ESIA 2013 ONSHORE SUMMARY

ENERGEAN OIL & GAS

KAVALA OIL S.A.
EXPLORATION AND EXPLOITATION OF HYDROCARBONS

SUMMARY OF THE ENVIRONMENTAL IMPACT ASSESSMENT FOR ONSHORE FACILITIES

Based on the EIA compiled in AUGUST 2009 and revised in 2013

Summary compiled: 2016

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INTRODUCTION

This document provides an overview of Energean's onshore facilities in Kavala (the SIGMA plant operated by Kavala Oil S.A.) that are linked to the offshore facilities in the Gulf of Kavala that are the subject of the current Environmental and Social Impact Assessment by a series of pipelines and power cables. The onshore facilities process the hydrocarbon streams produced offshore by Energean's existing offshore facilities and will process additional production from Energean proposed offshore developments. The onshore facilities are covered by a detailed Environmental Impact Assessment (EIA in Greek) which was renewed and reapproved by the Greek authorities in 2013. The key findings of that EIA are described in this document in English together with current environmental performance data. The modus operandi of these facilities is not affected by the planned offshore development. The facilities were designed to handle oil, gas, water and sulphur product streams at a rate considerably in excess of that which will be achieved post the planned development and have been operated at design capacity for many years in the past. Hence the onshore facilities were not required to be included in the scope of the current ESIA. The 2013 EIA for SIGMA (in Greek) is attached to the current ESIA as an annex providing a comprehensive overview of the entire environmental footprint of the operations of Energean Oil and Gas in the Prinos Basin.

Energean is the only oil & gas producer in Greece with a track record of over 35 years as an offshore and onshore operator of oil & gas assets. In December 2007, Energean acquired the majority shareholding of Kavala Oil, which held 100% interest in the Prinos Concession Agreement. Kavala Oil has been engaged in offshore exploration activities in the Gulf of Kavala since 1999, when it took over operations from the NAPC consortium which discovered and developed the Prinos field in the early 1980.

1. NAME AND PROJECT TYPE

The main activity of KAVALA OIL S.A. is the exploration and exploitation of hydrocarbons. The official inauguration of the offshore and onshore facilities was held on May 24, 1981 while exploration activities commenced back on 1971. The core business is including production and loading of stabilized crude oil, natural gas and sulfur, having an installed power of 17,600 kW. The onshore facilities interconnect with the offshore platforms through three hydrocarbon submarine pipelines and two submarine power cables, as described below. The company has the capacity to generate electricity through a cogeneration system, consisted of 2x5.5 MW gas turbines and 1x5.5 MW steam turbine, which is out of operation since 2010 due to non-effective operation because of the high price of natural gas.

Current production of stabilized crude oil under the new program initiated by Energean in 2015 is expected to be 7,000 bbls/d while design capacity of the plant is 27,000 bbls/d. The planned production coming from the future installations is expected to be up to 16,000 bbls/d and thus resuming a total production of 23,000 bbls/d. The values for sour gas current / capacity / planned / total production are 85,000 / 333,000 / 150,000 / 235,000

Nm3/d. The relevant values for sulfur production are 120 / 478 / 130 / 160 MT/d and for NGL 60 / 265 / 130 / 195 m3/d.

The company's base and activity location is Nea Karvali, Kavala, Greece.

1.1. LOCATION

The KAVALA OIL onshore installation lays 3 km east of the village of Nea Karvali, in a short distance from the coastline and south of the old national road connecting the town of Kavala with the town of Xanthi. The coordinates at the middle of the plant is 40°57′29,85′′ N, 24°32′35,14′′ E.

Picture 1.1.1: Onshore plant locality maps

1.2. ACTIVITY AREA

The onshore plant is covering an area of 204,059 sq.m.

2. PROJECT DESCRIPTION

2.1. OPERATING SCHEDULE

The plant is operating since the 1st of July 1981, including a small period of discontinuance from November 1998 until December 1999 due to the global crude oil prices reduction and change in management ownership.

The plant is also having a 15-days turnaround period every 2,5 years.

2.2. EMPLOYEES

KAVALA OIL is employs 261 staff, 245 men and 16 women. On the onshore facilities there are 75 employees working on 8-hours daily program and 87 working on 8-hours shift programs. On the offshore facilities there are 29 working on 8-hours daily program and 70 on 8-hours shift programs.

Another 80 contractor employees are also occupied under a permanent contract. During the turnaround periods the number of the contractor employees increases.

KAVALA OIL technical staff consists of production operators, electricians, instrumentation technicians, welders, lifting equipment operators and mechanical maintenance technicians.

2.3. RAW MATERIALS

No raw materials are used from KAVALA OIL.

2.4. PRODUCTS

Production products are presented in the table below:

Table 3.4.1: Prinos field production

Type of product		Quantity			
	Design capacity	Current Production	Planned production (from existing facilities, Prinos / South Kavala fields)[1]	Planned Production (from future installations, Epsilon, North Prinos fields)	Total production (existing & planned)
Stabilised crude oil (barrels or bbls/day)	27,000 bbls/d	3,000 bbls/d	7,000 bbls/d	16,000 bbls/d	23,000 bbls/d
Sour gas (cubic meters or Nm^3/d)	333,000 Nm^3/d	40,000 Nm^3/d	85,000 Nm^3/d	150,000 Nm^3/d	235,000 Nm^3/d
Sulphur (megatons or MT/day)	478 MT/d	40 MT/d	90 MT/d	130 MT/d	220 MT/d
Condensates (cubic meters or m^3/d	265 m^3/d	40 m^3/d	70 m^3/d	130 m^3/d	200 m^3/d

The produced crude oil is exclusively transferred to BP Oil International based on a six-year offtake agreement signed on 2014. The sulfur is transferred as liquid to the nearby Fertilizers Industry ELFE S.A. based on a valid permanent agreement. Gas production is now below the process needs but by the end of the planned program there will be an excess of gas that will be exported to the national gas distributing network.

During the various production and processing phases the following auxiliary materials (corrosion inhibitors, demulsifiers, etc.) are used.

Material	Consumption MT/year	Packaging / transportation
Di Glycol Amine (DGA):	12	Road Tankers / portable vessels

[1] Under the new production programme initiated by ENERGEAN in 2015, that has already increased the capacities in comparison to the previous operational years (as described in previous EIS and associated environmental permits).

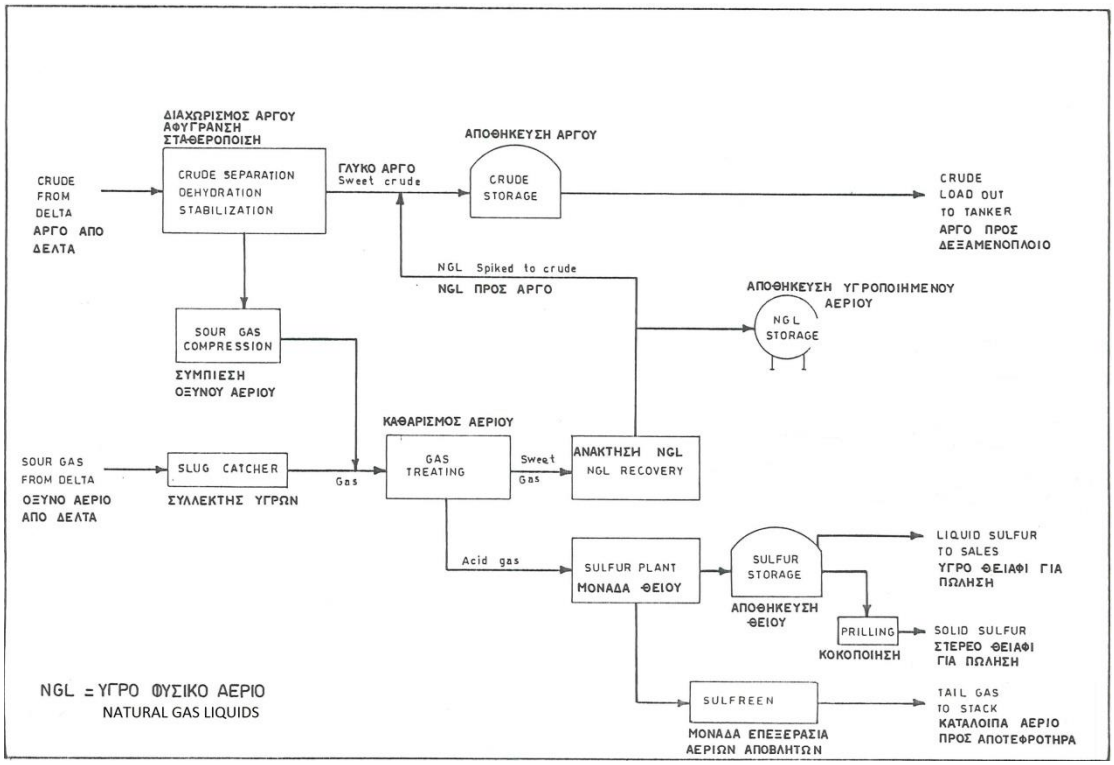
Chlorine (Cl_2):	15	Cylinders of 1 tn
Antifreeze:	0,2	Drums
Oxygen scavenger:	10,7	Drums
Sodium hydroxide (NaOH):	20,5	Drums
Sodium phosphate (Na_3PO_4):	0,15	Bags of 50 kg
Sodium hypochlorite (NaOCl):	0,6	Portable containers of 60 kg
Sulfuric acid (H_2SO_4):	25,8	Road Tankers
Citric acid:	8,8	Bags (pallets)
Lubricants:	10	Drums

2.5. PROCESS

2.5.1. ONSHORE OPERATIONS

The South Kavala field is classified as a sweet retrograde, wet gas field. The liquid hydrocarbons produced from South Kavala are comingled with the liquid hydrocarbons produced from the Prinos and Prinos North fields. The oil from Prinos Field is moderately heavy (27-28° API), under-saturated and sour with a dissolved gas content of 674scf/bbl (120m3/m3) and up to 60% mole H2S in the gas phase and a high wax and asphaltene content. The oil from Prinos North Field is moderately heavy (17-24° API), sour, with a dissolved gas content of 253scf/bbl (45m3/m3), 20-30% H2S and a high wax and asphaltene content. The Epsilon discovery is located in the northern part of the Aegean Sea between 2 and 5km northwest of Prinos. Crude oil from the Epsilon has a light gravity of 36o API, H2S of 8-14% and a dissolved gas content of 349scf/bbl (62.1m3/m3).

Picture 3.5.1: Onshore simplified process flow diagram



Picture 3.5.2: Plant layout map

2.5.1.1. TRANSFER PIPELINES

Six pipelines are used for the transport of hydrocarbons as follows:

- 12" submarine pipeline of 18 km length for the transfer of dehydrated sour natural gas from Delta platform to the onshore facilities (operating pressure of 8 barg)
- 8" submarine pipeline of 18 km length for the transfer of dehydrated sour crude oil from Delta platform to the onshore facilities (operating pressure of 25-40 barg)
- 5,3" submarine pipeline of 18 km length for the transfer of dehydrated sweet natural gas from the onshore facilities to Delta platform for gas lifting the production wells (operating pressure of 20-40 barg)
- 6" underground pipeline of 7 km length for the transfer of dehydrated natural gas from the network of PUBLIC GAS CORPORATION, at Phosphoric Fertilizers Industry facilities, to the onshore facilities (operating pressure of 30-40 barg)
- 24" submarine pipeline of 3 km length for the transfer of stabilized crude oil from the storage tanks to the tanker loading point (operating pressure of 12 barg)
- 16" submarine pipeline of 3 km length for the transfer of ballast from the tanker compartments to the onshore ballast storage tank (operating pressure of 12 barg)

2.5.1.2. CRUDE OIL STABILIZATION

The crude oil after its first processing on Delta platform is transferred with pumps to the onshore facilities, where it is dehydrated, desalinated, stabilized and stored. Water and salts are separated from the oil in the desalter using electricity and special electrodes. The contaminated water saturated with hydrogen sulfide is forwarded to the sour water treatment unit.

Crude, clean of salts and water, is transferred to the low pressure separator. There the expanded gas is transferred to the sour gas treatment unit, while crude oil goes to the stabilizer. The stabilizer is a column consisting of 30 valve trays operating at 2,4 barg with an upper temperature of 78^{o}C and a bottom temperature of 160^{o}C. The stabilized crude is subsequently cooled via a heat recovery system before it is stored in the 3 floating roof tanks.

The gas liberated from the low pressure separator as well as the stabilizer is cooled down thereby condensing heavy hydrocarbons and water. These three phases are fed to a water separator. The separated sour water is then fed to the sour water treatment unit. The gas coming off the top of the tank is mixed with that coming from desalter and fed to a condensate separator together with a stream from the water separator and a stream of condensates from the desalter.

2.5.1.3. CRUDE STORAGE

Two floating roof tanks having a capacity of 125.000 bbls (19.874 m3) each and one floating roof tank having a capacity of 250.000 bbls (39.748 m3) are installed onshore. Thus there is a total storing capacity of 500.000 bbls (59.622 m3).

2.5.1.4. MOORING

Crude is transferred to tankers through a submarine 24'' pipeline as mentioned above. The crude loading is achieved through 4 electrical pumps (2 in operation and 2 spares) having a capacity of 993 m3/h each at 12,83 barg.
The open type mooring (without docking facilities) lies at a distance of 3 km south of the onshore facilities. It consists of 3 buoys that are used for the anchorage of the tanker's stern. Water depth in the area of the mooring facilities is 24 m. Two submarine pipelines connect to the mooring facilities, one 24'' for crude loading and one 16'' for tanker's waste waters transfer to the onshore facilities.

Picture 3.5.1: A tanker at the crude oil mooring facilities

2.5.1.5. GAS TREATMENT UNIT

Sour gas is fed to the DGA absorption tower that operates at 7 barg pressure and 80 ^{o}C temperature and releases sweet gas from its top. Rich DGA that had absorbed sour compounds is stripped with steam and clean DGA is reused. The sour gas from the top of the DGA stripper is fed to the sulfur unit.

2.5.1.6. NGL UNIT

Sweet gas from the DGA absorption tower is fed to the NGL recovery unit. The gas is cooled and heavy hydrocarbons are thus condensed and separated. The resulting separated gas represents the final sweet gas production line and the heavy separated hydrocarbons / NGL are finally spiked to the crude storage tanks, through the NGL storage sphere.

2.5.1.7. CLAUS UNITS

The sour gas from the DGA stripper is fed to the Claus units where one third is burned to produce sulfur dioxide. The rest of the sour gas together with this sulfur dioxide stream is

chemically transformed to sulfur. The sulfur is liquefied and stored in an underground tank. The achieved percentage of the conversion is about 96%. The stored liquid sulfur before loading in road tankers is transferred to a second underground tank where the diluted hydrogen sulfide is separated to a remaining level of less than 10 ppm w/w.

2.5.1.8. SULFREEN UNIT

The Sulfreen unit is designed for transforming to sulfur the remaining hydrogen sulfide and sulfur dioxide existing in the Claus unit flue gases increasing the conversion percentage to 99%. The reaction in the Sulfreen unit follows the same conversion process but at a temperature lower than the sulfur dew point and thus making sulfur stay absorbed in the Sulfreen's catalyst.

2.5.1.9. INCENARATOR AND INCENARATOR STACK

The Sulfreen flue gases and the vents from the two underground sulfur storage tanks are burned in an incinerator with a small supply of natural gas. Thus all sulfur compounds left in the flue gases are transformed to sulfur dioxide.

Exhaust gases are emitted via natural convection in the atmosphere through a 72 m height stack. The gas release temperature is 380 ^{o}C providing effective dispersion of sulfur dioxide in all weather conditions. The release of sulfur dioxide through the stack is controlled by a continuous measuring instrument which is located at a height of 35 m that measures the flow of gases through the stack, the concentration of sulfur dioxide and the daily release of sulfur dioxide into the atmosphere.

2.5.2. PREVENTION MEASURES

2.5.2.1. PROTECTION AGAINST CORROSION

2.5.2.1.1. FACILITIES

The basic methods for addressing corrosion issues are cathodic protection (combination of active and passive) for the underground steel structures and protective coating for the over ground steel structures.

A biannual verification program of the effectiveness of the cathodic protection system is in place.

2.5.2.1.2. PIPELINES

All submarine pipelines are protected against corrosion by a layer of tar and after that by special cement having a thickness of 1 inch together with Zinc anodes.

A biannual verification program of the effectiveness of the cathodic protection is in place.

2.5.2.2. CRUDE OIL STORAGE TANKS BUNDS

The three crude oil storage tanks are installed within bunds preventing spread of crude oil in case of structural failure. Two bunds exist, one containing one 125.000 bbl storage tank

capable of holding full containment of the tank and one containing one 125.000 bbl and one 250.000 bbl storage tank capable of holding the volume of the biggest tank and additional 10% of the total volume of both tanks.

2.5.2.3. FLARE

The flare height is 76,2 m, its maximum supply is 92.000 kg/h and the its smokeless capacity 45.400 kg/h.

The flare system is designed to receive gas vented by pressure safety valves from two segregated relief systems; one operating at low pressures and the other at high pressures. Gas from the relief systems is then passed to the elevated flare where it can be safely burned. At the top of the flare there is a molecular seal to prevent entrance of air into the relief systems. The flare is kept lit continuously via a natural gas pilot supply.

Flaring is regularly followed once per about 2.5 years during the general maintenance (turnaround) of the plant.

2.5.2.4. FIRE AND GAS DETECTION SYSTEMS

The major hazard is the hydrogen sulfide which is highly toxic and highly explosive. To protect employees and installations the onshore facilities are covered by a comprehensive network of detectors according to the requirements of the protected location. Three types of detectors are installed, hydrogen sulfide detectors, fire detectors and combustible gas detectors. A mimic panel in the Control Room is indicating (optical and acoustic) the location of a gas or fire alarm.

2.5.2.5. EMERGENCY SHUT DOWN SYSTEMS

In case of emergency the units can by shut down either automatically of manually.

2.5.2.6. FIREFIGHTING WATER SYSTEM

The firefighting system uses sea water pumped by one main electric fire pump. A diesel fire pump is also installed as spare and an electric jockey pump maintains the system pressure.

The firewater network is located underground and consists of 12'' pipelines. 25 isolation valves allow it to be segregated into sub systems.

The capacity of the fire pumps is verified once per six months and the firewater network is inspected once per 3 months.

2.5.2.7. CONTINGENCY PLAN

The company holds an extensive contingency plan defining all appropriate responsibilities and procedures to be followed in case an emergency response is required. This contingency plan covers cases of accidents, environmental pollution in the air and sea and finally damages within the installation. It defines in detail the administrative and the technical

coordination and the intervention structure that has to be followed during minor and major incidents and the reporting to be followed after that.

2.5.2.8. SEVESO REPORT

The onshore facilities are classified as Seveso II upper limit establishment due to the existing storage facilities for stabilized crude oil and natural gas liquids. The plant has to comply to Seveso III requirements until June 2016. All relevant requirements coming of the Greek Law which puts into force the Council Directive 92/82/EC, such as the safety report, the notification of the dangerous chemical substances, the emergency plans etc. are fulfilled and verified by the Greek Ministry of Oil & Gas industries which is accountable for companies in the Oil & Gas sector.

2.5.2.9. TANKER LOADING BERTH MANUAL

A safety manual for tanker loading berth is available and sent to all tankers booked for crude loading from Prinos Oil Terminal. This manual is referring to all necessary information that has to be exchanged before tanker's arrival in order to assure the safety of the operations. Such information is referring to the sea depth at mooring point, technical features of the crude oil loading pipe, restrictions that have to be followed, eg maximum length and width of the tanker, maximum expected draught at the end of cargo handling etc. Moreover the manual is referring to the minimum required number of tug boats and their minimum required power according to tanker's total dead weight, the necessity of using a pilot for entering of leaving terminal's anchorage, the time restrictions for loading only during the daylight, the wind speed restrictions for stopping the loading operation in more than 24 knots, the prohibition of all maintenance activities on the tanker during the crude loading ,etc. It also includes safety check lists to be filled prior crude loading and short instructions in case of fire to be followed from both parties.

The KAVALA OIL terminal is classified as an ISPS terminal and is equipped with the appropriate, approved by the Ministry of Marine security plan. The security level of the port is 1 and the company divers are regularly monitoring the loading procedures to ensure the security and the safety of the operation. Moreover the tanker's crew is instructed to continuously keep a careful safeguarding for possible crude oil escape. Means of pollution control are always available on the vessel's deck for quick capturing any overflowed oily product.

2.5.3. SERVICES – AUXILIARY EQUIPMENT

2.5.3.1. ENVIRONMENTAL BUREAU

KAVALA OIL is operating an environmental bureau that falls under the HSE Department. An Environmental Engineer is fully occupied in order to assure continuous operation of the Environmental Station that is located 500 m north of the plant, correct evaluation of the environmental monitored parameters, to issue appropriate environmental reports and provide assistance to all relevant issues.

2.5.3.2. PERSONAL PROTECTIVE EQUIPMENT

All the necessary personal protective equipment is provided to employees according to their position, including coveralls, helmets, safety shoes, safety glasses, gloves, chemical suits, earplugs and harnesses.

2.5.3.3. RESCUE EQUIPMENT

All plant locations are provided with 5 min and 30 min breathing apparatus, breathing air cascade cylinders, resuscitation units and automated external defibrillators.

2.5.3.4. FIRST AID

The plant is occupying a doctor on a daily basis and is equipped with a first aid office, first aid boxes, stretchers, eye cleaning devices, safety showers, medical fire blankets and one ambulance.

2.5.3.5. EMERGENCY EXITS

Four gates and seven emergency exits are distributed around the plant fence. The main gate is manned on a 24/7 shift program.

2.5.4. MONITORING SYSTEM

The monitoring of the operational parameters is accomplished in the Control Room, while the environmental parameters are monitored by the environmental analyzers connected to the control room, the Environmental Station and through an additional 12 “total sulfation” stations that are distributed in the region around the plant; 8 onshore around Kavala and 4 on Thassos Island. All signals from these stations are connected directly with the Environmental Office of the Sigma plant.

2.5.4.1. CONTROL ROOM

The Control Room is manned on a 7/24 shift base. Two of the six units are equipped with a computer based SCADA system while the rest are still operated with the classical type of electromechanical controllers and indicators.

2.5.4.2. ENVIRONMENTAL STATION

KAVALA OIL has operated the Environmental Station since 1979. The environmental analyzers are monitoring and recording the concentrations of sulfur dioxide (SO2), hydrogen sulfide (H2S), total hydrocarbons (HCT), methane (CH4) and non-methane hydrocarbons (HCNM) in the atmosphere. It is also monitoring and recording meteorological data, wind speed and direction, ambient temperature and relative humidity of the atmosphere.

Responsible for operating the Environmental Station is the Environmental Engineer and accountable the HSE Manager.

2.5.4.3. TOTAL SULFATION UNITS

Sulphurous gases such as sulfur dioxide, hydrogen sulfide and mercaptans are oxidized with lead dioxide on lead sulfate. The oxidation is known as “total sulfation”. The lead dioxide in the form of a special cream with mastic alcoholic solution is placed in special surfaces (medical dressings) and are placed at 12 permanent installed stations as shown in the below area, measuring total sulfation.

The results of the measurements are included in the monthly and annual environmental reports.

Picture 3.5.4: Locations of total sulfation stations

2.5.5. FUEL

KAVALA OIL is mainly consuming natural gas as fuel gas. The fuel gas is a mixture of three types of sweet gas, the produced gas from Prinos, the produced gas from South Kavala and natural gas through the national distribution system.

Diesel is mainly used in internal combustion engines, as well as a cleaning agent against asphaltenes in drilling activities.

2.6. WASTE GASES

Waste gases from onshore facilities are released from the incinerator stack of the sulfur production (Claus) units, the stack of the gas regeneration burner of the Sulfreen unit, the steam boilers chimney, the steam superheater chimney and the gas turbines chimneys (which are currently out of operation since 2010).

The main emissions include sulfur dioxide, carbon dioxide, nitrogen oxides and hydrocarbons coming from the crude oil storage floating roof tanks. Carbon dioxide and nitrogen oxides originate from the combustion of natural gas whilst sulfur dioxide is produced from the incinerator stack of the Claus units and less so from the sulfur content of gas burnt as fuel.

Due to the fact that the main fuel gas is natural gas, smoke emanating from the stacks and chimneys, does not exceed 1 degree on the Ringelmann scale and generally no burning chamber or point of the production process is producing smoke on the wider environment around the plant.

Hydrocarbon releases are generally associated with leakage past the floating roof tanks' rim seals; the rate of loss being proportional to the wind speed.

2.7. LIQUID WASTES

Liquid waste streams are associated with the sour water treatment unit, the oily water treatment unit, the waste oil unit, the wastewater of the sewage treatment unit, sea water used for cooling, rain water run-off and waste waters from the desalination unit.

2.8. SOLID WASTES – SLUDGES – TOXIC WASTES – GENERAL WASTES

Solid wastes coming from the process include oil base mud, spent catalysts, sludge from the sewage treatment unit, batteries and accumulators as well as domestic wastes.

Their EWC Codes are the following:

EWC Code	Waste Description
01 05 07	barite-containing drilling muds and wastes
01 05 05*	oil-containing drilling muds and wastes
05 01 06*	oily sludges from maintenance operations of the plant or equipment
16 06 05	other batteries and accumulators
16 08 03	spent catalysts containing transition metals or transition metal compounds not otherwise specified
16 06 01*	lead batteries
16 06 02*	Ni-Cd batteries
16 07 08*	wastes containing oil
19 08 05	sludges from treatment of urban waste water
20 01 01	paper and cardboard
20 01 08	biodegradable kitchen and canteen waste

All wastes are managed by authorized 3rd parties according to Greek and European legislation.

2.9. NOISE

The plant equipment is normally producing high level of noise. These equipment include the steam turbines (that are out of operation since 2010), the steam turbine (that is also out of operation since 2010), various compressors' and pumps' motors and engines.

The plant is in operation continuously and there are minor fluctuations in the noise intensity. Moreover the equipment due to their type is not causing high impact noises or explosions that could disrupt employees' attention.

Measurements have shown that the level of noise is not exceeding the 65 dBA outside of the plant boundary, provided that the safe noise level for humans is 85 dBA for continuous 8-hour work without ear protection.

3. CURRENT ENVIRONMENTAL SITUATION

3.1. NATURAL ENVIRONMENT

3.1.1. GEOLOGY OF THE AREA

The southern parts of the prefectures of Kavala, Xanthi and Rodopi are located in the geological tectonic zone of Rodopi and are part of tertiary tectonic wells of Nestos and Visthonidas. The background of the wells appears in northern parts of the lowlands where begins the mountainous mass of Rodopi. It consists of metamorphic rocks of the homonymous zone as gneiss, schists, amphibolites, marbles, formations which in many places are crossed by granitic intrusions or covered locally by volcanic rocks. This background is very deep beneath the sediments of the lowland area due to zone faults with E-W direction identified on the line nearly mountain curbs and delimits the lowlands. Characteristic is the size of the transition resulting from these faults. Wells after the main folds formed during the tertiary geological period. Depending on the immersion time initially filled with water corresponding age sediments and then by rotations sediments and activities of fluviotorrential and lacustrine phase. These formations in the broad axes of streams and lakes are now covered by recent alluvial deposits with similar lithologic composition. The total sediment basins are affected by faults - transitions systems, which in turn have contributed to the evolution of the wells having main directions NE-SW, E-W and SE-NW. These faults may influence the hydrogeological conditions mainly of the plain parts and especially the emergence of heterogeneous aquifer in depth, as they change the geometry of the individual horizons. This is the main cause for the appearance of geothermal areas in the area of study.

Neogene sediments form the first precipitates set for most of the Nestos basin. A characteristic of Neogene sediments is that the Miocene in the basin of Nestos represented by considerable deposits of evaporites (rock salt, anhydrite), whose thickness ranges from 480-850 m and the absence of Miocene strata on the surface.

Quaternary and paleo-Quaternary sediments occupy a small surface area and mainly located at depth beneath younger Quaternary deposits. The paleo-Quaternary encountered under modern sediments of the plain and has their origins in the deposition material streams and rivers of the region. Later Quaternary deposits are covering most parts of the lowlands.

3.1.2. MORPHOLOGY OF THE AREA

The coastal zone morphology of the region is highly distinctive and interesting with long sandy beaches, alternating lakes, lagoons and islets land. The whole of the Nestos valley can be considered to consist of land which has similar characteristics such as common bedrock of quaternary deposits, small land development and lack of horizons, common substrate by sand aquifer at a depth from 0 to 4 m and a thickness up to 5 m in most cases, rare

occurrence of calcium carbonate, pH from 6.3 to 7.6, small content of Ca, N, P and organic substances and adequate K.

The sediments of the plain are of very young age and territories are in the early stages of development. The progress of the evolution is restricted to the formation of one horizon and leaching of soluble salts and alternative cations. The hilly area consists mainly of hills with gentle slopes. But in the regions that are linked to the mountain call is sizable. Erosion has greatly influenced the formation of soils. The mountainous region consists of mountains with steep slopes, covered by sparse scrub vegetation. The rocks that take part in the formation of land are marble and slates. On cracks and hollows created in the course of the dissolution of limestone, exists red clay soil material.

3.1.3. ECOSYSTEMS

The mountains surrounding the plant on the north create a land morphology that is conducive to surface water flow. Rain waters form numerous streams to the plain which are flowing to the sea through drainage channels.

The plain is largely composed of light sandy soil with limited water holding capacity. Swampy areas were raising barriers to land farming. The limitation of water through irrigation and drainage were the first steps necessary for the cultivation and increasing the productivity of the plain soils. The problem was permanently solved by creating drainage channels.

The area belongs to the Mediterranean zone of sclerophyllous forests. Within this zone evergreen forest sclerophyllous oaks such as Quercus Ilex should be the predominant vegetation. Today these forests have disappeared and in its place mainly dominated the brushwood Quercus Cocciferer Juniperus in zones that are not cultivated and heather Erica Verticilata mainly over silicate rocks. In saline or alkalized soils if not cultivated dominated by halophytes as Myrica Alimos Tamarix and Atriplex.

Terrain in the hilly and mountainous area favors erosion; soils are shallow and covered with rocks and stones making agricultural use not possible. In the rest of the hilly area cereals, vines and almond trees are mainly cultivated. The bionics sand plain is mainly cultivated with wheat, corn, beans, peppers, watermelons, melons and tomatoes. Cultivation is intensive and there is very rare natural vegetation except brambles, Recdus Fruricosus, and some other shrubs in the channels.

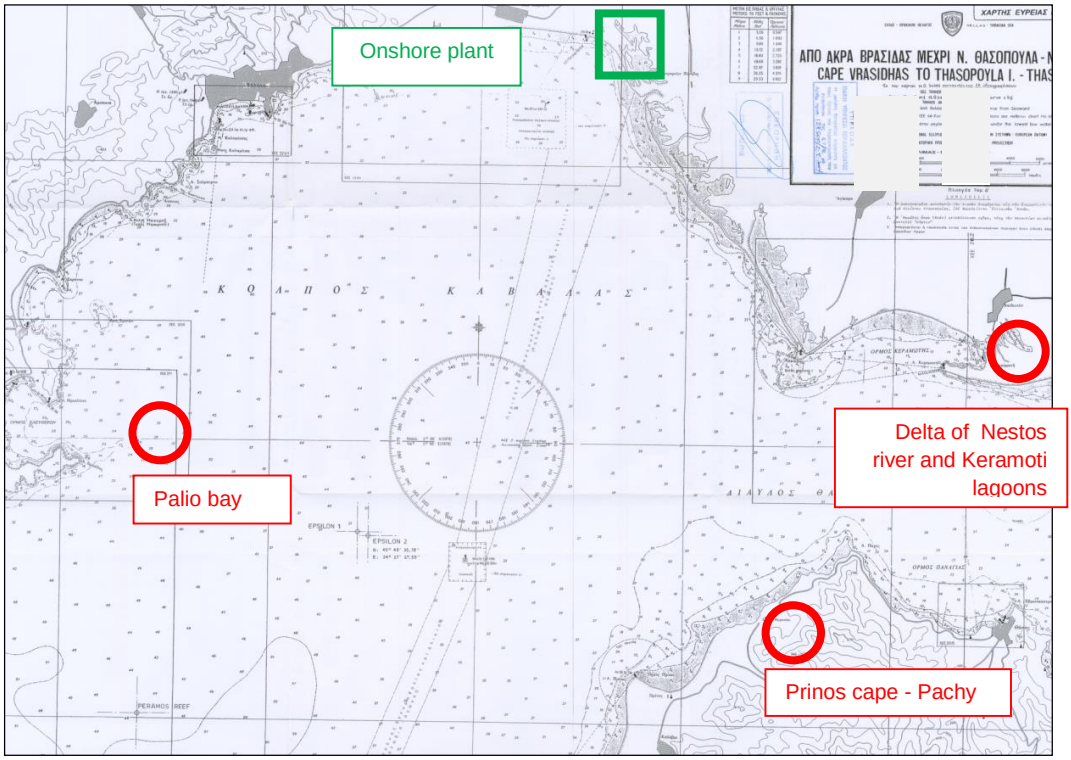
The first ecological assessment of the area of Eastern Macedonia and Thrace was held by the Ministry of Environment, delimiting the Ramsar Convention wetlands where it was recognized that the three wetlands Nestos - Visthonida - Maternal are single natural ecosystems and should be dealt with accordingly. In general we may accept that this first estimate is facing reality even today after the establishment of the Ramsar Convention.

The three wetlands are of great ecological value for Greece and Europe, when viewed either as indivisible ecosystem (a large wetland complex in the eastern part of the Mediterranean) or considering each wetland individually.

In the broader area there are also 3 places included in NATURA-2000.

- Prinos cape – Pachy GR1150006
- Palio bay – Eleftheres bay GR1150009
- Delta of Nestos river and Keramoti lagoons GR1150010

Picture 2.1.1: NATURA-2000 areas



The western border of the Delta of Nestos river and Keramoti lagoons GR1150010 Natura 2000 area is 800m from the plant. A Special Ecological Assessment conducted in 2015 confirmed that the plant or an unplanned event such as an oil spill from a pipeline, is not impacting, or would not impact, this Natura 2000 area or impact upon it's objectives.

3.1.3.1. METEOROLOGICAL AND CLIMATIC DATA

The climate in the area of study is between Mediterranean and mid-continental and is characterized by rainy and mild winters and hot and dry summer. The area meteorological data are coming from the KAVALA OIL Environmental Station and are average values of the last 5 years.

These data show that predominant winds direction in the study area is North - Northeast and South - East and the average wind speed is 3 to 5 Beaufort, ie 12 km/h to 38 km/h respectively.

The warm period (May to September) is dry to very dry with high temperatures in July and August. The average annual temperature in the area is 16,3 ^{o}C, while the maximum and minimum temperature recorded in the last 5 years is 41 ^{o}C and -8 ^{o}C respectively.

The cold season is long and comprises moderate rainfall with relatively even distribution (average annual rainfall of 300-400 mm). Snow rarely falls during December and February on the surrounding mountains. Fog rarely occurs. The moisture content ranges from 52,8% to 77,1%.

3.1.3.2. HYDROGRAPHIC – HYDROLOGIC DATA

3.1.3.2.1. GROUNDWATER AND SURFACE WATER

The groundwater quality is closely linked to the geological – geomorphological environment where aquifers are located effecting the environment. Aquifers receive various pressures and thus differentiating the groundwater quality, being in communication with them as confirmed by conductivity measurements undertaken in the past.

The area around the plant has several drain channels in order to collect the excess of water from the fields, which is then streamed into the sea. The surface water in the plant is treated in two ways:

- The water from open areas, roads etc. is collected and flows outside of the plant,
- The water from the area of the units potentially containing small quantities of oil is collected through a network of sumps and pipelines and is finally treated in the Oily Water Treatment Unit.

3.1.3.2.2. GULF OF KAVALA

The gulf of Kavala shapes amphitheatrically having its symmetrical axis in the direction NNE-SSW and has a length of about 40 km. Its total area, including the sea area between the Thasos Island and the Peramos southwest coastline, covers an area of approximately 600 km^2, with low tilt smooth seabed, which rises abruptly near the coast. The average depth does not exceed 40 - 45 m while sediments covering seabed are mostly fine.

Wave heights in the coastal area have been observed to be about 0,5 to 1 m most of the time having a period as 5 s but rarely waves height is higher than 3 to 4 m.

Sea currents in the Gulf of Kavala are observed to have alternating cyclonic-anticyclonic movement with a relatively low speed (Kardaras, 1984). These changes of motion are substantially affected by the prevailing wind and tide which has a width of approximately 25 cm in the area (Zois, 1981). Measurements contacted in the past by the Hellenic Hydrographic Office revealed low speeds in the range of 5 to 10 cm/s.

3.1.4. FLORA – FAUNA

The current situation on flora and fauna of wetlands under direct and indirect human pressures includes two zones:

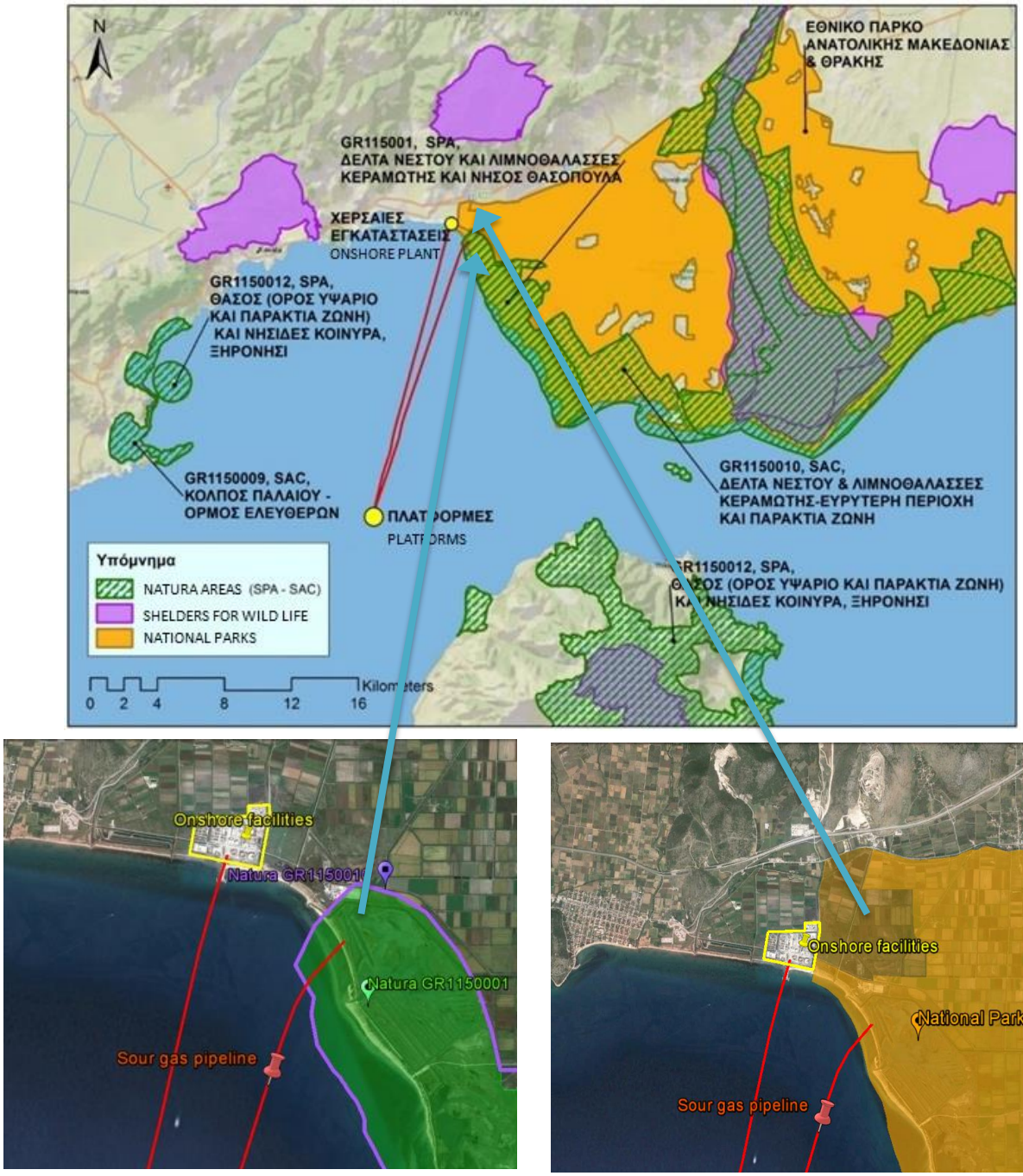
- The coastal wetlands zone lying East of Nea Karvali village to Imeros coast having a width of 500 – 4.000 m
- The cultivated areas zone lying North of wetlands up to the old national road

The main vegetation includes ammophilous and halophytic communities, shrub Tamarix and reedbeds, scrub vegetation (Morus, Crataegus, Frangula), herbaceous vegetation (Arum, Chelidonium, Geum, Brachypodium Dactylis) and large numbers of climbing plants (Hedera, Periploca, Humulus, Tamus , Smilax, Vitis, Clematis).

The remarkable variety of fauna in the region lies in the zone of wetlands and includes amphibians, reptiles, mammals and birds. Remarkable is the artificial and free fish production.

The wetland in the Delta of Nestos River with a system of lagoons hosts a particularly rich avifauna. Literature and personal observations made by the ornithologist Jerrentrup Hans showed a variety of about 310 bird species in the region. It should be also noted that the area is used for feeding a variety of predators coming from the mountainous region of Nestos River.

Picture 2.1.4: Natura areas, National parks and shelters for wild life in the project area



3.2. ANTHROPOGENIC ENRVIRONMENT

3.2.1. SETTLEMENTS IN THE AREA

3.2.1.1. IN GENERAL

According to the 2011 census, the population of the regional unity of Kavala is 145.000 inhabitants living in 4 municipalities, Kavala, Thassos, Nestos and Paggaio . The city of Kavala gathers a wide range of activities and services because of the high population numbers, its locational capacity and its regional role, while small provincial centers serve as local commercial market places and locate certain administrative services.

The settlements in the broader study area include Nea Karvali having a population of 1.950 inhabitants, Lefki having 56 inhabitants, Chalkero having 212 inhabitants, Nea Komie having 62 inhabitants, Pontolivado having 461 inhabitants and Petropegie having 596 inhabitants. Nea Karvali is the nearest settlement to the plant. It is located 2km to the west. The plant is an industrial area and surround on three sides by agricultural land. Gulf of Kavala is located to the south of the plant.

In Kavala city there is a big hospital and a numerous of private clinics.

Picture 2.2.1: Map of wider area around the onshore plant

3.2.1.2. EDUCATION – CULTURAL INFRASTRUCTURE

Kindergarten and primary school exists in Nea Karvali, Pontolivado and Petropigie. High school and church school exist in Nea Karvali. Children coming from Lefki, Chalkero and Nea Komie are using the primary school in Nea Karvali and Pontolivado. All settlements' children are using the secondary and high schools in Kavala.

Cultural events are quite strong in the area. There is cultural association in Nea Karvali that organizes every year many events culminating in the international cultural event called “Sun and Stone” lasting three days.

3.2.1.3. PUBLIC SERVICES

All public services are based in Kavala. Minor basic services (police dept., post office etc) exist in Nea Karvali.

3.2.1.4. TECHNICAL INFRASTRUCTURE

The potable water to Kavala and Nea Karvali is coming from the sources of Agios Athanasios at the Prefecture of Drama, while the remaining settlements are sourced from the springs of Paradisos at the foot of the mountains west of Nestos River.

The road network in the area is satisfactory. Most of the roads are paved. The transportation to the villages is carried out by public buses.

3.2.2. PRODUCTION SECTORS – NATURAL RESOURCES – TOURISM

3.2.2.1. INDUSTRIES

The units in the area within a radius of 5 km which is considered industrial is KAVALA OIL SA, the Phosphoric Fertilizers Industry, the NASCON S.A. a wind turbine tower manufacturing industry, Kavala Marbles, the storage and handling facilities of liquid fuels PENYLAN, the liquid fuel storage and handling facilities REVOIL, the aggregates mining unit VOUGIOUKLI and the aggregates mining unit KORAKAS.

3.2.2.2. AGRICULTURE – OWNERSHIP

Data from the National Statistical Institute shows the average size of agricultural property in Kavala is 35,3 acres and distributed by size order as follows:

- 18,7% of agricultural properties sizes 1-9 acres (aver. of 5 acres)
- 45,9% of agricultural properties sizes 10-29 acres (aver. of 22 acres)
- 20,8% of agricultural properties sizes 30-49 acres (aver. of 42 acres)
- 10,3% of agricultural properties sizes 50-99 acres (aver. of 76 acres)
- 4,3% of agricultural properties sizes over 100 acres

In recent years significant problems began to appear due to the intensification of agriculture having direct effects on wetlands in the area due to the excessive use of fertilizers, pesticides and insecticides.

3.2.2.3. LIVESTOCK BREEDING

Livestock production remains at a low level since the pastures are limited.

3.2.2.4. FISHERIES – FISH FARMING

Fishing and fish farming are important economic activities in the region. Natural fish farms in Kavala is one of the most productive in Greece, the only ones in the region who make semi-intensive fish farming and the first that made improvement works (dredging, metallic fish capturing facilities, wintering areas, drilling for fresh water supply).

Kavala is the third major fishing port in Greece having a fleet of 51 medium fishing vessels and 450 coastal vessels. The annual fishery production is about 6,000 tons. They employ 1,000 people in total.

3.2.2.5. FORESTS

At Delta of Nestos River there is a small residual of hydrophilic forest Kotza - Orman with white and black poplar, lowland elm, oak, flat and tatar maple, alder and climbing species (Periploca, Hedera, Humulus, Tamus, Smilax , Vitis, Clematis).

Elsewhere in the Delta area and on the banks of the Nestos River till Toxotes village, there is a solid poplar artificial forest in a width of 60-80 m from the river bank protection. The large pine forests that existed around Kavala and Thassos almost completely destroyed by the fires of 1985 and beyond.

3.2.2.6. WATER RESOURCES

Nestos River rises in the Rila Mountains and flows into the Aegean Sea near the island of Thassos. At the end of his route, the main stream spreads over the coastal plain of Chrysoupolis, east of Nea Karvali and expands as a deltaic system with freshwater lakes and ponds forming the Nestos delta.
One of the major low enthalpy geothermal fields in Greece is the sedimentary basin of East of Nea Karvali at Nestos delta, covering the region of the plain of Chrysoupoli and particularly among communities of Petropigi and Eratino in the Municipality of Chrysoupoli.

3.2.2.7. MINERAL WEALTH

The mineral wealth around the onshore facilities and within 5 km from them is limited to marble and aggregates.

3.2.2.8. TOURISM

Tourism areas within the Prefecture of Kavala in the city of Kavala, the seaside villages West of the city of Kavala (Palio, Iraklitsa, Nea Peramos), the seaside area of Keramoti East of Kavala and the Thassos Island.

3.2.3. EXISTING INFRASTRUCTURE IN THE AREA

3.2.3.1. ROAD TRANSPORT NETWORKS

Egnatia motorway is the main road axis in the area. There is also the old highway connecting Kavala with Xanthi and settlements in the surrounding area are interconnected with smaller public roads.

3.2.3.2. PORTS

The main area port is Kavala port and other smaller ports exist in Keramoti, Thassos Island and Nea Peramos 20 km West of Kavala.

The passenger port of Kavala is at city's coastline while the commercial port of Kavala is East of Kavala and West of Nea Karvali.

There is also a port at the Phosphoric Fertilizers Industry to transport raw materials and products and also KAVALA OIL operates a small jetty in a distance of 200 m from the onshore facilities, to transport material to and from the offshore facilities.

On the jetty a 30 tn capacity crane is installed in order to serve the materials' transportation on and off the vessels connecting the onshore with the offshore facilities. The jetty is also used as a mooring position for the barge Limin Prinos that transfers oily water from offshore to onshore facilities. The jetty is equipped with power supply and 8 small diameter pipelines for transferring air at 8 bar pressure, firewater and potable water from the onshore facilities to the company's vessels and oily water from the barge to the onshore facilities.

3.2.3.3. AIRPORTS

The national airport lies in a distance of about 15 km east of the onshore facilities, near Chisoupoli village and there is also a military airport about 5 km north of the city of Kavala.

3.2.3.4. ELECTRICITY AND TELECOMMUNICATIONS NETWORKS

KAVALA OIL plant is fed in a ring interconnection through a 150 KV volts network that is supported from Kavala station from the one side and from Xanthi station from the other side. That's why the power supply to the plant is extremely smooth and stable.

Telecommunications are achieved through the fiber optics backbone network of the ex-National Telecommunications Company and others' private companies' sub-centralized networks.

3.2.3.5. POTABLE WATER AND WASTEWATER NETWORKS

The settlements in the study area, and also KAVALA OIL, are supplied with potable water from the springs of Paradisos community. Nea Karvali village is an exception that is supplied from the sources of Agios Athanasios from Drama Prefecture.

The city of Kavala has a modern sewage system and wastewater treatment plant (biological treatment plant).

KAVALA OIL is also equipped with a sewage treatment plant for the treatment of the anthropogenic effluents.

3.3. PRESSURES TO THE NATURAL ENVIRONMENT

3.3.1. IN GENERAL

In the study area there have been constructed in recent years full drainage and irrigation networks, resulting in excess cultivation of a broader area. This resulted in the disappearance of parts of habitats near the sea.

3.3.2. LAND RECLAMATION – DRAINAGES

Drainages in wetlands and land reclamation occurred in recent years having as consequences the systematic removal of sand, the distruction of aquatic vegetation and reed beds, the disappearance of species of birds, the distruction of areas with rushes Juncus, with plenary vegetation with Tamarix and the overthrow of the ecological balance in the area.

3.3.3. IRRIGATION WORKS

Most areas are served by surface irrigation networks. The producers are using fertilizers in high frequency and the amounts of these fertilizers and their drainages go through the underground aquifers formations or through the drainage ditches and end up in natural recipients (lagoons - sea), creating eutrophication due to high concentrations of NO_3 and PO_3.

In the areas served by wells the problem is more complex. The exhaustive consumption of aquifer formations have led to a significant drop in level in most wells. In order to face this problem they dredge the wells or drill new wells and thus extending the pollution to deeper formations.

Reducing further the volume of the aquifer that are in communication with the sea result in the invasion of seawater to them that increase the concentration of Cl- and Na + making it unsuitable for irrigation.

3.3.4. FISH FARMS

The opening of new communication channels with the sea, the abolition of ditches, the dredging, the roads constructed and dikes created by the excavation are probably disturbed lagoons and wetlands.

3.3.5. FIRES

Fires happened 15 years ago in the region of Kavala and Thassos Island, destroyed a significant part of the vegetation and expelled from the region many species of birds, animals and reptiles.

3.3.6. HUNTING

The exceptional wealth of the fauna of wetlands complex attracts large number of hunters not only from the surrounding area but also from the neighboring cities, i.e. Xanthi and Komotini and from larger urban centers like Athens and Thessaloniki. This large number of hunters causes intense discomfort and possible reduction of game population.

3.3.7. TOURISM

There are a large and increasing number of tourists that visit the broader study area. Thassos Island is the first tourism destination in the broader area while there are more than 10 beaches with blue flags in the wider area of Kavala and Thassos.

In the close proximity of the study area there is limited tourism activity due to restricted tourism infrastructure.

3.3.8. CURRENT POLLUTION STATUS – INTERACTION BETWEEN NATURAL AND HUMAN ENVIRONMENT

East of the onshore facilities of KAVALA OIL is the old garbage disposal area of the city of Kavala and the rest of the settlements which has been abandoned several years ago hence eliminating any health hazard.

The industries, the cars and the central heating of accommodations are environmental pollutions sources having normal emissions in the area due to the low percentage of surface coverage by population.

4. ASSESSMENT AND EVALUATION OF ENVIRONMENTAL IMPACT

4.1. ECOLOGICAL IMPACT

4.1.1. EMISSIONS TO ATMOSPHERE

Gaseous emissions during KAVALA OIL operation include the following pollutants: CO_2 (carbon dioxide), NOx (nitrogen oxides) SO_2 (Sulphur dioxide) plus hydrocarbon vapours from bleeder vents of the stabilized crude oil storage tanks.

4.1.1.1. CARBON DIOXIDE (CO_2)

CO_2 is emitted during natural gas combustion, which is the main fuel used in the installation. KAVALA OIL participates in the program for reduction of greenhouse gases (Kyoto protocol) and during the first period of its implementation (2004-2007) CO_2 emissions were below the quantities allocated as per the National Plan for Allocation of Emission Rights.

At present the CO2 emissions are about 35,000 tn per year. After the development project it will be decided whether the excess gas production is exported to the national gas network of used for electricity generation. In case of exporting there will be no additional emissions,

while in case of producing electricity the additional CO2 emissions will be about 40,000 tn per year.

4.1.1.2. NITROGEN OXIDES (NOx)

NOx are emitted during natural gas combustion, which is the main fuel used in the installation. The company has budget the replacement of the existing steam boilers' burners with low NOx burners in order to reduce NOx emissions. Moreover it is also assessing the optimization of the cogeneration gas turbines burners. The new development project will not impact NOx emissions.

4.1.1.3. SULPHUR DIOXIDE (SO_2)

SO_2 is the main gaseous pollutant of the onshore facilities and is emitted from the stack of the SRU (Sulphur Recovery Unit) Incinerator. It also originates, in a much lesser degree, from the Sulphur content of burnt natural gas.

ALOHA® (Areal Locations Of Hazardous Atmospheres) software (developed by U.S. Environmental Protection Agency and U.S. National Oceanic and Atmospheric Administration) is used to assess SO_2 dispersion. ALOHA software uses a Gaussian dispersion modelling and can incorporate dispersion of gases heavier than air. It concluded the following regarding the normal emissions coming from the incinerator stack.

Normal Conditions		
Distance from stack (meters)	SO2 concentration at surface ($\mu g/m^3$)	Threat zone color (Picture 1)
0-750	0	-
750-2100	50	Red
2100-2800	40	Orange
2800-3700	30	Yellow

According to the Legislation the maximum SO2 concentration in the atmosphere is 350 μg/m3 (hourly average) and 125 μg/m3 (daily average).

Picture 4.1.1: ALOHA SO2 dispersion under normal conditions under prevailing N-E winds

As shown in the table at the end of the document the Sulphur Dioxide measured in the 12 total sulfation units is within the EU limits. The new development project will slightly increase SO2 emissions but they will remain within the limits.

4.1.1.4. HYDROCARBON VAPOUR EMISSIONS FROM STABILIZED CRUDE OIL STORAGE TANKS

Stabilized crude oil is stored in floating-roof tanks. Hydrocarbon vapours are emitted from the bleeder vents of the storage tanks.

Following the methodology detailed in API 2517 “Evaporation Loss from External Floating Roof Tanks”, the hydrocarbon vapours emitted have been calculated at 265 bbls/year. These emissions will be increased by the final development of the new project by will remain within the limits specified in existing permits.

4.1.2. DISCHARGES AT SEA

Seawater used for cooling purposes is discharged unpolluted through the cooling water discharge header in a ditch (at the east side of the onshore installation) which is used for drainage of adjacent plots and land. This drainage ditch starts from the old Kavala-Xanthi national road and ends up at the coast.

The only negative, but not significant, impact is the increase of the temperature of the seawater used for cooling by approximately 10 ^{o}C. Cooling water is dispersed quickly in the nearshore and changes in sweater temperatures are limited to a small area. With the offshore development, cooling water discharges will increase but will not result in a significant impact on the marine environment. Volumes will be below the maximum design discharge volumes.

The new project development will not impact discharges at sea.

Figure 4.1.2.: Outlet of waste water discharge pipe

4.1.3. WATER

As mentioned in the description of the operation, the nature and the quality of liquid and solid waste streams of the KAVALA OIL onshore facilities is such that there is no impact to the area's groundwater.

Moreover, there is no possibility of impacting the quality of groundwater or surface water from disposal of the facilities' solid waste or toxic waste/sludge or domestic waste.

There are no groundwater wells in the facility or any groundwater consumption other than that from the Paradisos village springs, 35km east of the installation, this being the only negative impact on the area's water resources.

4.1.4. IMPACT ON GROUND AND LANDSCAPE

The area where the onshore facilities were built in 1979 was a sandy area by the coast, part of a garbage dump for Kavala and nearby settlements. Substantial strengthening of soil took place to allow safe foundation for installing the facilities.

Therefore, it cannot be assumed that onshore facilities had a negative impact on ground or landscape. Furthermore, KAVALA OIL conducts annual tests on ground pH in the area, all results being normal and hence facilities operation has no negative impact on the physical and chemical properties of arable ground in the area.

4.1.5. FLORA – FAUNA

Considering the description of the, mainly atmospheric, environmental impact, the measurements taken by the company's Environmental Station and results of ground pH measurements, it can be concluded that there is no impact in the area's flora and fauna. This stands as much for terrestrial as for marine flora and fauna. Moreover the onshore plant was built in an area that was used as municipality's dump and thus having no impact on the area, if not positive due to the accomplished ground remediation.

4.2. IMPACT FROM NOISE

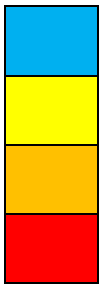
High-noise equipment (gas turbines and steam turbine generators) are installed inside soundproof enclosures, hence the noise impact outside the enclosures remains at safely low level. Moreover, there are signs appropriately located to prompt for ear protection as well as ear plugs available in boxes nearby. It is to be noted that there is no requirement for continuous personnel presence in high-noise areas.

4.3. ENVIRONMENTAL IMPACT ASSESSMENT

Table below summarizes the assessment of expected impact from the operation of the onshore facilities.

Impact / Receptor / Activity	ATMOSPHERE	SEA	WATER (other than sea)	GROUND	LANDSCAPE	FLORA	FAUNA	STATE INFRASTRUCTURE	NETWORKS	SOCIAL IMPACT
Gaseous emissions										
Wastewater										
Solid waste										
Water resources consumption										
Energy consumption										
Electrical Power generation										
Facilities Operation										

Positive impact



No impact

Negative impact, not significant following mitigation

Negative impact, fully reversible

Negative impact, not reversible

5. ENVIRONMENTAL MITIGATION AND MANAGEMENT MEASURES

5.1. AIR EMISSIONS

As it has been mentioned sulfur dioxide is the main air pollutant from the facilities and the largest quantity comes from the Sulfur Recovery Unit incinerator and the rest is from the use of fuel gas. Carbon dioxide (CO_2) and Nitrogen oxide (NOx) are emissions that result from the use of fuel gas, which is the main type of fuel in the facilities. Volatile hydrocarbons are emitted from the floating roof sealing of the stabilized crude storage tanks.

There is no alternate fuel to be used in Kavala Oil S.A. since the fuel gas (natural gas) is the least carbon intensive and polluting fossil fuel among this type of industries worldwide.

One very important action that took place is the downsizing of the main burners ½-H-501 due to lower capacity of acid gas. The result of this is a lower fuel gas consumption without compromising the efficiency of the unit which is still about 99%.

Plant emissions have not resulted in changes in ambient air quality such that air quality limits have been exceeded.

5.2. WASTE WATER

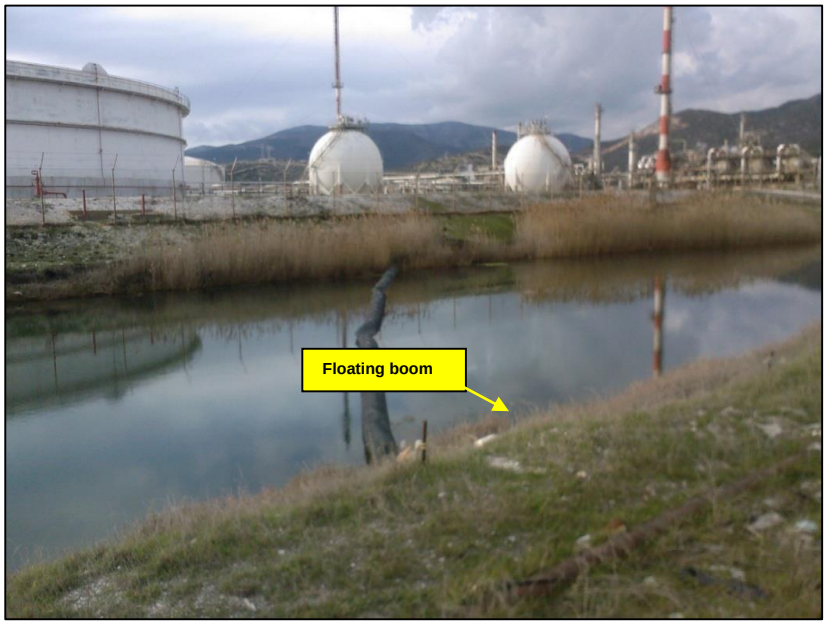
In order to avoid sea pollution the proper operation of waste water treatment equipment must be ensured. These are the sour water treatment unit, the oily water treatment unit and the sewage treatment unit.

Further action has been taken in the east drainage ditch by installing two floating barriers to contain any oil quantity accidentally released (picture below).

Picture 5.2.1: Floating Barriers in the area water drainage ditch

Picture 5.2.2.: First barrier position

Picture 5.2.3.: Second barrier



5.3. HAZARDOUS SOLID WASTE – OILY SLUDGES

There is a small quantity of oily sludge that occurs in the plant during the cleaning of the vessels during every turn around and ends up in the Oily Sludge Treatment Unit for further management by authorized 3rd parties.

Garbage is collected in several bins and Municipality's trucks take them to the Municipality dump. The sludge of the sewage treatment is collected with a special vacuum truck.

5.4. NOISE

Certain equipment in KAVALA OIL S.A. facilities such as the gas turbines and the steam turbine, produce an eleveated level of noise. This equipment is installed in sound proof containers and the noise in the surrounding area is limited and furthermore this equipment has been out of operation since 2010 due to low gas production levels. This equipment might be brought back into operation as the planned offshore development is undertaken and oil and gas production levels rise. Alternatively all excess gas could be sold and the power generation equipment remain mothballed.

Warning signs and ear plugs are installed in all the high noise level areas (compressors, blowers, fans, pumps, etc)

All employees are continuously informed about the consequences of the noise and the proper use of protective means during the annual training sessions. Moreover an annual noise monitoring plan in all locations inside and outside of the plant is in place.

The nearest residential area is 2km away. No noise issues have been recorded.

5.5. ENVIRONMENTAL MONITORING PLAN

A comprehensive environmental monitoring plan is implemented in KAVALA OIL facilities as shown in the table below.

Approved Environmental Terms Monitoring Program

Frequency	Sampling Point	Monitoring Parameter	Limit Values	Average Values
6 times / 24 h	Cooling Water Inlet	Temp	< 35°C	18,3°C (year)
	Cooling Water Outlet	Temp	< 35°C	27,3°C (year)
		Cl_2	2 mg/l	0,1 mg/l
		Flow	-	1.200 m3/h
Weekly	Cooling Water Outlet	pH	6,6 – 8,5	8,1
		HC	0,05-1,5 mg/l	< 0,5 mg/l
		Sulfates	2,0 mg/l	< 1,0 mg/l
	Sewage Treatment Outlet	pH	6,6 – 8,5	7,9
		TSS	35 mg/l	8,3 mg/l
		BOD_5	25 mg/l	5,9 mg/l
		COD	125 mg/l	16,3 mg/l
		VSS	-	6,5 mg/l
		Cl_2	2 mg/l	0,1 mg/l
	Oily Water Separators Outlet (under operation)	pH	6,6 – 8,5	7,8
		TSS	35 mg/l	11,7 mg/l
		BOD_5	25 mg/l	21,1 mg/l
		COD	125 mg/l	62,8 mg/l
		HC	10 mg/l	9,1 mg/l
		Fe total	20 mg/l	< 0,5 mg/l
		Sulfates	2,0 mg/l	1,7 mg/l
Monthly	Cooling Water Outlet	TSS	10-20 mg/l	3,4 mg/l
		BOD_5	2-20 mg/l	16,2 mg/l
		COD	30-125 mg/l	48,3 mg/l
		Fe total	20 mg/l	< 0,5 mg/l
	In the 3 boreholes constructed in the shore at the South of the crude storage tanks TK-704 A/B/C	pH	6,6 – 8,5	8,1
		HC	10 mg/l	< 0,5 mg/l
		TOC	20 mg/l	0,0 mg/l
		Sulfates	2,0 mg/l	< 1,0 mg/l
		Hg	0,01 mg/l	0,0 mg/l
	4 sampling points in Thassos island & 8 sampling points in Kavala	Atmosphere Total Sulfation	0,5 mg/100cm2	0,031 mg/100cm2
Bi-monthly	Area of Flare	Soil pH	-	8

	Area of TK-665 (Sewage Treatment Tank)		-	7,9
	Area of S-501 (Incinerator Stack)		-	7,9
	Area of yard		-	7,9
Quarterly	B-611 Stack (Steam boiler) (O_2 3% κ.ο.)	SO_2 (through calculations)	35 mg/Nm^3	3,1 mg/Nm^3 (y) 6,3 mg/Nm^3 (d)
		CO (2016 onwards)	100 mg/Nm^3	15 mg/Nm^3
		Flow	-	17,85 m3/s @ operating temp
	B-612 Stack (Steam boiler) (O_2 3% κ.ο.)	SO_2 (through calculations)	35 mg/Nm^3	3,1 mg/Nm^3 (y) 6,3 mg/Nm^3 (d)
		CO (2016 onwards)	100 mg/Nm^3	15 mg/Nm^3
		Flow	-	17,85 m3/s @ operating temp
	H-611 Stack (Superheater)	O_2	> 3% vol	8,45 % vol
		Flow	-	1,7 m3/s @ operating temp
		Temp	-	250^{o}C
	GT-1 Stack (Gas turbine) **out of operation since 2010**	O_2	>15% vol	16%
		Flow	-	43,3 m3/s @ operating temp
		Temp	-	205^{o}C
	GT-2 Stack (Gas turbine) **out of operation since 2010**	O_2	> 15% vol	16%
		Flow	-	43,3 m3/s @ operating temp
		Temp	-	205^{o}C
	H-504 Stack (Regen. gas heater)	Flow	-	0,94 m3/s @ operating temp
		O_2	>3% vol	8,5 %
Biannual	B-611 Stack (Steam boiler)	NOx (up to 2016)	300 mg/Nm^3	250 mg/Nm^3 (y) 290 mg/Nm^3 (d)
		NOx (2016 onwards)	100 mg/Nm^3	-
		Smoke	5 mg/Nm^3	0,0 mg/Nm^3
	B-612 Stack (Steam boiler)	NOx (up to 2016)	300 mg/Nm^3	250 mg/Nm^3 (y) 290 mg/Nm^3 (d)
		NOx (2016 onwards)	100 mg/Nm^3	-

		Smoke	5 mg/Nm^3	0,0 mg/Nm^3
	H-611 Stack (Superheater)	SO_2 (through calculations)	35 mg/Nm^3	5,4 mg/Nm^3 (y) 12,2 mg/Nm^3 (d)
		Smoke	5 mg/Nm^3	0,0 mg/Nm^3
		NOx	300 mg/Nm^3	150 mg/Nm^3 (y) 200 mg/Nm^3 (d)
	GT-1 Stack (Gas turbine) **out of operation since 2010**	SO_2 (through calculations)	35 mg/Nm^3	0,9 mg/Nm^3 (y) 2,0 mg/Nm^3 (d)
		NOx (not applicable for operation up to 500 h per year)	200 mg/Nm^3	380 mg/Nm^3 (y) 420 mg/Nm^3 (d)
		Smoke	5 mg/Nm^3	
	GT-2 Stack (Gas turbine) **out of operation since 2010**	SO_2 (through calculations)	35 mg/Nm^3	0,9 mg/Nm^3 (y) 2,0 mg/Nm^3 (d)
		NOx (not applicable for operation up to 500 h per year)	200 mg/Nm^3	Out of operation 380 mg/Nm^3 (y) 420 mg/Nm^3 (d)
		Smoke	5 mg/Nm^3	
	S-501 Incinerator Stack	Smoke	5 mg/Nm^3	3 mg/Nm^3
		NOx	300 mg/Nm^3	20 mg/Nm^3 (y) 30 mg/Nm^3 (d)
	H-504 Stack (Regen. gas heater)	Smoke	5 mg/Nm^3	0,0 mg/Nm^3
		SO_2 (through calculations)	35 mg/Nm^3	3,6 mg/Nm^3 (y) 6,6 mg/Nm^3 (d)
		NOx	300 mg/Nm^3	30 mg/Nm^3 (y) 50 mg/Nm^3 (d)
Yearly by an accredited laboratory	Cooling Water Outlet	pH	6,6 – 8,5	8,19
		HC	0,05-1,5 mg/l	< 1 mg/l
		Cl_2	2 mg/l	0 mg/l
		Sulfates	2,0 mg/l	< 0,1 mg/l
		TSS	10-20 mg/l	< 10 mg/l
		BOD_5	2-20 mg/l	< 3 mg/l
		COD	30-125 mg/l	6 mg/l
		Fe total	20 mg/l	0,24 mg/l
	Sewage Treatment Outlet	pH	6,6 – 8,5	7,45
		TSS	70 mg/l	12 mg/l
		BOD_5	40 mg/l	< 3 mg/l
		COD	120 mg/l	5 mg/l
		VSS	-	< 10 mg/l
		Cl_2	2 mg/l	0 mg/l
	Oily Water Separators	pH	6,6 – 8,5	5

	Outlet (under operation)	TSS	70 mg/l	< 10 mg/l
		BOD_5	40 mg/l	5 mg/l
		COD	120 mg/l	46 mg/l
		HC	10 mg/l	< 10 mg/l
		Fe total	20 mg/l	0,13 mg/l
		Sulfates	2,0 mg/l	2,0 mg/l
	Area of Flare	Soil pH	-	7,46
	Area of TK-665 (Sewage Treatment Tank)		-	7,50
	Area of S-501 (Incinerator Stack)		-	7,52
	Area of yard		-	7,46
Continuously	S-501 Incinerator Stack	SO_2	-	3 g/Nm^3 (y) 5 g/Nm^3 (d)
		H_2S	10 mg/Nm^3	0,0 mg/Nm^3
		O_2	-	11,52 % vol
		Flow	-	15,43 m3/s @ operating temp
		Temp	-	400^{o}C
	B-611 Stack (Steam boiler)	O_2	< 8,5 %	5,45 % vol
		Temp	-	175^{o}C
	B-612 Stack (Steam boiler)	O_2	< 8,5 %	4,99 % vol
		Temp	-	163 ^{o}C
	H-504 Stack (Regen. gas heater)	Temp	-	200 ^{o}C

5.6. HSE MANAGEMENT SYSTEM

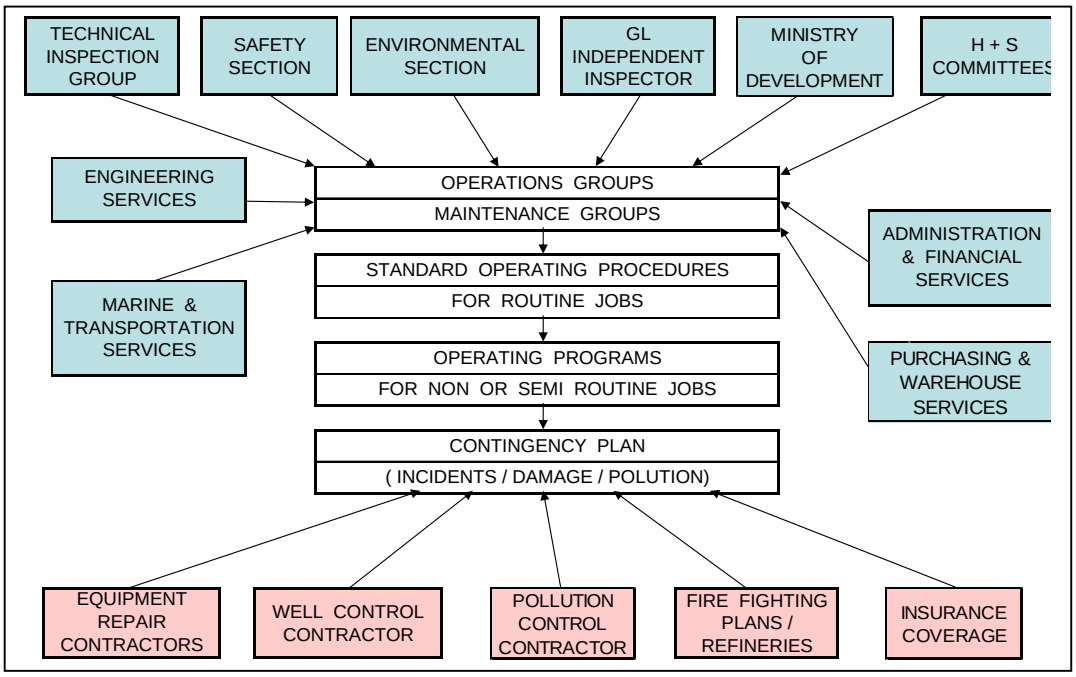
Energean's HSE Management System outlines and provides all necessary provisions for ensuring that all required procedures are followed and actions are undertaken in order to keep all environmental and social issues under control and thus minimizing the risk to As Low As Reasonably Practical (ALARP).

HSE inductions, regular annual training in basic safety issues, pre-job safety meetings, job safety analysis (JSA), toolbox talk risk assessment cards (TRACK), safety observation system (SOS) cards together with hot and cold work permits, confined spaced entry permits, isolation permits and excavation permits, safety drills on firefighting, rescue, evacuation etc. are the basic safety procedures followed.

Moreover Energean's onshore and offshore facilities are certified by DNV-GL for their safe operation since the beginning of their activities (ex Germanisher Lloyd).

Energean's safety structure consists of various working groups that cooperate for achieving the ultimate target of "Zero Accidents" to people, "Zero Incidents" to environment and "Zero Incidents" to the facilities.

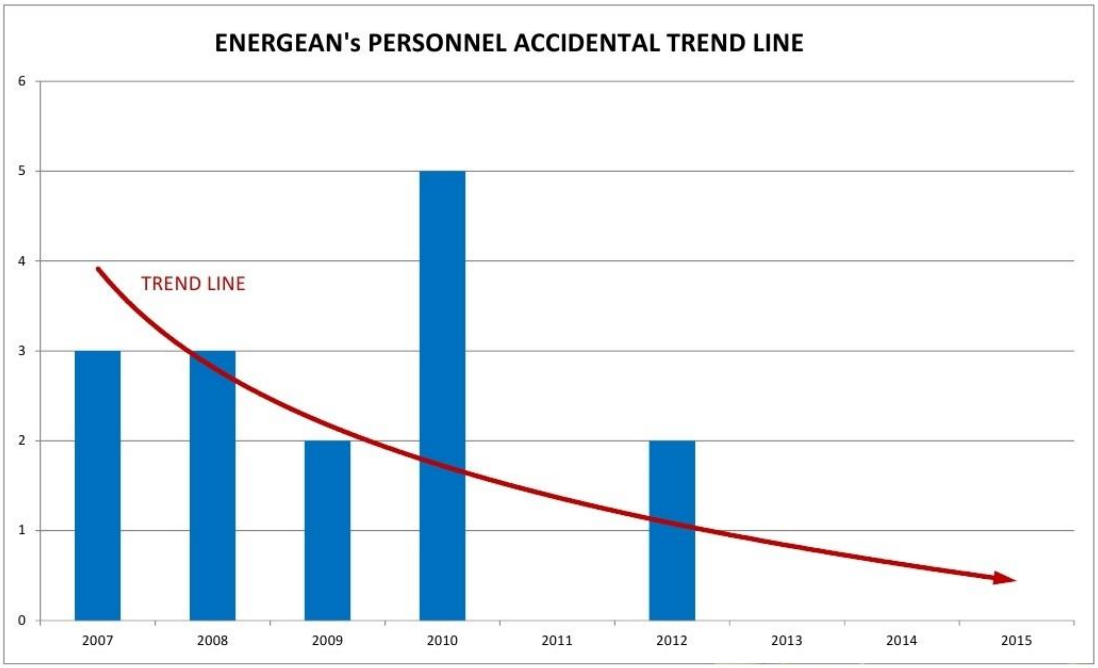
Picture 5.6.1: Energean's Operating Safety Structure



Energean holds excellent environmental performance records having no environmental incident throughout the initial operation of the plant in 1980.

Moreover during the last 2 years (3 including the current year) no accidents occurred inside all Energean Group. Based on the continuously declining accidental trend line, as shown below, Energean is regularly expecting zero accident for the upcoming years. Similarly, no incidents have occurred which have resulted in offsite impacts or risks to third parties.

Picture 5.6.2: Energean's personnel accidental trend line


ENERGEAN's PERSONNEL ACCIDENTAL TREND LINE
TREND LINE
6
5
4
3
2
1
0
2007
2008
2009
2010
2011
2012
2013
2014
2015