposition products are highly dependent on the combustion conditions. A complex mixture of airborne solid, liquid, particulates and gases will evolve when this material undergoes pyrolysis or combustion. Carbon monoxide and other unidentified organic compounds may be formed upon combustion. Nitrogen oxides, sulfur oxides and metal oxides. |

**EMPLOYEE PROTECTION**

| | |
|---|---|
| **Engineering Controls:** | Ventilation: Work in well-ventilated areas and up wind of any leak or spill. In confined spaces, mechanical ventilation may be required to keep levels of certain components below mandated standards. Ventilation equipment must be explosion proof. Keep away from all ignition sources.<br>Precautionary Statements: This product may contain small quantities of $H_2S$, benzene and /or n-hexane. Persons handling this material should be evaluated for exposure to these chemicals in accordance with applicable local, state and federal regulations and good industrial hygiene practices.<br>Handling: Store and transfer to grounded and approved containers. Tank truck should be bonded to load line before starting loading. Use only explosion proof or intrinsically safe electrical equipment where product is stored or handled. Store away from ignition sources.<br>Work Practices: Use non-sparking tools where liquids or vapors from the oil may be generated at flammable concentrations. Do not smoke in areas where this product is stored or handled. Use combustible gas monitors to test for ignitable atmospheres. |
| **Personal Protective Equipment:** | Eye Protection: Face shield and chemical goggles should be worn where liquid oil may be sprayed.<br>Respiratory Protection: Not required during normal use. Follow NIOSH/OSHA criteria for working (and entry) into confined space (tank entry) and where gases and vapors from crude oil may be generated. Use NIOSH approved respiratory protection as required to prevent overexposure to oil, mist, vapor, and $H_2S$.<br>Protective clothing: As needed to prevent chronic skin contact. Normal work clothing. Wash contaminated clothing prior to reuse; discard boots, shoes or clothing that can not be decontaminated. Clothing washed in solvents must be air dried and washed in soap and water before reuse.<br>Gloves: Impervious gloves for frequent or prolonged contact. Thermal insulated gloves should be worn where temperature extremes are expected. |

**EMERGENCY PROCEDURES**

| | |
|---|---|
| **First Aid:**<br><br>* Should be performed only to extent of training | Eye: If eye has been exposed to hot liquid, cover eyes with cloth, **SEEK MEDICAL ATTENTION IMMEDIATELY.** Cold liquid in the eye should be washed with plenty of water for at least 15 minutes. If irritation persists, seek medical attention.<br>Skin: If exposed to liquid, remove contaminated clothing, wash skin with mild soap and water until clean. Launder contaminated clothing before reuse. In case of hot crude spill, do not remove or treat. **SEEK MEDICAL ATTENTION IMMEDIATELY.** Wash only unburned area; do not use solvents to clean at any time.<br>Inhalation: Remove from further exposure. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance and call a physician. If breathing has stopped, use mouth to mouth resuscitation.<br>Ingestion: Do not induce vomiting. Give 1 to 2 glasses of water. Get medical assistance.<br>**Note to Physician:** High aspiration risk. For large amounts, careful gastric lavage. Eructation and gastroenteritis may be complications. Aspiration may cause chemical pneumonitis or lipoid pneumonia. |
| **Spill Response:** | Spill Containment: Wear the appropriate equipment as described in the personal protective equipment section. Absorb utilizing materials such as fire retardant treated sawdust, diatomaceous earth, etc. For large spills: Contain or dam material and pump back to holding tank for later recycling/ disposal. Eliminate all ignition sources. Remove leaking containers to detached, diked area. Recover spilled oil and dispose of oil contaminated waste according to local, state and Federal regulations. Report spills as required to appropriate authorities. U.S. Coast Guard Regulations require immediate reporting of spills that have reached any waterways including intermittent dry creeks. **Report spill to Coast Guard toll free (800) 424-8802. In case of accident or road spill notify Chemtrec (800) 424-9300.** |

**REGULATORY INFORMATION**

**OSHA:** Product assessed in accordance with OSHA 29 CFR 19109.1200 and determined to be hazardous.

**DOT:** Hazard class: Flammable liquid; Shipping Name: Petroleum Crude Oil; I.D. Number: UN 1267 Reportable Quantity: NA

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The information contained herein is based on the data available to us and is believed to be correct. However, Apache makes no warranty, expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. Apache assumes no responsibility for injury from the use of the product described herein.

---

**DATE REVISED:** November 1, 2002

**Paul Griesedieck**
**Manager, Environmental, Health & Safety**

# MATERIAL SAFETY DATA SHEET

**2000 Post Oak Blvd., Suite #100**
**Houston, TX 77056-4400**
**24 Hour Hotline (800) 874-3262**
**Canutec: (613) 996-6666**

| | |
|---|---|
| **Product:** | CONDENSATE |
| **Synonyms:** | SOUR CONDENSATE, CRUDE OIL |
| **Chemical Name:** | |
| **Chemical Family:** | ALIPHATIC HYDROCARBONS |
| **NFPA Classification:** | Health: 1 - 3 Fire: 4 Reactivity: 0 Special: |

**PRODUCT/INGREDIENT**

| Composition | CAS Number | % | OSHA PEL | ACGIH TLV | Carcinogen* |
|---|---|---|---|---|---|
| Mixture of aliphatic hydrocarbons of carbon number ≥4 | Mixture | | | | |
| Benzene | 71-43-2 | .1 - .99 | 1 ppm | | NTP, IARC, OSHA |
| Hydrogen sulfide ($H_2S$) | 7783-06-4 | 0 - 3 | 20 ppm | 10 ppm | |
| Natural Gas | 8006-14-2 | | | | |
| n-Hexane | 110-54-3 | | 500 ppm | 50 ppm | |

* The source that indicates carcinogenicity

**ACUTE HAZARD DATA**

Possible IDLH levels of poisonous $H_2S$ Gas; Extremely flammable liquid; Benzene, a minor constituent is a known carcinogen (Leukemia); Vapors can be simple asphyxiant/anesthetic; Ingestion of liquids may be harmful or fatal; Skin and eye irritant.

**PHYSICAL DATA**

| | | |
|---|---|---|
| **Boiling Point** (°F): < 100 | **Specific Gravity** ($H_2O$ = 1)**:** NA | **Vapor Pressure** (mm Hg @ 25°C) < 1823 |
| **Melting Point** (°F): NA | **Solubility** (In Water)**:** (% by Wt.) <15 | **Vapor Density** (Air = 1)**:** >1 |
| **Evaporation Rate** (N-Butyl acetate = 1)**:** >1 | | **Auto ignition Temperature** (°F): >500 |
| **Appearance/Odor:** Compressed gases and liquids - clear to yellow - petroleum distillate odor, or pungent rotten egg odor when containing $H_2S$. | | |

**HEALTH INFORMATION**

| | |
|---|---|
| **Eye Contact:** | Irritating |
| **Skin Irritation:** | Contact with compressed material may cause freezing burns. Prolonged, repeated contact may cause drying, cracking or dermatitis. |
| **Skin Absorption:** | No probable hazard. |
| **Ingestion:** | Ingestion of liquid portion (at room temperature) may cause burning of mouth, nausea, vomiting |
| **Inhalation:** | Concentrations of vapors above 1% may cause anesthesia, nausea, vomiting, or lung irritation. Condensate may contain $H_2S$, and exposure above 300ppm is immediately dangerous to life or health. OSHA has concluded benzene can cause leukemia in humans and has established a TWA of 1ppm and a STEL of 5ppm. Prolonged, repeated exposure may have leukemogenic effects if air concentrations of 1ppm are exceeded. |

**FIRE AND EXPLOSION HAZARDS**

| | |
|---|---|
| **Flash Point and Method** (°F)**:** -40 | **Flammable Limits** (% by Volume in Air): **Lower**: ~3.0 **Upper**: ~12.5 |
| **Extinguishing Media:** | Use water fog, foam, dry-chemical or $CO_2$. Do not use a direct stream of water. Product will float and can be re-ignited on surface of water. |
| **Special Fire Fighting Procedures and Precautions:**<br><br>* Should be attempted only to extent of training. | *Stop flow of fuel if possible, prior to extinguishing.* Clear fire area of unprotected personnel. Do not enter confined fire space without full bunker gear (helmet with face shield, bunker coats, gloves and rubber boots), including a positive pressure NIOSH approved self-contained breathing apparatus. Water may not be effective for fire, but water should be used to keep fire-exposed containers cool. *Caution should be used in storage tank fires due to potential for boil-over of water at bottom of tank.* If a leak or spill has not ignited, use water spray to disperse the vapors and to protect personnel attempting to stop leak. Water spray may be used to flush spills away from exposures. Prevent runoff from fire control or dilution from entering streams, sewers (possibly explosive), or drinking water supply. |
| **Unusual Fire and Explosion Hazards:** | Sulfur oxides and hydrogen sulfide, both of which are toxic, may be released upon combustion. Vapor accumulation could flash and/or explode if ignited. Vapors from condensate can be heavier than air and may travel some distance to ignition sources. Immediately withdraw from fire if vessel-venting noise increases or the container becomes discolored. |

**REACTIVITY**

| | |
|---|---|
| **Stability:** Stable | **Hazardous Polymerization:** Will not occur |
| **Conditions and Materials to Avoid:** | Heat, sparks, flame, contact with strong oxidizing agents, and build up of static electricity. |
| **Hazardous Decomposition Products:** | Thermal decomposition products are highly dependent on the combustion conditions. A complex mixture of airborne solid, liquid, particulates and gases will evolve when this material undergoes pyrolysis or combustion. Carbon monoxide and other unidentified organic compounds may be formed upon combustion. Nitrogen oxides, sulfur oxides and metal oxides. |

**EMPLOYEE PROTECTION**

| | |
|---|---|
| **Engineering Controls:** | Ventilation: Work in well-ventilated areas and up wind of any leak or spill. In confined spaces, mechanical ventilation may be required to keep levels of certain components below mandated standards. Ventilation equipment must be explosion proof. Keep away from all ignition sources.<br>Precautionary Statements: This product may contain small quantities of $H_2S$, benzene and /or n-hexane. Persons handling this material should be evaluated for exposure to these chemicals in accordance with applicable local, state and federal regulations and good industrial hygiene practices.<br>Handling: Store and transfer to grounded and approved containers. Tank truck should be bonded to load line before starting loading. Use only explosion proof or intrinsically safe electrical equipment where product is stored or handled. Store away from ignition sources.<br>Work Practices: Use non-sparking tools where liquids or vapors from the oil may be generated at flammable concentrations. Do not smoke in areas where this product is stored or handled. Use combustible gas monitors to test for ignitable atmospheres. |
| **Personal Protective Equipment:** | Eye Protection: Face shield and chemical goggles should be worn where liquid oil may be sprayed.<br>Respiratory Protection: Not required during normal use. Follow NIOSH/OSHA criteria for working (and entry) into confined space (tank entry) and where gases and vapors from crude oil may be generated. Use NIOSH approved respiratory protection as required to prevent overexposure to oil, mist, vapor, and $H_2S$.<br>Gloves: Impervious gloves for frequent or prolonged contact. Thermal insulated gloves should be worn where temperature extremes are expected.<br>Protective clothing: As needed to prevent chronic skin contact. Normal work clothing. Wash contaminated clothing prior to reuse; discard boots, shoes or clothing that can not be decontaminated. Clothing washed in solvents must be air dried and washed in soap and water before reuse. |

**EMERGENCY PROCEDURES**

| | |
|---|---|
| **First Aid:**<br><br>* Should be performed only to extent of training | Eye: Flush with large volumes of water for 15 minutes. If irritation persists, seek medical attention.<br>Skin: If exposed to liquid, remove contaminated clothing, wash skin with mild soap and water until clean. Launder contaminated clothing before reuse.<br>Inhalation: Remove from further exposure. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance and call a physician. If breathing has stopped, use mouth to mouth resuscitation.<br>Ingestion: Do not induce vomiting. Give 1 to 2 glasses of water. Get medical assistance.<br>**Note to Physician:** High aspiration risk. For large amounts, careful gastric lavage. Eructation and gastroenteritis may be complications. Aspiration may cause chemical pneumonitis or lipoid pneumonia. |

| | |
|---|---|
| **Spill Response:** | Spill Containment: Wear the appropriate equipment as described in the personal protective equipment section. Absorb utilizing materials such as fire retardant treated sawdust, diatomaceous earth, etc. For large spills: Contain or dam material and pump back to holding tank for later recycling/ disposal. Eliminate all ignition sources. Remove leaking containers to detached, diked area. Recover spilled oil and dispose of oil contaminated waste according to local, state and Federal regulations. Report spills as required to appropriate authorities. U.S. Coast Guard Regulations require immediate reporting of spills that have reached any waterways including intermittent dry creeks. **Report spill to Coast Guard toll free (800) 424-8802. In case of accident or road spill notify Chemtrec (800) 424-9300.** |

**REGULATORY INFORMATION**

**OSHA:** Product assessed in accordance with OSHA 29 CFR 19109.1200 and determined to be hazardous.

**DOT:** Hazard class: Flammable liquid; Shipping Name: Petroleum Crude Oil; I.D. Number: UN 1267 Reportable Quantity: NA

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**DATE REVISED:** November 1, 2002

**Paul Griesedieck**
**Manager, Environmental, Health & Safety**

# MATERIAL SAFETY DATA SHEET

**2000 Post Oak Blvd., Suite #100**
**Houston, TX 77056-4400**
**24 Hour Hotline (800) 874-3262**
**Canutec: (613) 996-6666**

| | |
|---|---|
| **Product:** | NATURAL GAS |
| **Synonyms:** | FUEL GAS, PETROLEUM GAS, WELL HEAD GAS |
| **Chemical Name:** | METHANE, ETHANE, PROPANE MIXTURE |
| **Chemical Family:** | HYDROCARBON |
| **NFPA Classification:** | Health: 1 Fire: 4 Reactivity: 0 Special: |

**PRODUCT/INGREDIENT**

| **Composition** | **CAS Number** | **%** | **OSHA PEL** | **ACGIH TLV** | **Carcinogen*** |
|---|---|---|---|---|---|
| Methane | 74-82-8 | >85 | Simple Asphyxiant | Simple Asphyxiant | |
| Ethane | 74-84-0 | | " | " | |
| Propane | 74-98-6 | | " | " | |
| Nitrogen | 7727-37-9 | | " | " | |
| C4 - C6 Aliphatic Hydrocarbons | NA | >1 ea. | | | |

* The source that indicates carcinogenicity

**ACUTE HAZARD DATA**

Flammable gas, simple asphyxiant, freeze burns from liquid natural gas.

**PHYSICAL DATA**

| | | |
|---|---|---|
| **Boiling Point** (°F): < -100, varies with composition | **Specific Gravity** ($H_2O$ = 1)**:** 0.555, varies with composition | **Vapor Pressure** (mm Hg) @ 25°C**:** > 760 |
| **Melting Point** (°F): NA | **Solubility** (In Water)**:** NEGLIGIBLE | **Vapor Density** (Air = 1)**:** 0.6, varies with composition |
| **Evaporation Rate** (N-Butyl acetate = 1)**:** GAS | | **Auto ignition Temperature** (°F): 900 - 1170 |
| **Appearance/Odor:** Colorless, odorless to slight hydrocarbon | | |

**HEALTH INFORMATION**

| | |
|---|---|
| **Eye Contact:** | Liquid or expanding gas can cause severe freeze burns of the eye. |
| **Skin Irritation:** | None for gas; liquid or expanding gas can cause severe freeze burns on the skin. |

| | |
|---|---|
| **Skin Absorption:** | NA |
| **Ingestion:** | NA |
| **Inhalation:** | Mild narcosis is produced at elevated concentrations and is an asphyxiant when the oxygen concentration falls below 18% at sea level ($PO_2$ <35 mm Hg). |

**FIRE AND EXPLOSION HAZARDS**

| | |
|---|---|
| **Flash Point and Method** (°F)**:**<br><0 | **Flammable Limits** (% by Volume in Air):<br>**Lower**: Approx. 5 **Upper**: Approx. 15 |
| **Extinguishing Media:** | **STOP LEAK,** if it can be done without risk. If ignited, allow small fire to burn. |
| **Special Fire Fighting Procedures and Precautions:**<br><br>* Should be attempted only to extent of training. | *Stop flow of fuel prior to extinguishing.* Water may not be effective for fire, but water should be used to keep fire-exposed containers cool. If a leak or spill has not ignited, use water spray to disperse gas and to protect persons attempting to stop leak. Water may be used to flush spills away from exposures. Isolate for 1/2 mile in all directions if large container (tanker or storage vessel) is involved in fire. |
| **Unusual Fire and Explosion Hazards:** | A gas plume that has not ignited or gas in a confined space is explosive upon ignition. |

**REACTIVITY**

| | |
|---|---|
| **Stability:** Stable | **Hazardous Polymerization:** Will not occur. |
| **Conditions and Materials to Avoid:** | Heat, sparks or flame. Avoid contact with oxidizers such as liquid chlorine. |
| **Hazardous Decomposition Products:** | Carbon Dioxide ($CO_2$) from burning and Carbon Monoxide (CO) where oxygen level is low. |

**EMPLOYEE PROTECTION**

| | |
|---|---|
| **Engineering Controls:** | Ventilation: Work in well-ventilated areas and up wind of any leak or spill.<br>Work practices: Use non-sparking tools where liquids or vapors may be present.<br>Precautions to be taken in handling and storing: Store and transfer to grounded and approved containers, away from sources of ignition. Transfer high-pressure liquid and gas in approved systems.<br>Other precautions: Use only explosion proof or intrinsically safe electrical equipment where product is stored or handled.<br>Biological Monitoring: Breath analysis for hydrocarbons may be related to exposure concentration. |

| | |
|---|---|
| **Personal Protective Equipment:** | Protective gloves: Thermal insulated gloves should be worn where liquefied gas may escape.<br>Eye Protection: Face shield and chemical goggles should be worn where liquid or gas may escape.<br>Respiratory Protection: Respiratory protection is not required during normal use. Follow NIOSH/OSHA criteria for working (and entry) into confined space (tank entry). Where sour gas may be present, respirator protection must be readily available.<br>Protective clothing: Normal work clothing.<br>Hygienic practices: Do not smoke in areas where this product is stored or handled. |

**EMERGENCY PROCEDURES**

| | |
|---|---|
| **First Aid:**<br><br>* Should be performed only to extent of training | Eye: If eye has been exposed to liquid, protect the eyes; **SEEK MEDICAL ATTENTION IMMEDIATELY.**<br>Skin: If exposed to liquid, allow clothing to thaw before removing. In case of frost bite or freeze burns, wash only unburned area and **SEEK MEDICAL ATTENTION IMMEDIATELY.**<br>Inhalation: Move victim to fresh air; if not breathing, start artificial respiration. If breathing is difficult, give oxygen if readily available. **SEEK MEDICAL ATTENTION** if recovery is not prompt.<br>Ingestion: Not a route of entry. |
| **Spill Response:** | **Stop Leaks** to prevent spread of hazard. See Fire and Explosion Hazards Section. **Follow local, state, and federal laws** for proper reporting. |

**REGULATORY INFORMATION**

**OSHA:**

**DOT: Shipping Name:** Flammable Gas, **Hazard Class:** Flammable Gas, UN 1971, UN 1972. Transported under pressure without odorant. No reportable quantity.

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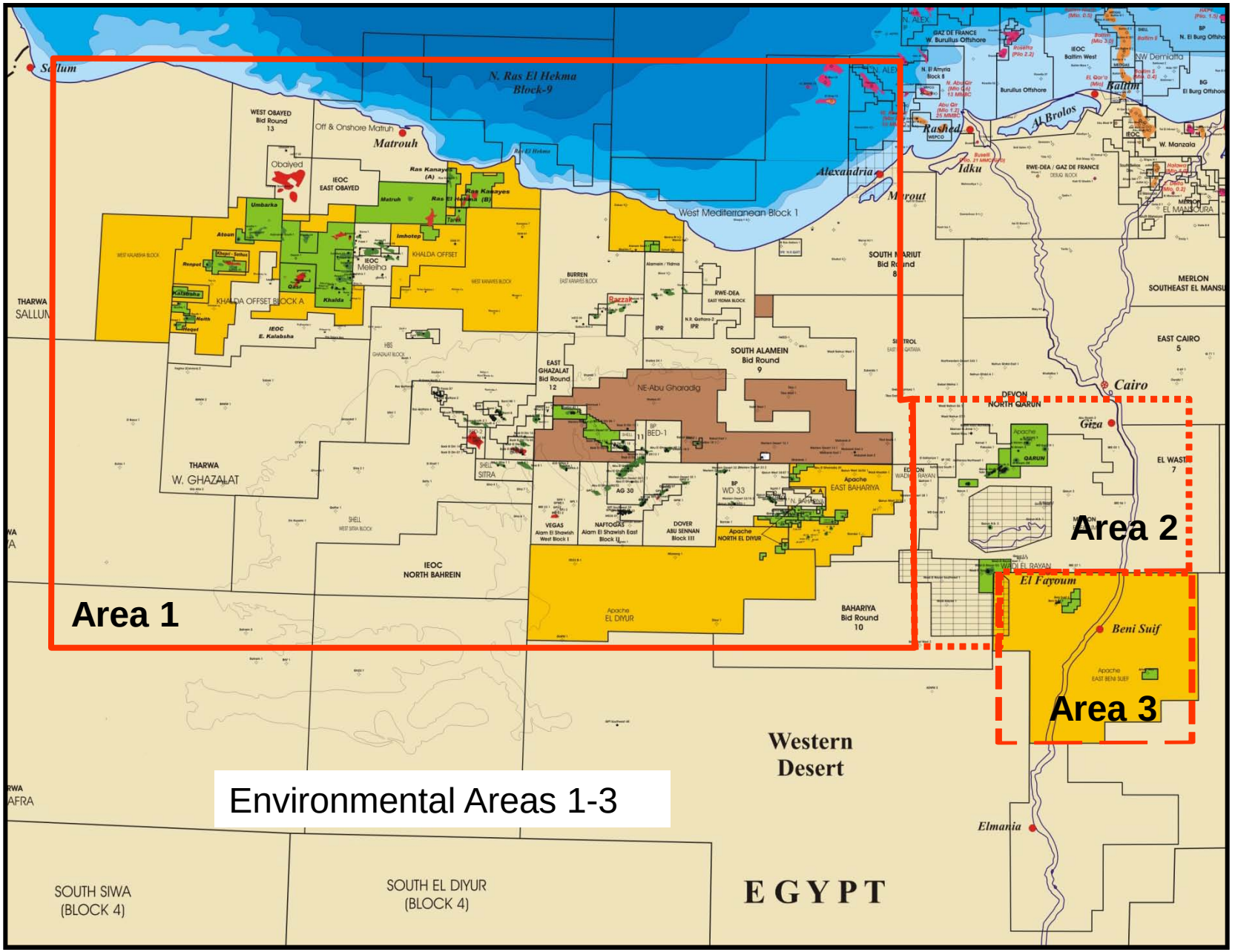
**DATE REVISED: November 1, 2002**

**Paul Griesedieck**
**Manager, Environmental, Health & Safety**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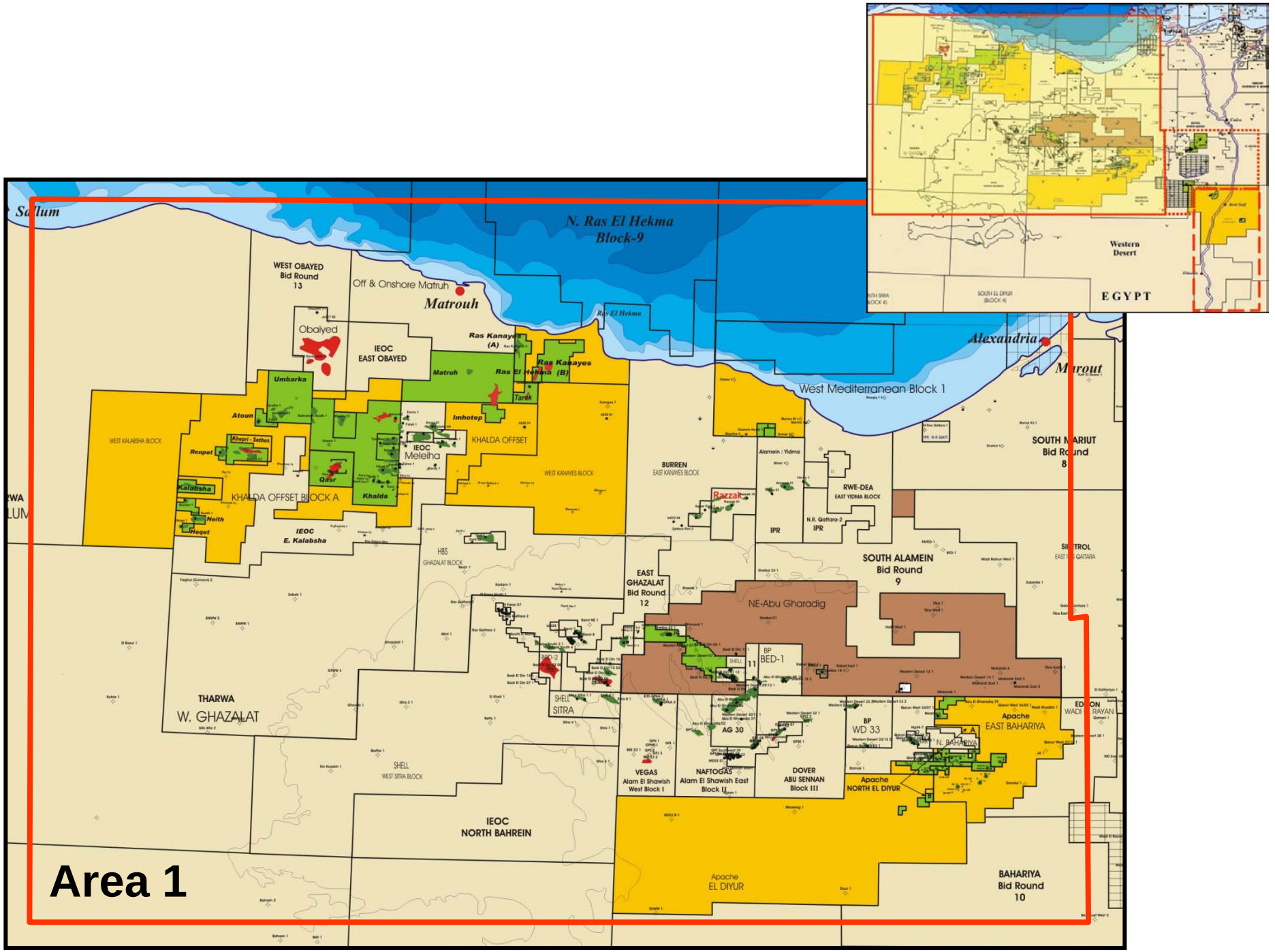
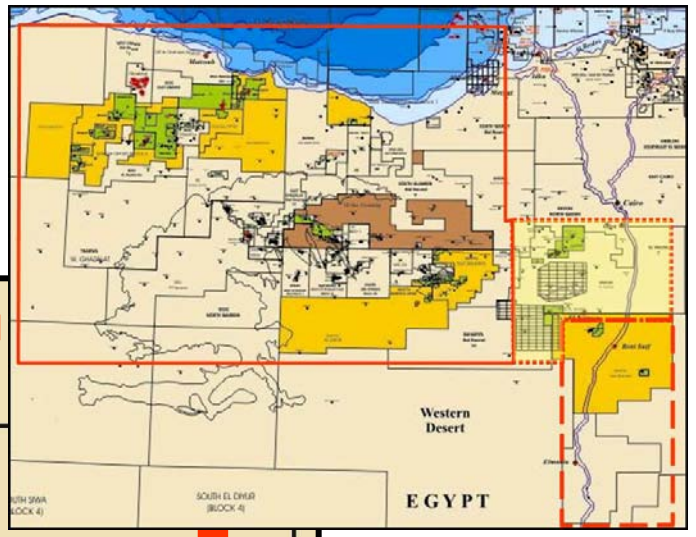
Area 2
Area 3
Environmental Areas 1-3
N. Ras El Hekma Block-9
West Mediterranean Block 1
Off & Onshore Matruh
Matrouh
Alexandria
Marout
Idku
Rashed
Al Brolos
Kattim
Cairo
Giza
Western Desert
EGYPT
SOUTH SIWA (BLOCK 4)
SOUTH EL DIYUR (BLOCK 4)
Elmania
El Fayoum
Beni Suif
THARWA W. GHAZALAT
IEOC NORTH BAHREIN
KHALDA OFFSET BLOCK A
KHALDA OFFSET
SOUTH ALAMEIN Bid Round 9
EAST GHAZALAT Bid Round 12
BAHARIYA Bid Round 10
WEST OBAYED Bid Round 13
SOUTH MARIUT Bid Round 8
EAST CAIRO 5
EL WASTA 7
MERLON SOUTHEAST EL MANSURA
NE-Abu Gharadig
Razzak
Obaiyed
IEOC EAST OBAYED
IEOC Meleiha
IEOC E. Kalabsha
RWE-DEA EAST YIDMA BLOCK
RWE-DEA / GAZ DE FRANCE DEIBA BLOCK
GAZ DE FRANCE W. Burullus Offshore
Burullus Offshore
IEOC Baltim West
NW Damietta
BG El Burg Offshore
W. Manzala
MERLON EL MANSOURA
DEVON NORTH QARUN
QARUN
EL WADI RAYAN
Apache EAST BAHARIYA
Apache NORTH EL DIYUR
Apache EL DIYUR
Apache EAST BENI SUEF
VEGAS Alam El Shawish West Block I
NAFTOGAS Alam El Shawish East Block II
DOVER ABU SENNAN Block III
BP BED-1
BP WD 33
AG 30
SHELL SITRA
SHELL WEST SITRA BLOCK
HBS GHAZALAT BLOCK
Umbarka
Atoun
Khepri - Seiba
Renpet
Qasr
Khalda
Kalabsha
Neith
Meqet
Imhotep
Tarek
Matruh
Ras Kanayes (A)
Ras El Hekma (B)
Razzak
Alamein / Yidma
N.P. Qahra-2
IPR
Busaiti
Rashid
Salloum


N. Ras El Hekma
Block-9
Off & Onshore Matruh
Matrouh
WEST OBAYED
Bid Round
13
Obaiyed
IEOC
EAST OBAYED
Ras Kanayes
(A)
Ras Kanayes
(B)
Matruh
Ras El Hekma
Tarek
Umbarka
Atoun
Imhotep
Khepri - Sethos
Renpet
IEOC
Meleiha
KHALDA OFFSET
WEST KANAYES BLOCK
Qasr
Khalda
Kalabsha
KHALDA OFFSET BLOCK A
Neith
Heqet
IEOC
E. Kalabsha
WEST KALABSHA BLOCK
HBS
GHAZALAT BLOCK
BURREN
EAST KANAYES BLOCK
Razzak
IPR
N.R. Qattara-2
IPR
RWE-DEA
EAST YIDMA BLOCK
Alamein / Yidma
West Mediterranean Block 1
Alexandria
Marout
SOUTH MARIUT
Bid Round
8
SOUTH ALAMEIN
Bid Round
9
EAST
GHAZALAT
Bid Round
12
NE-Abu Gharadig
BP
BED-1
SHELL
11
THARWA
W. GHAZALAT
SHELL
SITRA
AG 30
BP
WD 33
Apache
EAST BAHARIYA
N. BAHARIYA
SHELL
WEST SITRA BLOCK
VEGAS
Alam El Shawish
West Block I
NAFTOGAS
Alam El Shawish East
Block II
DOVER
ABU SENNAN
Block III
Apache
NORTH EL DIYUR
IEOC
NORTH BAHREIN
Apache
EL DIYUR
BAHARIYA
Bid Round
10
Western
Desert
EGYPT
Area 1




DEVON

NORTH QARUN

Tiba East 1

Wadi Natrun 56 1

Wadi Natrun 57 1

Gebel Rissu Northeast 1

Mamarr El Jimal 1

Gebel Rissu 1

Abu Roash 2

Giza

Apache

Al Ahram 3

Al Ahram 1

Al Ahram 4

Al Ahram 2

WD East 19 1

Kamel 1

Faloukа 1

QARUN

Al Ahram SW

BRE 03 1

El Kattaniya 1

SP 1SC

Kattaniya Northeast 1

Kattaniya South 1

North 5

Qarun Southwest Sakr Deep 1

EDISON

WADI EL RAYAN

Qatrani 1

EL WASTA

7

Harun 1

Qarun 3

Western Desert 38 1

Nesr 1

El Gindi 1

Gindi Deep 1

BRE 06 1

WD East 38 1

Qarun N.B. 1

Qarun N.B. 2

MERLON

EL FAYUM

Area 2

Qarun 2 2

Qarun 2

Wadi El Rayan East 1

Wadi El Rayan 03

WADI EL RAYAN

BRE 27 1

Wadi El Rayan 02

Wadi El Rayan Southwest 1

El Fayoum

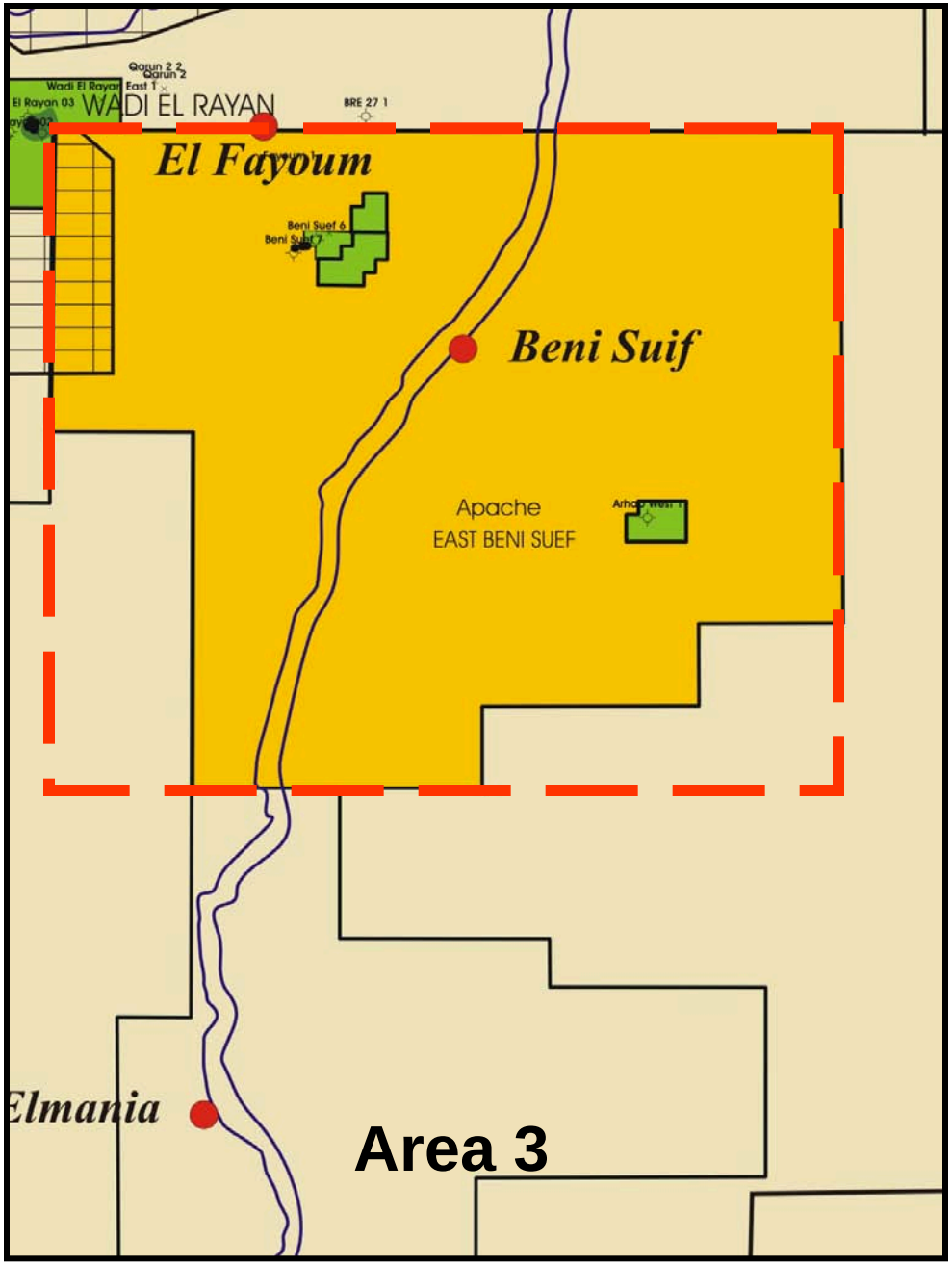
Beni Suef 6

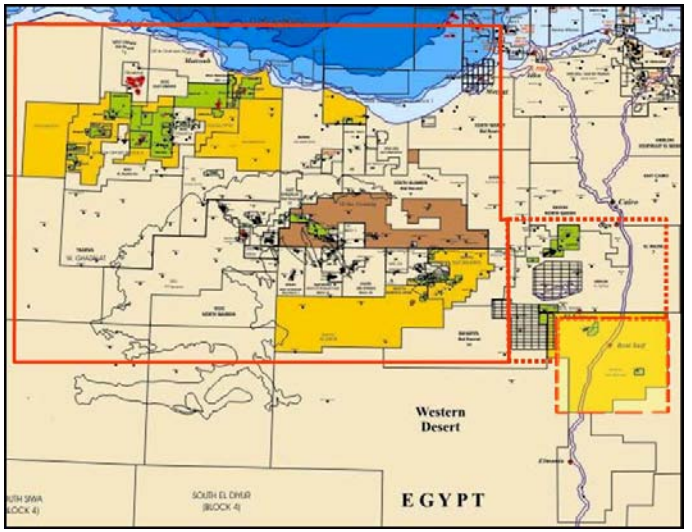
Beni Suef 7

Wadi Raiyan 1

Beni Suif

Beni Suef West 3


Qarun 2 2
Qarun 2
Wadi El Rayan East 1
El Rayan 03
WADI EL RAYAN
BRE 27 1
El Fayoum
Beni Suef 6
Beni Suef 7
Beni Suif
Apache
EAST BENI SUEF
Elmania
Area 3


Western
Desert
EGYPT

## APPENDIX B – PHOTOS

This appendix contains an assortment of photos from various areas of the Apache Egypt operations.


**Tank Containment - Qarun Oil Process Facility**


**Storage Tanks – Qarun Oil Process Facility**


**Qarun Oil Process Facility**


**Qarun Oil Process Facility**

**Salam Gas Plant (Khalda)**

**Salam Gas Plant (Khalda)**

**Umbarka Process Facility**

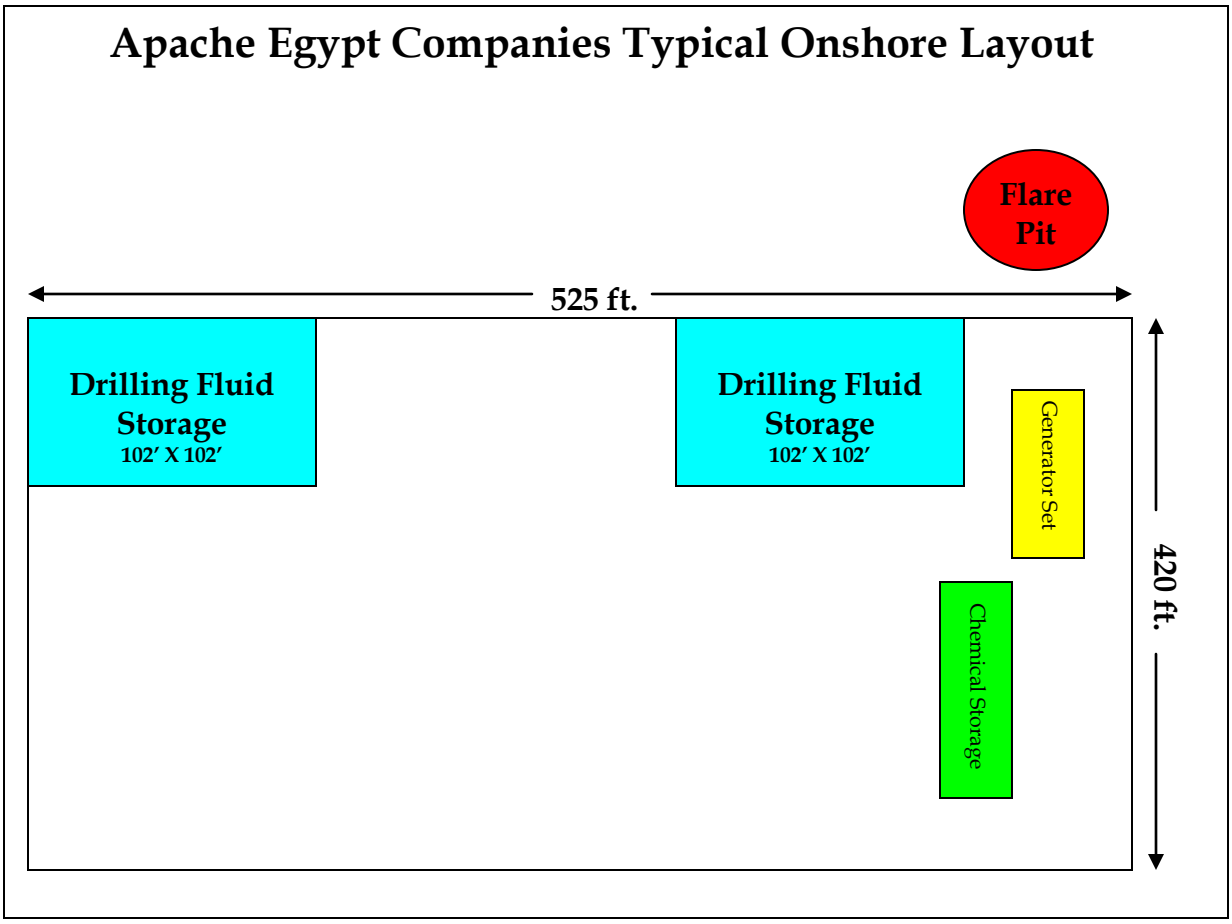

**Typical Wellhead**

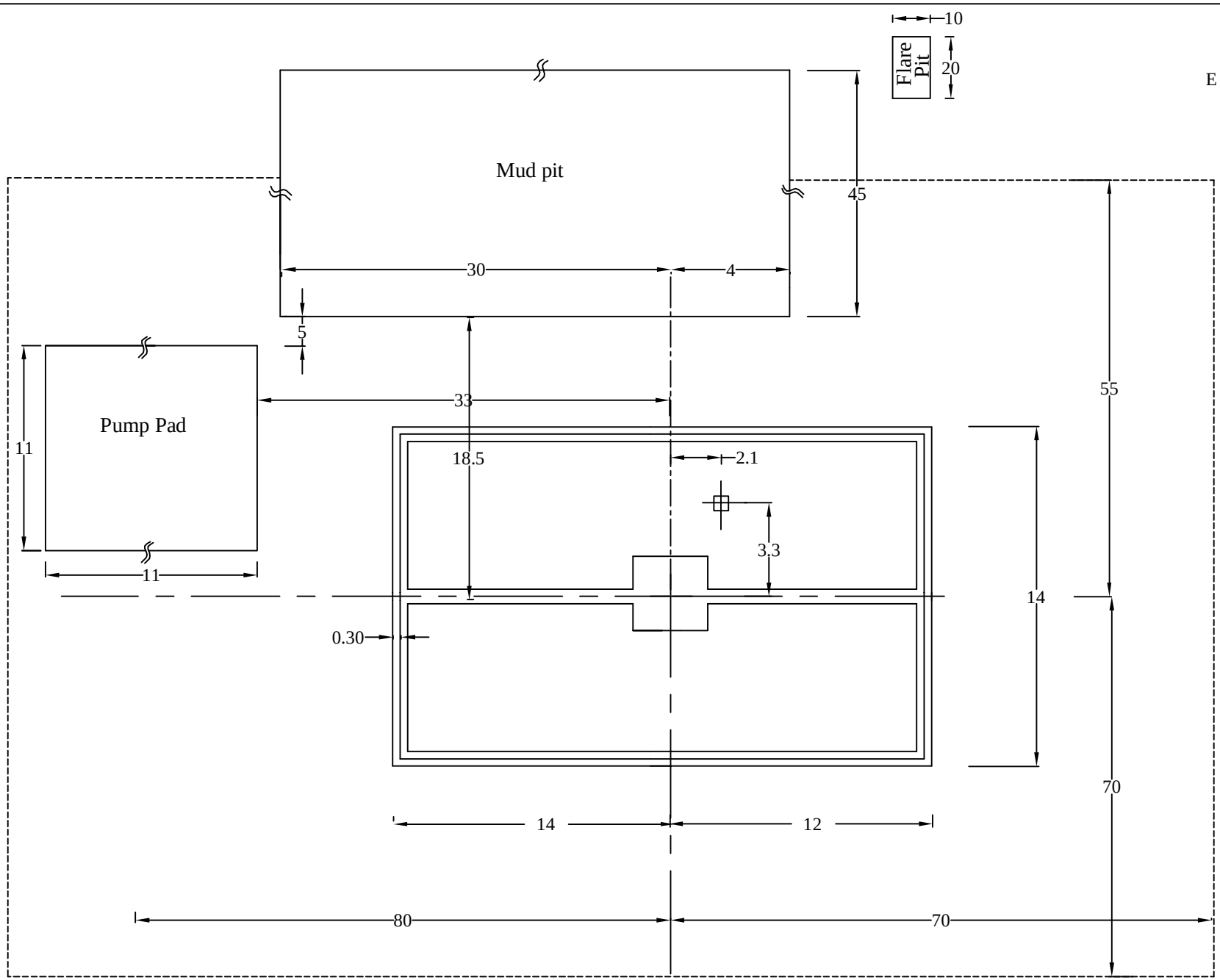
**Tarek Gas Plant (Khalda)**

**Nodal Compressor Station (Khalda)**

**Typical Oil Well – With Pump-Jack (Khalda)**

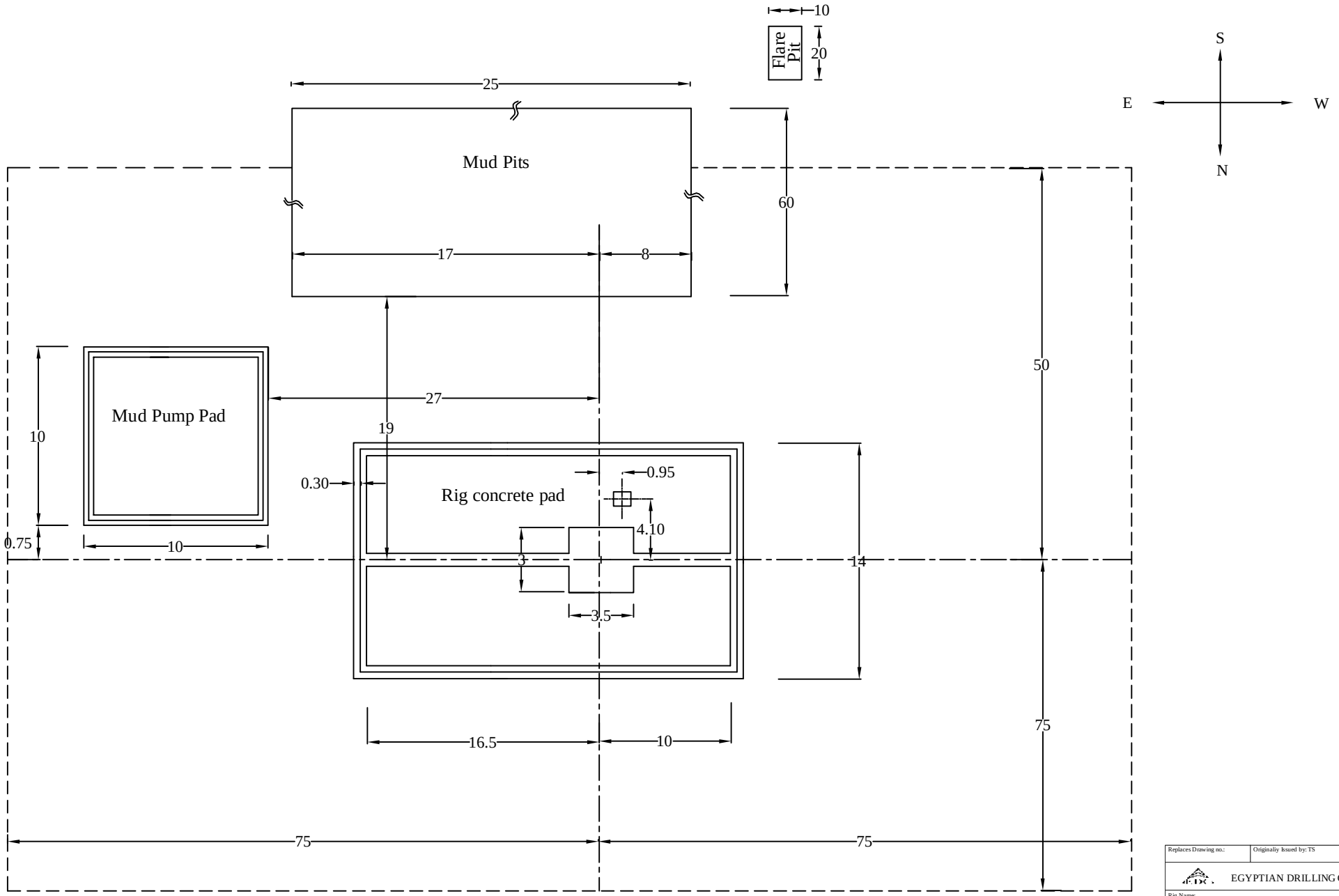
# Apache Egypt Companies Typical Onshore Layout






| Replaces Drawing no.: | Originally Issued by: TS |
|---|---|
| EGYPTIAN DRILLING COMPANY | |
| Rig Name: EDC RIG 51 | |
| Title: RIG LOCATION | Dim: Meter |
| | Size: A4 |
| | Rev. no. 01 |
| Drawings no.: R51 (Case/Rig) 04 (Code) 002 (Number) 001 (Sheet) | 1 Sheet of |

| Rev. | Description | Date | Draw | Chkd. | App. |
|---|---|---|---|---|---|
| A | FOR REVIEW | 26.01.04 | Tawar | | |




| Replaces Drawing no.: | Originaliy Issued by: TS |
|---|---|
| EGYPTIAN DRILLING COMPANY | |
| Rig Name: EDC RIG 42 | |
| Title: RIG LOCATION | Dim: Meter |
| | Size: A4 |
| | Rev. no. 01 |
| Drawings no.: R42 (Case/Rig) 03 (Code) 003 (Number) 001 (Sheet) | 1 (Sheet of) |

| Rev. | Description | Date | Draw | Chkd. | App. |
|---|---|---|---|---|---|
| B | Rev.01 | 01.12.03 | Tamer | | |
| A | FOR REVIEW | 05.10.98 | Tamer | | |