



**REPUBLIC OF SUDAN
HIGHER COUNCIL FOR ENVIRONMENT AND NATURAL
RESOURCE
RED SEA STATE MINISTRY OF ENVIRONMENT**

Assessment Report

Development of national action plans and assessment of the priority locations for BAT/BEP implementation

Prepared for the project:

Promotion of Strategies to Reduce Unintentional Production of Pops in the Red Sea and Gulf of Aden (PERSGA) Coastal Zone

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**Regional Organization for the Conservation of Environment of
the Red Sea and Gulf of Aden (PERSGA)**

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06/12/2010 11:52

Consultancy Team Discussing Resident Engineer of Sudan Ports Company

1. TECHNOLOGY ASSESSMENT:

1.1 Summary:

This study has been conducted and arranged according to the steps and sequence recommended by PERSGA based on the 2009 inventory for identification and quantification of dioxins and furans releases in Sudanese Red Sea Coast that has identified the sources and estimated the unintentional releases of Dioxin and Furan in the state.

Two subcategories from the main sources categories (asphalt mixing industry and open burning of waste) are chosen for detailed technology assessment.

Information needed to classify and evaluate the processes of subcategories were obtained by questionnaires pre-designed for each source category, interviews with the authorities and field visits for three asphalt mixing companies and the Municipality and one waste collection company and the waste disposal area. The results of which are represented in this report.

For hot asphalt mixing technology assessment information of raw materials, fuel types and quantities, machinery, sources of emission, current emission control and management practices, operating process, costs associated with emission control systems and management practices,

The three assessed hot-mix asphalt facilities in Port Sudan locality are Port Engineering CO, Althager Engineering(both Sudanese companies),and Alnasr Contracting Company (an Egyptian company) . All of them are stationary in an area of about few kilometers far from Port Sudan city centre.

Asphalt production is a subcategory of mineral products which has potential release routes of U-POPs to air, in product and the residues.

There are three types of asphalt products: rolled asphalt concrete, mastic asphalt and asphalt emulsion.

Rolled asphalt concrete is produced by mixing asphalt with aggregates using one of two techniques: hot mix asphalt (HMA) or warm mix asphalt (WMA).

The companies areas are in the range of 65000- 60000 sq m, located in an area adjacent to the ring road, and the waste dumping area, to the south of which are some of the city extended residential areas .

The main product of the factories is asphalt rolling mixture. The raw materials include aggregates, asphalt and limestone. The companies have

different production capacities ranging from 40,000 to 90,000 ton per year. The work is according to contracts for variable time during the year.

The production steps include: storage of aggregates and asphalt, loading into plant, preheating, mixing and discharge into trucks.

The mixing units temperature is of the range 150-200 °C

The points where Annex C POPs released is the mixing tanks, fuel burning and trucks loading.

Port Engineering Company is the most new of the three plants. It is the only factory that has a unit for air pollution control and heat recovery
Proposal for BAT/BEP implementation.

The control of source emissions of the air contaminants associated with HMA production includes adjustment of the chimney height and the chimney off gases volume, the temperature of the released gases . The control the off gases pollutants can be achieved by controlling the air-fuel ratio Also the factory equipment and processes should be periodically checked by competent authorities

Open burning of waste:

In all cities at Red Sea State disposal sites are open. Most are close to or within the residential areas.

Solid waste produced daily in Port Sudan municipality is about 150 tons and is collected by the Municipality and two other private companies (Alhadaf and Traffic companies) .This waste is burned in open at different frequencies. Uncontrolled burning of waste is considered as one of the main sources of UPOPs.

The city has several uncontrolled waste disposal sites on its fringes. The main dumping site is located along the banks of a broad valley, in the vicinity of the proposed residential area extension, approximately 7.5 kilometers from the city center. The waste is dumped on its surface at any place accessed by the trucks.

All municipal and medical waste in Port Sudan city is collected by the Municipality and two other private companies (Alhadaf and Traffic companies) :

The Municipality waste collecting about 90 ton per day with 11 trailers of 2.5 ton capacity per vehicle in addition to two composting vehicles of 5 ton capacity each used in two rounds per day.

Traffic Company collects 60 tons of waste per day that include domestic, the Port and hospitals' wastes. The company has 8 vehicles 2 of which are tip-cart and 6 waste compacting vehicles (3 with 25T capacity and 3 of 16 tons the work cover two shifts).

All the waste collected is unsorted & transported to the dumping site and the final disposal is the responsibility of the Municipality. Fire is set on any waste brought from hospitals the burning of which is always not complete.

Proper waste management includes the reduction of the quantities generated, reuse, recovery and recycle of any valuable material or applying techniques for production of energy from the waste.

There are many techniques and measures for safe waste disposal that include sanitary landfill, composting and incineration.

For the proposal of **BAT and BEP for the** final disposal of waste, activities for management and minimization of the waste should be implemented.

The waste volume is to be reduced and the materials that result in UPOPs releases are to be eliminated from the waste

Open burning of waste can be of controlled effect on the health and the environment when the recommended waste management is done

Landfill is a controlled engineered waste storage site The area where landfill should be located need to be selected after many detailed studies in order to control its effect on the environment.

Waste incineration is used for the disposal of hazardous chemical or medical wastes. The process requires high temperatures for incineration of waste and several devices for the control of the emissions from it. This is an expensive method in terms of the cost of the incinerator and the pollution control devices incorporated with it and the required specialized technical staff for its operation and maintenance

1.2. Background:

1.2.1. Asphalt mixing

Asphalt production is a subcategory of mineral products which has potential release routes of U-POPs to air, in product and the residues.

There are three types of asphalt products:

1. Rolled asphalt concrete which represents 85% of all asphalt types and is composed of 5% bitumen and 95% aggregates and used for road pavement.
2. Mastic asphalt which is composed of 7-10% bitumen and 90-93% aggregates and is used mainly for roofing, insulation, and pavements
3. Asphalt emulsion composed from 70% asphalt, mixed with petroleum solvents and other additives

Rolled asphalt concrete is produced by mixing asphalt with aggregates using one of two techniques: hot mix asphalt (HMA) or warm mix asphalt (WMA).

Asphalt is a Sticky, black, highly viscous liquid or semi-solid material, a carefully refined residue from the distillation of crude oils.

Aggregates:

Aggregates are solid materials that have been specifically sorted or processed to achieve given properties

There are five general steps for the preparation of individual stockpiles of aggregates: excavation, transportation, crushing, sizing and washing. Once stockpiles have been prepared, two or more stockpiles are typically blended together to produce a final gradation for a given asphalt mix applications.

This report addresses the hot-mix asphalt (HMA) technology which is the common practice in the Red Sea State for asphalt concrete mix production.

The processes whereby asphalt is mixed with aggregate to produce hot-mix asphalt (HMA) start with the receipt of the asphalt and the raw aggregates at the facility, preheating of the raw materials and mixing of the asphalt with aggregates. It concludes with the transfer of HMA into transport trucks and the movement of these trucks to the HMA plant boundary

1.2.2 Solid Waste:

Proper waste management implies the reduce of the quantities of waste generated, reuse and recycle of any valuable material or to apply techniques for the recovery of materials or produce energy from the waste

There are many techniques and measures for safe waste disposal that include sanitary landfill, composting and incineration.

Landfill is a controlled engineered waste storage site whereas surface dumping is a site that contains mixed waste disposed of without any pollution prevention devices.

In all cities at Red Sea State disposal sites are unmanaged and can be classified as open disposal sites. Most are close to or within the residential areas.

Solid waste produced in Port Sudan municipality is collected by the locality and two other private companies (Alhadaf and Traffic companies)

Domestic and medical waste are collected every day from household, markets, hospitals and private clinics and disposed off in certain area outside the city. This waste is burned in open at different frequencies. The amount collected daily is about 150 tons. Uncontrolled burning of waste is considered as one of the main sources of POPs.

1.3 General information on the location

1.3.1 Asphalt mixing:

At the time of this study there are three working plants located across the Red Sea State that produce concrete asphalt mix, all of them are stationary.

Two of the plants (Port Engineering Co & Althager Engineering Co) are owned and operated by governmental -held Sudanese corporations, the third (Alnasr Contracting Company) is an Egyptian company which is contracted to pave roads in the Red Sea State..

1.3.1.1 Port Engineering Co:

- **Factory name:** Port Engineering Co
- **Factory address:** Port Sudan, Tel.0311830005, Fax: 0311821250
- **Engineer in charge:** Dak Paolo Malwak, Mobil 012377164
- **Starting production date:** since March 2003.
- **Site (GPS)**
 - Longitude: 19 36 26, 57 N
 - Latitude: 37 10 47, 50 E

Altitude: 64 ft

The company occupies an area of 65000 sq m, located in an area adjacent to the ring road, to the north of which is the municipal waste dumping area, to the south is Althager Asphalt Mixing Co. & Nahdda residential area. To the east is an open area and in the western side is Alnasr Contracting Company Plant.

It is 8 kilometers far from Port Sudan city centre (fig ())

The area layout includes offices, power generators, mixing plant, grinder, aggregate piles storage area, parking for trucks and unpaved roads.

1.3.1.2. Elthager Engineering Asphalt Mixing Plant

- ✚ Factory name : Elthager Engineering Asphalt Mixing Plant
- ✚ Contract: Engineer Ahmed Mohamed Tahir,
- ✚ Mobil: 00249912505413. e-mail: ataher90@gmail.com
- ✚ Factory address : Port Sudan, Sudan
- ✚ Starting production date:
- ✚ Site Daralsalam- west to tissaa- kabary residential area Site (GPS)
 - Longitude : 19 35 54,27 N
 - Latitude : 37 10 48.66
 - Altitude: 63 ft



The company occupies an area of 60000 sq m, located in an area adjacent to the ring road, to the north of which is an open area, south to it is **Yathrib residential area**, to the east is **Port Engineering Co** and in the west side is the **ring road** and an open area. It is 7.5 kilometers far from the city centre.

The area layout includes offices, power generators, mixing plant, grinder aggregate piles storage area, parking for trucks and unpaved roads for truck movement.

Machinery of the factory is composed of power generators. Fuel storage tanks, asphalt preheating tank and the mixing tank

1.3.1.3. Alnasr General Contracting Company

This is a public Egyptian company which has been working in Egypt since 1984 and now is contracted to pave roads in the Red State for the last three years and according to contract is responsible of most of the state roads pavement.

The Company Manager Engineer Ahmed Mohamed AlHosain . Mobil: 0024912334257.

The factory address is Kasara Area behind the Port Engineering Company

Site (GPS) :

Longitude : 19 36 20,59 N
Latitude : 37 10 47.96
Altitude : 69 ft

The factory is located in an area of 60000 square meters to the north, south and West of which are open areas. Its Eastern neighbor is the Port Engineering Company .Its distance from the city centre is 7.8 kilometers. The area layout includes offices, power generators, mixing plant, grinder aggregate piles storage area, and parking for trucks and unpaved roads for truck movement

1.3.2 Waste Disposal Site:

The case of Port Sudan is an example of the solid waste management throughout the Red Sea State. The city has several uncontrolled waste disposal sites on its fringes. The largest is located along the banks of a broad valley, in the vicinity of the proposed residential area extension, .approximately 7.5 kilometers from the city center via the ring

road. The bulk of Port Sudan city waste “estimated about 150 tons per day is transported by trucks to this dumping site. It occupies an area of 5 kilometers approximately. The boundaries of the site are difficult to determine. The waste is dumped on its surface at any place accessed by the trucks. The accumulated wastes cover the surface with a layer of mixed waste ranging from 0.1 to 1m in thickness.

All municipal and medical waste in Port Sudan city is collected by the Municipality and two other private companies (Alhadaf and Traffic companies)

1.3.2.1 Environmental Health Department. Ministry of Health. Red Sea State:

Director : Mustafa Mohamed Ohag
Address : Port Sudan Municipality:
Tel : The Municipality Department of Health is the governmental authority responsible for collection and disposal of wastes in the state. It has the right of policies and planning for the work related to the waste management. It specifies and determines the site for the waste disposal. It has contracts with the two private companies working in the state. Its head offices are within the locality complex.

1.3.2.2 Traffic Company:

This is a private company that collects waste and transports it to the waste disposal site in coordination with the local authorities.

The work is on a daily basis starting from 8am to 5pm.

The responsible manager is Mr. Mohammed Abdel Moniem Izzadeen.

Tel. 0912314244, Fax 311826143, E-mail: darilinvpr@yahoo.com

The head office is in Port Sudan city market near the Ministry of Trade. The company collects waste from the agreed upon residential areas of the city and hospitals and transports it to the waste disposal site

1.4. Description of the applied technology:

1.4.1 Asphalt Mixing

1.4.1.1 Port Engineering Co

The main product of the factory is asphalt rolling mixture produced using aggregates, asphalt and limestone as the raw materials. The factory production capacity is 40,000 ton per year. The operation is continuous in two shifts per day .The company work is seasonal according to the needs and contracts with the Sea Port Corporation.

The factory production capacity per unit is 100 tons per hour and the quantity produced daily is 400 tons.

They use two types of fuel diesel and sometimes Bunker C-oil with a rate of 2500L/ day.

1.4.1.2. Elthager Engineering Asphalt Mixing Plant

The factory mainly produces asphalt concrete mixture using aggregates (gravel and sand), and asphalt as the raw materials, with production capacity of 50,000 ton per year. The operation is intermittent in a one shift of 12 hours duration. The company work is according to the needs and contracts. Currently the factory is not working due to the market conditions. The grinder is working and they sell aggregates for the building construction sector.

The factory production capacity per unit is 80 tons per hour and the quantity produced daily is 850 tons. They use diesel fuel for power generation with a rate of 1270 L/ day.

1.4.1.3. Alnasr General Contracting Company

The main product of the factory is asphaltic concrete mixture. The raw materials used are asphalt and aggregates which is composed of sand and gravel with different sizes.

The factory has one night shift per day the duration of which is 8 hours. The factory operation is intermittent.

The production capacity of factory is 300 Ton per day and the actual quantity produced is 250 Ton per day.

They use electricity and gasoline. The gasoline used for the grinder and mixer is 7000 liters per day.

1.4.2 Waste Disposal:

1.4.2.1 Municipality collection capacity:

The Municipality waste collecting vehicles are 11 trailers of 2.5 ton capacity per vehicle in addition to two composting vehicles of 5 ton capacity each. All the vehicles are used in two rounds per day. The total waste collected amounts to 55 tons by trailer vehicles and 20 tons by the compacting vehicles.

In Port Sudan city central units waste is collected twice per week. The daily shifts are two; the morning is of 13 hours duration and the night shift is of 8 hours duration. Waste collection for the eastern and western units is in one shift for eight hours duration.

The city residential areas collecting frequency is twice per week and for the commercial places and markets is twice daily in the morning and at night the actual quantity collected is 15 tons approximately

1.4.2.2 Traffic Company collection capacity:

The company collects 60 tons per day of domestic waste, hospitals' waste and the Port waste.

The company has 8 vehicles 2 of which are tip-cart and 6 waste compacting vehicles 3 with 25T capacity and 3 of 16 tons the work cover two shifts. The waste collected is unsorted. The company only transports the waste to the dumping site and the final disposal is the responsibility of the Municipality

1.5 Detailed Technology Description:

1.5.1 Asphalt Mixing

1.5.1.1 Port Engineering Co

The production steps include: production and storage of aggregates, storage of asphalt, loading into plant, heating, - mixing and discharge into trucks.

The company has one rotary mixing unit, the temperature of which is of the range 150-170 °C.

This is almost the newest of the three plants. Its machinery is installed and started production in March 2003. The machinery is in good condition and they have system for air pollution control and energy exchange and the machinery and processes are checked and revised annually.

The points where Annex C POPs released is the mixing tanks, fuel burning and trucks loading.

1.5.1.2. Elthager Engineering Asphalt Mixing Plant

The production steps include- heating of aggregates and asphalt, spraying asphalt onto aggregates, mixing and discharge into trucks

The company has one DSSP Asphalt mixing machine the maximum temperature of which is 200 °C. There is no system for air pollution control.

The machinery of the factory is composed of power generators. Fuel storage tanks, asphalt preheating tank and the mixing tank.

The machinery of the plant are in good condition and can accept any modification e.g. addition of system for air pollution control or energy consumption reduction or recovery.

The points where Annex C POPs released is the mixing tanks, fuel burning and trucks loading

1.5.1.3 Alnasr General Contracting Company:

The main production steps include the preheating of raw materials and mixing. The asphalt barrels are opened and left under sun so as to gain some energy (energy conservation) then dropped and arranged in rows inside a tank where the asphalt falls under its weight for the preheating step , preheating is done with air heated using butane gas. The aggregates and sand are conveyed to the mixer with open belts.

The machinery of the factory are asphalt preheating tank, a mixing station and two electricity generators and fuel storage tanks.

They use a rotary furnace for heating and mixing of asphalt. The furnace temperature is 150 °C.



The points where Annex C POPs released is the mixing tanks, fuel combustion and trucks loading

This is the oldest plant of the three. Its machinery can't accept any modification

1.5.2 Waste:

1.5.2.1 Waste Collection:

Port Sudan municipality is divided into three units: eastern, central and southern unit. The central unit includes the main city. The responsibility of its domestic waste collection is shared between the municipality and Alhadaf Company, for the residential areas of deim Arab, salalab, Alwahda, deim Mayo and Shangule.

Traffic is responsible of the main city market, and Alhadaf is responsible of Dabaioa, Almadiyna, alsikka Hadeed, tarradouna and Alazama residential areas in the central unit,

Eastern unit includes daim Alnor, Alghadesya , alshouhada, and Althora 1 to 9 squares. The waste of these squares is the responsibility of the locality. Traffic Company is responsible of the waste of Alssahil, Haddal, Alkhalieg and the rest of Althora squares.

The Southern unit: includes Philue, all Inghaz squares, Dar Alsslam, and deim Gabir which is the responsibility of the municipality and Traffic Company is responsible of Transiet, Diem Alshatty, Almerghania, Deim Swakin and Korea.

The hospitals waste is the responsibility of Traffic Company except for the port hospital waste which is the responsibility of Alhadaf Company and the municipality is responsible of the Army Hospital

1.5.2.2 Waste Disposal

The trucks and vehicles that transport the collected (municipal, domestic, commercial, medical, industrial and construction) solid waste, empty their load on the surface of the disposal area. The types of waste dumped on site include clinical waste (syringes, catheters, blood packs, drugs and bandages), plastic and papers, drums and other metal scraps, abattoirs, and food wastes, and septic tanks solid and liquids. The waste is disposed on the surface of the dumping site without any sorting or separation technique. The waste attracts animals looking for edible stuffs and is a good media for microorganisms and insects growth. Animals observed feeding on the waste include dogs, goat and camels.

There are some Municipality employees working at the site also there are some resident group of waste pickers(scavengers) who live in terrible conditions on the site used to sort the waste for recyclable materials such as metal scrap

The site is virtually uncontrolled and presents obvious health and environmental hazards. Any waste brought from hospitals is set on fire by the Municipality personnel. The accumulated waste piles on the site are almost partially burned.

Because the waste management service does not cover the remote areas or the waste collection is not efficient, some of the domestic waste is burned in open places within residential areas as well.

1.6 Pollution control system

1.6.1. Asphalt mixing:

The **Port Engineering Co** factory has bag filters as an air pollution control system together with a heat recovery system in the same unit. This was fixed in 2008 to the factory when they had faced a problem of rupture of the fan due to the fine dust that arises from the aggregates addition in the mixing tank. The fan rupture and replacement resulted in production halt, worker's injury and economical losses.

The height of the plant chimney is 13 meters. The chimney off gases volume is not known exactly but the temperature of the released gases is 100 °C. Also they control the off gases pollutants by controlling the air-

fuel ratio. The factory machinery and components including the air pollution control system are reviewed and checked annually by an engineer from Malaysia; the country of origin of the machinery of the factory.

Elthager Engineering Asphalt Mixing Plant has neither air pollution control system nor energy reduction system.

Alnasr General for Contracts factory has not any air pollution control system or heat recovery system with the exception of the energy saving in the preheating of asphalt barrels with solar energy They has a chimney with a 4m height.

1.6.2 Open burning of waste is an uncontrolled method for solid waste disposal so there is no any means or way of controlling the pollution that arises from it.

1.7. Proposals for BAT/BEP implementation

1.7.1 BAT and BEP for asphalt mixing:

Implementation of BAT/BEP in asphalt mixing plants is required for the reduction of U-POPs releases and other environmental pollutants.

This can be achieved by many ways such as replacing the fuel; the burner;[modification of process or technology or introducing additional air pollution control system (APC). Also with regard to technology; modification of the process or altering the processes sequence by mixing the coarse aggregates with bitumen, then the finer aggregates or follow two phase mixing of soft bitumen grade with aggregates, then hard bitumen.

Reduction of the mixing temperature can be achieved by applying the warm mix asphalt technology instead of the hot mix asphalt one.

Although the immediate benefit of using WMA producing technology is the reduction in energy consumption required by burning fuels to heat asphalt in HMA technology to temperature in excess of 150°C (300°F) at the production plants and consequently a reduction of releases of U-pops from its source i.e. fuel combustion but in comparison with hot mixing of asphalt (HMA) there are many difference in the quality of the concrete asphalt produced. These high production temperatures are needed to allow asphalt binder to become viscous enough to completely coat the aggregates in HMA, have good workability during laying and compaction and durability. With the decreased production temperature there is

additional benefit of reduced emission from burning of fuels, fumes and odors generated at the plant and the paving site. The benefits are in terms of energy savings and air quality improvement. ***This technology as assessed by the asphalt mixing companies is not suitable for the Red Sea State area due to the climatic conditions and the high relative humidity in the State***

The proposed best available techniques (BAT) to be adopted by the plants include the operating practices (such as replacing the fuel; or modification of process or altering the processes sequence) and incorporating systems (such as APC) that lead to air pollution control at source and may be suitable for asphalt mixing plants operating in Red Sea State . Although the asphalt mixing companies are not operating all the year round, the application of proposed BAT is essential in order to protect environmental quality and minimize the industry impact on residential areas.

The application of the BATs depends highly on the type and condition of machinery of the plants.

The possible environmental and human health benefits by further reducing source emissions and the consequent improvement in ambient air quality in the vicinity of plants should be considered.

Best Available Techniques for particulate Matter capture and control at sources:

- ✚ For stationary Aggregate stock piles and truck movement as the principle source of PM within a facility control options include application of water sprays or mists on a daily basis or when there is evidence of wind driven or use of temporary covering of storage piles.
- ✚ Particulate emission from batch dryers & drum mixers use of fabric filters or wet Scrubber
- ✚ Pollutants emitted from drums/dryers operations are controlled by adjustment of temperature of burner and dryer/drum operation.

Carbon Monoxide and NOX through good combustion practices for burner and drum mixer operation. Annual burner calibration by a competent individual to verify operation and minimize emissions and conserve fuel.

Sulphur Dioxide emission is controlled by use of lower sulphur content fuel for burner or replaces fuel oil by natural gas.

Volatile Organics Control is achieved by controlling temperature for burner and dryer / drum mixer operation, and burner check and calibration by a competent engineer to verify operation exhaust gas limits.

1.7. 2 BAT and BEP for Solid Wastes:

Waste management and waste treatment are key issues in the whole UPOPs production. The open burning of waste has significant share of the total UPOPs production. There is a need for proper management of the continuously increased volumes of wastes generated as well as the increased contents of materials that classify the waste as hazardous waste or as source of POPs releases.

Development of a waste management system is essential in the Red Sea State and should include:

Waste minimization and is achieved by:

- ✚ Diverting the stream of the wastes components that are identified as a potentially UPOPs and POPs emitting sources such as industrial wastes like tanneries waste or medical wastes that require special technique for final disposal
- ✚ Introducing waste sorting and separation process at sources to reduce the generated waste volume and enhance recycle or reuse processes.
- ✚ Reclamation of substances of specific concern.
- ✚ Making use of components that can produce energy such as paper materials or biodegradable waste from which biogas can be generated.

BAT and BEP Options for final disposal of waste:

1. Open burning of waste can be of controlled effect on the health and the environment when the recommended waste minimization activities are implemented.
The waste volume will be reduced and the materials that result in UPOPs releases are eliminated from the waste
2. Landfills are the most common practice of waste management around the world. It seems to be the solution for the increasing waste volumes. The area where landfill should be located need to be selected after many detailed studies that take into consideration the type and composition of waste to be dumped , the geology and permeability of the land, the climatic conditions prevailing in the area ...etc. Also landfill disposal of wastes should be preceded by the processes of waste minimization through separation, recycling and reuse. However, such activity can affect the area and



Environmental components and the deposition of several waste fractions in landfills is recognized to have strong drawbacks and may create huge problems for the future.

For some waste fractions Sudan in general does not have the appropriate waste management options. Examples of these waste fractions include electronic wastes, PVC, softeners like phthalates and chlorinated paraffin.

There should be regulations and policies that prohibit disposal of hazardous medical and industrial wastes, identified as POPs releasing source, in the normal waste stream which is not the case in the Red Sea State yet.

3. Wastes Incineration:

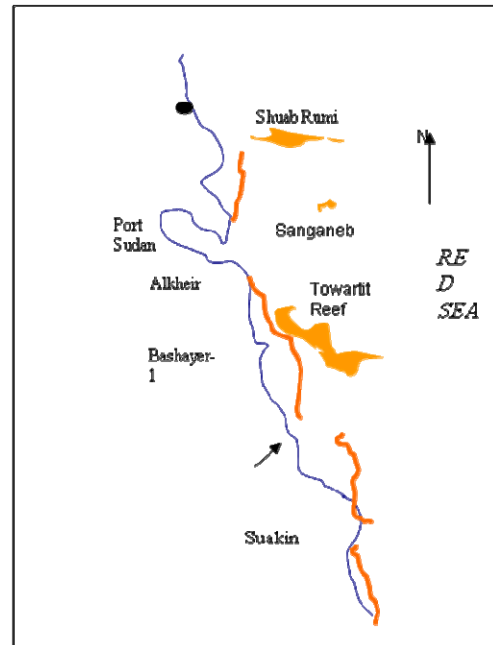
Basically incineration is the method used for the disposal of hazardous chemical or medical wastes. The process requires high temperatures for incineration of waste and several devices for the control of the emissions from it. For air pollution control a scrubber is required for water soluble gases such as SO₂ & HCl, electrostatic precipitator or cyclone for particulate matter and heat exchanger for reducing the off gases temperature and a tall chimney for the dispersion of the released gases. The incinerator location should be carefully chosen taking into consideration the expected risks to the health and the environment.

This is an expensive method in terms of the cost of the incinerator and the pollution control devices incorporated with it and the required specialized technical staff for its operation and maintenance.

2. Environmental and Health Related Research and Monitoring Assessment

2.1 Summary:

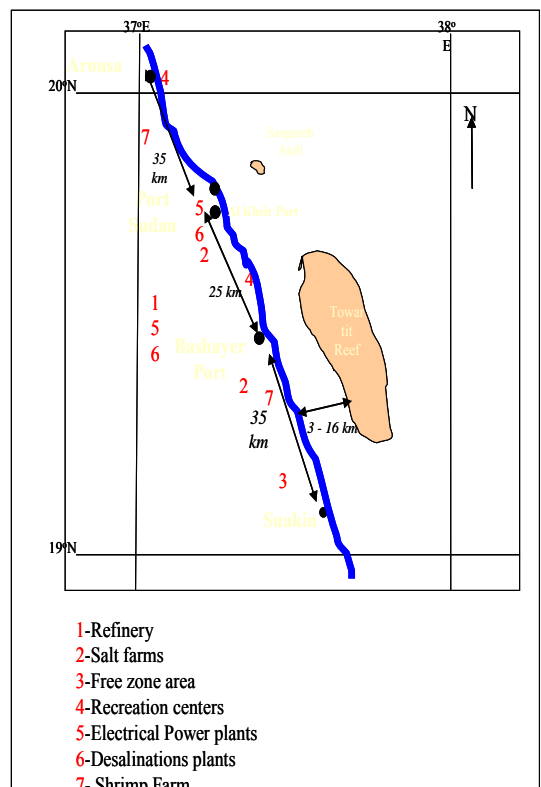
Red Sea State is located in the northeast of the Sudan, and extends northwards from the south western parts of the Sudan's Red Sea coast, between latitudes $15^{\circ} 52' - 23^{\circ} 15' N$ and longitudes $33^{\circ} 15' - 38^{\circ} 45' E$, it occupies an area of 212800 kilometers square. The state is characterized by the Red Sea mountainous ranges the coastal strip is about 750 km. long and 2- 9 km. wide, the water levels are rather shallow in the bays and the estuaries of the seasonal water courses.



Red Sea State has an approximate area of 212 416 km² with a total population of 1,400,000 persons.

The main city at the coastline is Port Sudan with a population of around 500,000. All the activities in the state are concentrated between Arous village in the North and Sawakin port in the South in distance of 100 Km approximately.

Red Sea State climate is characterized by high tropical temperatures ranging between $15^{\circ} - 47^{\circ} C$. The prevailing winds are generally northerly, the north eastern trade winds blow in winter and the north western winds in summer. The rain is in winter with an annual average not exceeding 101 mm. The relative humidity ranges between 42- 70 %.



Air pollutants sampling locations for HMA should be taken in relation to point source emission (mixing tanks, fuel burning, trucks loading) and to determine the workers exposure level of them and to determine to emission sources so as to determine the actual quantity of pollutants emitted whether it impose any risk to the health of the workers or the public. Sampling should be for air pollutants of most concern i.e. PCDD/PCDFs and dust and for soil PO PS concentration in one location in each plant. For open burning area eastern edge of the dumping site, center of the dumping site and the western edge of the dumping site.

Sampling program depends on the availability of sampling equipment, collection media and environmental condition.

To determine the risk of the air pollution from asphalt mixing industry and open burning of waste to the health of the population of the surrounding residential areas in the Red Sea State. Off site sampling points were suggested for air and soil for PCDD/PCDFs an PCDD/PCDFs in soil at three locations off site air and soil samples locations should be taken in residential Ares in relation to the distance from the sources i.e. at the nearest boarder, the center and the farthest edge of the residential areas

Occupational health measures

The asphalt mixing companies in the Red Sea State employ about 151 workers; 10 permanent staff and the rest are of temporary employment working as Engineers, drivers, workers in asphalt mixing and crusher section.

The expected health hazards to the worker' safety and health are exposure to the chemical air pollutants (gases, silica dust and fumes), mechanical risks; ergonomic, hazards in addition to the standing working condition for long hours.

For waste collection and disposal the total number of workers of the two assessed facilities are 180 perminant staff and 113 as temporary employment, The expected health hazards due to the exposure to the waste (biological hazards, exposure to particulate matters, and waste burning of fumes and gases), Also exposure to physical hazards such as heat, radiation and light from working in open space under different weather conditions and risk of accidents.

There is no pre-employment or periodical medical examination service provided for the workers in the two categories.

There isn't any recorded occupational disease among them but there are some recorded accidents in the form of injuries.

The only available protective clothes are overalls and the workers are committed to wear it for the asphalt mixing companies facilities for personal hygiene are available but for the waste collection workers that is not the case.

Gaseous emissions to the atmosphere generated both during operation of asphalt mixing plant and waste burning reduces air quality with impacts on human health particularly where emissions are of harmful gases. The impact can be extremely serious, e.g. where emissions contain harmful compounds such as dioxins.

The main releases to air derive from the grinding and sizing of the aggregates, fuel combustion, asphalt mixing and discharge into trucks. Also waste burning is a source of emissions to air include nitrogen oxides (NOx), sulphur dioxide (SO₂), carbon oxides (CO and CO₂) and dust VOC's, PCDD/ PCDFs.

Existing air quality in Red Sea State is strongly affected by weather conditions particularly the strength and direction of winds.

It is found essential to identify the actual concentrations of these pollutants and the health impacts of the population in the surrounding residential areas. And to consider what measures should be taken to avoid or reduce gaseous emissions from sources to an acceptable level.

Also there should be surveys for the assessment of the impact of the two activities on the worker's health and the population that include specialized medical examinations,

2.2. Background

Any man made activity either industrial, agricultural or a service may have some effects on the health and the environment. Environmental pollution affects the human health especially children and the elderly.

Air pollution is paid special consideration as it may lead to the pollution of other environmental media (water & soil).

Inhalation is the most important route for pollutants to enter the human body.

The activities assessed in this study (the asphalt mixing and open burning of waste) are sources of many types of pollutants.

All are known to affect the human health. The effect of these pollutants depends on the pollutant concentration, route and degree of exposure, the exposed person characteristics (age, sex, ...)and the environmental conditions.

The pollutants of concern to this assessment are PCDD/PCDF and fine airborne particles. Other pollutants of concern include SO₂, NO_x, CO.

All air pollutants can have potential impacts on health such as irritation of the eyes, nose and throat, respiratory diseases; it can worsen existing lung and heart problems, which may lead to increased hospital admissions, more emergency room visits and higher rates of absenteeism. Air point sources for PCDD/PCDF and particulate matter (PM) releases include fuel combustion. Raw material storage, production processes of the asphalt mixing and burning of different types of solid waste.

Environmental conditions (temperature, pressure, relative humidity, solar energy) can affect the concentration and dispersion characteristics of the pollutants. Rain as well results in the dispersion of soil contaminants

2.3 General geography and environmental information

2.3.1. Position:

Red Sea State is located in the northeast of the Sudan. It is delimited by Kassala State in the west, Eritrean borders and the coast of the Red Sea in the east and the River Nile State in the west.. It extends northwards from the south western parts of the Sudan's Red Sea coast, between latitudes 15° 52' – 23° 15' N and longitudes 33° 15' – 38° 45' E, and occupies an area of 212800 kilometers square. Red Sea was formed by the cleavage between the north eastern African and Asian land masses in about 70 million years ago. The state is characterized by the Red Sea mountainous ranges that reach altitudes of 3500 m. in the northern parts and 1000 m. in the southern parts. The ranges are traversed by numerous wadis and water courses that flow eastwards across the semi- desert coastal strip to the Red Sea and westwards towards the Nile. The coastal strip is about 750 km. long and 2- 9 km. wide, meanders to form several bays and harbors. The water levels are rather shallow in the bays and the estuaries of the seasonal water courses.

North of Port Sudan, the coastal plain is covered with stones and pebbles with some pockets of clay soil, bordered by a two meter high rocky plateau. In the south, the ground rises gradually towards the hinterland. The tide extends 7 km. beyond Port Sudan. The state has a total population of 1,400,000 persons. The most important crops: Durra and millet.

Animal resources: 66842 heads.

There are 308 Basic Schools and 26 Secondary Schools, 14 schools for nomads and one school for children of special needs.

Most important towns: Sauakin, Haya and Port Sudan which is the capital of the State.

The main city at the coastline is Port Sudan with a population of around 500,000. All the activities in the state are concentrated between Arous village in the North and Sawakin port in the South in distance of 100 Km approximately.

The Red Sea State (RSS) covering an approximate area of 212 416 km².
The

2.3.2. Climate:

Red Sea State is characterized by high tropical temperatures ranging between 15°- 47 ° C. The prevailing winds are generally northerly, the north eastern trade winds blow in winter and the north western winds in summer. The state enjoys winter rains with an annual average not exceeding 101 mm. The relative humidity ranges between 42- 70 %, increasing southwards with increasing rainfall. The cumulus clouds cover about 25- 50 % of the state surface area. According to the classification of the vegetation in the Sudan, RSS lies in the desert and the semi- desert zones. The state, like the other parts of the country, is affected by climate change, i.e. severe drought and desertification, degradation of the vegetation cover and loss of biodiversity.

2.4.1 Description of the on site sampling points

Sampling locations:

Samples should be taken at source to determine the actual quantity of pollutants emitted from it so as to compare it with the national or international allowable levels and in relation to the workers' position to determine the workers exposure level. This will help to determine

whether it impose any risk to the health of the workers or the public. Sampling should be for pollutants air concentration and for soil concentration.

2.4.1. 1. On site air samples

a- for asphalt mixing plants for U-Pops at:

- 1- mixing tanks
- 2- fuel burning
- 3- trucks loading

b- for open burning area:

- 1- eastern edge of the dumping site
- 2- center of the dumping site
- 3- western edge of the dumping site

2.4.1.2 Soil samples:

- a) for asphalt mixing at one location in each plant
- b) open burning area four samples at its boundaries in all directions and one at the center/

2.4.2 Sampling program depends on the availability of sampling equipment, collection media and environmental condition.

2.5 Description of off site sampling points:

Air pollution from asphalt mixing industry and open burning of waste may impose health hazards to the population of the surrounding residential areas in the Red Sea State. Although the sites for asphalt mixing and waste dumping had been selected at the outskirts of the city so as not to affect the residential areas but due to the growth and expansion of the city and its population the residential areas has come closer to these sites. Some of the residents complain from the effects of the dust from the asphalt mixing grinders on their health and their children in particular when the wind direction is towards their homes. Also they complain from the waste dumping area in the form of nuisance of flying matter (plastic, papers, and ashes), waste odour and gases from the burning of the waste.

Off site air and soil samples locations should be taken in residential Areas in relation to the distance from the sources i.e. at the nearest boarder, the center and the farthest edge of the residential areas

2.6 Occupational safety measures

2.6.1 General

Occupational health is the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations by preventing accidents, departures from health, controlling risks and the adaptation of work to people and people to their jobs.(ILO/WHO 1950).

Safety implies the provision of conditions which will ensure the greatest effectiveness in hazards avoidance through design for minimum risks, incorporate safety devices, provide warning signs ,development of and implementation of operating procedures and employee training programs and use of personal protective equipment.

Hazard is any condition in the workplace that impairs the safety and health of the workers and makes them lose time or work with less efficiency.

Occupational health hazards can be chemical, physical, biological, mechanical and electrical, and ergonomic hazards.

Occupational Health Services are preventive rather than curative, delivered in the workplace and include controlling the workers levels of exposure to the occupational health hazards, premedical examination for the placement of the right worker to the right job and periodical medical examination for the early detection of the occupational diseases, and awareness raising and training on safe work performance.

For the asphalt mixing industry in the Red Sea State, the expected health hazards to the worker' safety and health are exposure to the chemical air pollutants in the form of the combustion off gases, silica dust and organic fumes.

Also mechanical risks of unsafe machinery working conditions and the work incorporate ergonomic hazards from heavy work loads (barrels) in addition to the standing working condition for long hours.

For waste collection and disposal the expected health hazards due to the exposure to the waste includes contamination with waste and its content, biological hazards , exposure to the dust, particulate matters, fumes and gases that result from burning of waste , Also exposure to physical hazards such as heat, radiation and light from working in open space under different weather conditions and risk of accidents such as fall from moving trucks.

2.6.2 Asphalt mixing companies:

2.6.2.1 The Port Engineering Company employs 55 workers all of them are temporary employment 54 are males working as engineers, truck drivers and workers in asphalt mixing and crusher section. There is one lady for meals and tea preparation.

There is no pre-employment or periodical medical examination service provided for the workers.

There isn't any recorded occupational disease among them but there are 4 recorded accidents in the form of injuries.

The personal protective clothes available are overalls and boots and the workers are committed to use them.

The workers are educated and trained on safe work performance.

Facilities for washing and personal hygiene are available which include hand washing basin, bathrooms, and a place for changing clothes,

2.6.2.2 Elthager Engineering Asphalt Mixing company employs 30 workers 6 permanent staff, 8 of them are of temporary employment and 16 are in the production site. All are males working as Engineers, drivers, workers in asphalt mixing and crusher section There is pre-employment and periodical medical examination (every 6 month) service provided for the workers but these are not specialized i.e. not taking into account the hazards they are exposed to.

There isn't any recorded occupational disease or accidents among the workers.

The personal protective clothes available are overalls and boots and the workers are committed to use them.

The workers are educated and trained on safe work performance. There are facilities for washing and personal hygiene which include hand washing basin, bathrooms, and a place for changing clothes.

2.6.2. 3 Alnasr General for Contracts company has 12 workers in the asphalt mixing section; four of them are permanent staff and 8 as temporary employment and 50 temporary workers for the grinder and as drivers.

There is neither a pre-employment nor periodical medical examinations provided for the workers.

They stated that there is not any recorded occupational disease or accident among the working force.

The only personal protective equipment available is masks and the workers are using them.

The facilities available for washing are bathrooms which are used as a place for changing clothes as well.

2.6.3 Waste collection:

2.6.3.1 The Municipality waste working force is composed of 110 permanent staff and 89 temporary workers.

There is neither a pre-employment nor periodical medical examinations provided for the workers.

There are recorded accidents such as injuries and there is no recorded occupational disease among the working force.

There is not any available personal protective equipment provided for the workers except for those handling the slaughter house waste. And the workers are using them.

There is no facility available for the workers for washing or changing clothes.

2.6.3.2 Traffic

The company employs 70 permanent staff and 24 (daily temporary employment).

The workers don't have pre employment or periodical medical examinations as they aren't provided for them. There is no recorded occupational disease among the workers but there were some accidents that results in injuries.

The only available protective clothes are overalls that the workers used to wear

2.7 implications and measures of environment and human impact

Environmental pollution has recently become one of the important issues that gain much concern in the Sudan

Air pollution has been paid much attention as one of the most identified forms of pollution through vision, smell or even taste, travel from a place to another and has impact on health and the environment. Air pollution from asphalt mixing industry and open burning of waste may be considered as a particular problem in the workplace and to the surrounding residential areas in the Red Sea State.

Air pollution:

Air pollution means the presence in the atmosphere of one or more contaminants in such quantity and of such duration as being or may tend to be injurious to human, plant or animal life or property.

Air pollutants arising from the asphalt mixing industry are gases, vapors and particulate matter.

These pollutants vary according to the area and the level where it is emitted and the season. As air pollutants dispersion, concentrations and chemical reaction in the air are affected by atmospheric conditions (dilution by wind, washout by rain or through deposition). Meteorological conditions are important factors in the dispersion of pollutants when released to air.. The most important factors are the wind velocity and direction, air temperature and atmospheric stability

Sources and Types of Air Pollutants

Source	Pollutant
Mixing Tower	PM, PM ₁₀ , PM _{2.5} , CO, SO ₂ , NO _x , CO ₂ , VOCs, PAHs & PCDD/PCDF
Asphalt Storage Tanks	VOCs, PAHs
Aggregate Handling	PM, PM ₁₀ , PM _{2.5}
Electricity generation	PM, PM ₁₀ , PM _{2.5} , CO, SO ₂ , NO _x , CO ₂ , VOCs, PAHs & PCDD/PCDF
Solid waste burning	PM, PM ₁₀ , PM _{2.5} , CO, SO ₂ , NO _x , CO ₂ , VOCs, PAHs

- ✚ Hydrocarbons originating from hot asphalt mixing and evaporation from storage tanks.
- ✚ Carbon monoxide emitted from incomplete burning of fuel
- ✚ Nitrogen oxides produced from high temperature combustion processes.
- ✚ Sulfur oxides arising from burning of fuel with high sulfur content.
- ✚ Particulate matters emitted from combustion processes
 - The waste is exposed to wind and rains, became a suitable media for the reproduction and development of flying insects and parasites responsible of variety of diseases.

Health Effects of Air Pollutants:

Air pollutants include many substances that are harmful to human health and to the environment:

- ✚ **Carbon monoxide (CO)** may cause effects on the blood, cardiovascular system and central nervous system. The toxic effects of CO on human beings arise from its ability to combine with hemoglobin (Hb) in blood thus forming carboxyhemoglobin
- ✚ **Oxides of Nitrogen (NO_x)** :NO₂ is a strong oxidant and reacts violently with combustible and reducing materials. Reacts with water to form nitric acid and nitric oxide. Attacks steel in the presence of moisture. NO₂ may have effects on the immune system and lungs, resulting in decrease in resistance to infection and may cause genetic damage in human. NO irritates the eyes and the respiratory tract.. The substance may cause effects on the blood, resulting in formation of methaemoglobin.

✚ **Sulphur dioxide (SO₂):** the SO₂ solution in water is a medium strong acid causing corrosion hazard. Reacts violently with ammonia, attacks many metals and as well plastics, rubber and coatings in presence of water. Through inhalation SO₂ causes cough, shortness of breath, sore throat, eyes redness and pain. also SO₂ irritates strongly the eyes and the respiratory tract. SO₂ may cause effects on the respiratory tract, resulting in asthma-like reactions. (inhalation of NO or SO₂ may cause lung oedema)

✚ **Particulate matter** (small solid particles and liquid droplets) accelerate chemical reactions, obscure vision, cause grime on belongings and buildings and aggravate lung illness

✚ **PAH and POPs**

Poly Aromatic hydrocarbons are of greater threat to health and the environment than the aliphatic. The vapors are much more irritating to the mucous membranes, and some studies do indicate the carcinogenicity of certain aromatic.

POPs released to the environment have been shown to travel vast distances from their original source. Due to their chemical properties, many POPs are semi-volatile and insoluble. These compounds are therefore unable to transport directly through the environment. The indirect routes include attachment to particulate matter, and through the food chain. The chemicals' semi-volatility allows them to travel long

POP exposure can cause death and illnesses including disruption of the endocrine, reproductive and immune systems; neurobehavioral disorders; and cancers possibly including breast cancer Exposure to POPs can take place through diet, environmental exposure, or accidents.

3. Socio-economic and public participation assessment

3.1 Summary

This report outlines the findings of a study which was carried out in Port Sudan city in the Red Sea state. The study is about socio-economic and public participation assessment as a part of the regional project for promotion of strategies to reduce unintentional production of persistent organic Pollutants (UP-POPs) in the Red Sea and Gulf of Aden coastal zone.

The focus of the study is to assess socio economic and public participation in addressing persistent organic pollutants (POPs). According to PCDD/PCDF inventory, 2010, open burning practices have been identified as the main sources of unintentional POPs. Asphalt mixing also has been established in the inventory development as a source of unintentional production POPs.

The area where the dumping site and asphalt mixing facilities are located can be considered as the major UP-POPS contaminated site in the city. It has been noted that people living in the area around waste dumping site and asphalt mixing facilities may be potentially risk group. The total population in this area is 1543. Children, women and less educated people constitute a high percentage of this group (44.4%, 25.3% and 76% respectively). The study has resulted in strong indications that poor people, women and children are the most vulnerable group. On the other hand workers in both asphalt mixing and open burring represent another vulnerable group.

The level of information and awareness on UP-POPs throughout all population groups is low. There is need to increase public awareness on UP-POPs sources and their harmful effects on public health and environment and the economic benefits of BAT/BEP. Tools and techniques to be used for disseminating environmental related information are identified. Media and other means of communication including newspaper, radio, TV, brochures, posters, T-shirts, awareness campaigns, environmental days at the work place, Religious group in addition to training programs and development of educational materials are recommended as useful tools for information dissemination.

The recommended best available technique for open burning is the reduction of the volume of waste burned through improved waste management including separation of waste fractions. On the other hand, introducing additional air pollution control device (ABCD) to the existing asphalt mixing plants is recommended. Quantitative analysis for costs and benefits was conducted for each recommended BAT/BEP. There is strong evidence that the recommended BAT/BEP is economically feasible.

This report is structured as follows:

- ✚ Section 2 provides an introduction which gives an overview of PCDD/PCDF.
- ✚ Section 3 describes the target groups.
- ✚ Section 4 Identified adequate and effective tools for awareness raising
- ✚ Section 5 discusses Information content dissemination approach
- ✚ Section 6 Present the benefit cost analysis of the identified BAT/BEP.
- ✚ Annexes contain data collected and the assessment tools used for data collection.

3.2 Background

Polychlorinated dibenzo-p-dioxins (PCDD) and Polychlorinated dibenzo furans (PCDF) are unintentionally produced persistent organic pollutants (UP-POPs) formed and released from different sources identified in Annex C of the Stockholm Convention including uncontrolled combustion processes and production of mineral products. UP-POPs are extremely harmful to human beings and environment.

In order to ensure public participation in addressing POPs, public awareness raising is essential. It should be promoted as indicated in Article 10 (Public information, awareness and education) to the Stockholm convention.

Relevant Stockholm Convention requirements

Article 10 to the Stockholm convention requires each party within its capabilities, to promote and facilitate:

- ✚ Awareness among its policy and decision makers with regards, to persistent organic pollutants.
- ✚ Provision to the public of all available information on persistent organic pollutants.
- ✚ Development and implementation, especially for women, children and the least educated, of educational and public

awareness programmers on persistent organic pollutants, as well as on their health and environmental effects and on their alternatives.

- ✚ The public participation in addressing persistent organic pollutants and their environmental effects and in developing adequate responses, including opportunities for providing input at the national level regarding implementation of this convention.
- ✚ Training of workers, scientists, educators and technical and managerial personnel

The convention also requires each party within its capabilities, ensure that the public has access to the public information..

Further article 10 identified the target groups that are either sensitive to POPs or their role is important for the successful implementation of the convention. Generally vulnerable and marginalized groups including poor people, women and children are most affected groups.

Currently researches on UP-POPs in general and associated socio economic consequences in particular are not available specifically in the coastal area. There is no laboratory for PCDDs/PCDFs analysis due to limitation of financial resources and lack of the device.

However, Survey and inventory of the unintentional production of dioxins and furans in the country was developed in 2005. A specific inventory on PCDD/PCDF releases for the coastal zone was carried out in 2010, for the purpose of evaluation the Sudanese situation in coastal zone concerning the presence of the two persistent organic pollutants classes (dioxins and furans).

According to PCCD/PCDF inventory, 2010, the total amount of emissions from all identified source categories was found to be 36.487gTEQ/a. waste burning at open sites is the major contributor to PCDD/PCDF emissions amounting to 36.467gTEQ/a, this is equivalent to 99.95% of the total amount of the releases. Asphalt mixing also has been established in the inventory development as a source of unintentional POPs. It contributes to about 0.01225g TEQ/a (0.01% of the total emissions).

Based on the inventory dioxins and furans are released directly to residues and air, but due to their nature (semi volatile) they can be transmitted to other media including land, water and products.

Open burning has been identified as a prevailing method of waste disposal in the area. The main reason for this method is low cost, lack of awareness and ineffective laws. There are no landfills or waste separation in the city with the exception of certain amount of waste metals separated by individuals at the dumping site to be sold for reprocessing. The total waste volume generated in the city on daily basis from different sources is amounted to 150 tons excluding not managed amount that burned in the vicinity. There are two private companies working on waste collection beside the locality as a governmental body.

On the other hand the total number of asphalt mixing plants operating in the city is three, owned by private sector, two out of do not have air pollution control device.

The priority locations for best available techniques and best available practice (BAT/BEP) implementation were identified to be open burning and asphalt mixing facilities.

Best available techniques means the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for release limitations designed to prevent and, where that is not practicable, generally to reduce releases of chemicals listed in Part 1 of Annex C and their impact on the environment as a whole

Objectives of the study

The overall goal of the study is to assess socioeconomic implications and public participation in addressing UP-POPs resulting from open burning and asphalt mixing activities in Sudanese coastal zone and to provide decision makers with information relating to social and economic costs and benefits of implementing alternative actions that should be taken to reduce the releases of UP-POPs. Specifically the study seeks to identify:

- ✚ The target groups and their size in order to elaborate public awareness programs.
- ✚ The most appropriate public awareness tools for awareness rising at the selected location.
- ✚ Information that will be included in public awareness tools.

- ✚ And to provide evidence for the economic benefit of the recommended BAT/BEP.

By doing this, a broad database will be provided and accordingly effective measures can be taken at national and regional levels to reduce the releases of UP-POPs from their major sources in the coastal area.

Methodology

To achieve the objective of the study both primary and secondary data were collected. Primary data comprised local views, perceptions related to UP-POPs sources and their impacts. Guidance on socio economic assessment for national implementation plan development and implementation under Stockholm Convention, developed by UNEP, was used.

Fieldwork was used to gather data on the target groups and the risks faced by them due to open burning and asphalt mixing activities, information contents and tools to be used for awareness rising.

Data was collected through field visits, meetings, structured and semi structured interviews. Meetings were held with a range of key staff of the companies working in waste collection and asphalt mixing facilities and other relevant stakeholders. Interviews were held with households and public committees.

The fieldwork also aimed to collect more detailed data on the costs and benefits of the recommended BAT/BEP. The data on the costs and benefits were obtained by contacting the key staff of the companies. A quantitative analysis of costs and benefits was conducted, using the best data available. Economic values were assessed for those items that could be quantitative, and those that were qualitative or difficult to be assigned economic value were not included in the analysis although they are very important and inherently valuable. However, benefit valuation methods such as market price method, damage cost avoided and contingent valuation methods were applied in this analysis.

3.3 Identification of target groups

This section gives a short survey of those populations who are at potential risk of UP-POPs exposure. The most risky place is the area where the dumping site and asphalt mixing facilities are located. Identification of the impacted population can be roughly estimated from the population at risk as a result of exposure to PCDD/PCDF resulting from each source category.



Notably, the residential area around dump site and asphalt mixing facilities is highly vulnerable to the contamination of UP-POPs. People live in the area under consideration are identified as potentially risk group. However, the survey has resulted in strong indications that poor people, women and children are the most vulnerable group. The size of this group is found to be 1543 person or about 257 household. (see the annex2).

Average family size is 6 persons with a high percentage of children 44.4% and Women 25.3%. Less educated people among households' heads constitutes 76% of the sample (23.5% are illiterate and 53.5% are either with primary or Khalwa educational level). 76% of the households is considered to be poor as their average income is less than one dollar a day, their houses are made of local material (wood and cement blocks) and they lack other assets physical, capital and social assets..

Continuous exposure of these identified affected groups to UP-POPs may lead to further increase in the depth and severity of poverty in terms of spread of diseases especially among women and children, a decrease in food quality and livelihood potential and, therefore, reduction in socio-economic opportunities of these groups.

On the other hand the people working at asphalt mixing facilities and open burning site constitute another vulnerable group to immediate risk of UP-POPs. . The total number of workers is estimated to be 97 and 305 at asphalt mixing facilities and open burning respectively. However, this group may have an important role in implementation of the recommended BAT/BET. For example Traffic company services with its 94 workers could play a vital role in awareness rising on the implementation of BAT/BET.

3.4. Identification of adequate and effective tools for awareness

Raising

The consultant consulted with stakeholders in order to identify the most appropriate and available tools for awareness raising and dissemination of information related to UP-POPs, their sources and impacts.

Recognizing that the environmental awareness should reach all the sections of the society, some of specific tools and techniques to be used for disseminating environmental related information are identified. Media and other means of communication including newspaper, radio, TV, awareness campaigns, brochures, posters, and T-shirts can be used for promoting public awareness.

Other important tools include:

- ✚ Schools through development of educational materials
- ✚ Religious or faith based group
- ✚ Training program at community level
- ✚ Training of workers and technical personnel.
- ✚ Efforts should be made to promote awareness among policy makers.

- ✚ Use of NGOs such as Sudanese conservation Society that already plays an important role on various issues related to environmental problems

3.5 Information content dissemination approach

Environmental awareness covers some specific environmental issues such as environment sanitation, health and development. However, there is no special awareness program on persistent organic pollutants issues. There are seasonal television programs conducted in coordination with the localities and the Ministry of Health highlighting specific problems. However, some time can be allocated for environmental awareness through TV, if financial supports are provided. Environmental awareness program is also conducted through the schools. On the other hand, the College of Marine Sciences and faculty of natural resources encourage scientific researches in the field of coastal zone environment in general; accordingly a number of graduate researches were conducted.

It is obvious: that limited and very general environmental information is mainly disseminated through printing media (news papers), TV and radio and schools. However, there is no deep analysis of environmental related issue. One can conclude that:

- ✚ Low level of information and awareness on UP-POPs throughout all population groups.
- ✚ Limited level of awareness on UP-POPs among stakeholders, most of them do not know much about POPs..
- ✚ Public and the people working at asphalt mixing and open burning are not being advised on the health effects of UP-POPs.
- ✚ Low awareness about environmental and health hazards related to mismanagement of dump sites.
- ✚ The residents in the area, where the practices occur, are not informed about UP-POPs and their harmful effects on human health and environment and the benefits of a clean environment.

It is clear that, there is a great need for improved environmental awareness at all levels. Continuous and detailed awareness programs should be implemented at all levels of society so that everyone should become aware of the problem and fully assumes responsibility in safeguarding the environment.

Generally an effective implementation of BAT/BEP needs a cooperation among all public and relevant stakeholders at all levels with as well as those involved in the activities under consideration. Hence, the application of BAT/BEP can be promoted through increasing awareness of the general public.

Adequate and accurate information on UP-POPs should be gained access through vulnerable groups and general public. However, the information that may be disseminated should contain:

- ✚ Types and sources of UP-POPs and their harmful effects.
- ✚ The relationship between the UP-POPs, public health and environment.
- ✚ Possible health impacts of UP-POPs on children.
- ✚ Management of dump sites.
- ✚ Benefits of a clean environment
- ✚ Promotion of waste reduction and recycling (BAT/BEP).

However each message may be reported differently to different target groups.

3.6 Cost Benefit Analysis of BAT/BEP implementation

The purpose of this part is to produce an analytical evidence of the benefit versus the cost of the identified BAT/BEP.

Cost Benefit Analysis (CBA) is an economic tool used to compare the benefits against the costs of a given project or activity. CBA aims to value the economic benefits of a project (rather than simply the financial impacts), and therefore takes account of any changes in human wellbeing arising from a given project or activity.

Although CBA has a number of important limitations, It is a useful tool especially where the benefits are not obvious. These limitations include:

- Many project impacts simply cannot be quantified such as social impacts including increased awareness of risk. These impact are inherently valuable, therefore CBA must be taken as one piece of an evaluation that also looks at the qualitative impacts of an activity.
- Valuation of some benefits is contentious because of the difficulties in assigning them a value.
- CBA is reliant on the quality of the data available which may be weak particularly at a localized scale.

3.6.1. Asphalt mixing

Port Engineering Company is the one of the working companies in the field of asphalt mixing since 2003. It introduced APCD in 2008 for the existing facilities. For the purpose of this study the company was taken as an example for cost benefit analysis to provide an evidence for the economic benefit of adding-on APCD. The data on various costs and benefits were obtained by contacting key staff of the company.

Quantitative analysis of costs and benefits

For the purpose of this analysis two scenarios were constructed;

1. What is the cost without introduction of air pollution control device (APCD)
2. What is the cost with introduction of air pollution control device (APCD)

The scenario without APCD will be compared to the scenario with APCD to describe the changes in or additional costs and benefits that have taken place as a result of adding of APCD.

Costs without APCD = benefits with APCD

A simple analysis was conducted, due to unavailability or difficulties in obtaining the data especially on non market values. For example emissions reductions, people's willingness to pay for avoiding damages on environment or health, and the reduction in health and environmental impacts due to the implementation of BAT/BEP were not included in the analysis. Only additional costs and benefits generated due to the installation of air pollution control device were considered. It is worth mentioning that the costs of adding the equipment to an existing plant vary according to the type of equipment purchased and plant details such as type, size, age .etc.

Net benefit value at a certain point of time was calculated. Moreover, cost benefit ratio (C/B) was also calculated.

Identification of quantifiable benefits

In order to conduct quantitative analysis of BAT/BEP it is necessary to:

- ✚ Identify those benefits of BAT/BEP that can be quantified.
- ✚ Estimate and assign values to these quantifiable benefits
- ✚ Offsets the benefits against the costs

The integration of air pollution control device generated a range of benefits in different ways. These benefits include:

- ✚ Avoided maintenance costs (no maintenance cost was recorded since the installation of the APCD).
- ✚ Reduction in maintenance risks (incidents occurred during removal and installation of the fan)
- ✚ Avoided Loss in produce during the maintenance period:
- ✚ Increased efficiency due to the avoided loss in aggregates.
- ✚ Saved energy due to the recycling of aggregate
- ✚ Emissions reductions.
- ✚ Reduction in the incidence of diseases among workers.

Table 1: Detailed calculation of quantifiable benefit

without APCD ¹	With APCD	Value ²	Detailed calculation of benefits
Maintenance cost	Avoided (no maintenance cost was recorded)	<ul style="list-style-type: none"> • Maintenance of the fan costs about SDG 2000 every month. • There are two operational periods/ year. Each period ranges from 4 - 6 months 	2000 SDG *4months* 2 periods= 16,000 SDG
Loss in the production during the maintenance period:	Avoided	<ul style="list-style-type: none"> • Every month the facility stops for three days for the purpose of the maintenance. • On the average loss in the production is amounted to 10 trucks load/ day. • Value of the trucks = SDG 7250 	3days*10 trucks load * 4months *2periods*SDG 7250= SDG 1,740,000
Loss in sand as a part of aggregate (low efficiency)	avoided (high efficiency, recycling of sand)	<ul style="list-style-type: none"> • the production loss is estimated to be 12 trucks /each operational period .Value of the trucks = SDG 7250 	Total benefit from production saved =12 truck* 2preiods* SDG 7250= SDG 174,000
Incidents cost during the maintenance process:	Avoided	<ul style="list-style-type: none"> • During the removal & installation of the fan, about 10 workers on the average every month expose to an incident. • Cost of treatment is estimated to be SDG 100/ worker 	10cases* SDG 100* 2periods* 4months=SDG 8,000

¹ The APCD has been operating for two years, since that time; none of the above mentioned costs was recorded.

²The last end of the range of values is used in the calculation of benefits for example the operational period is 4-6 months, 4 months was used for the calculation of benefits, Therefore, the cost benefit ratio is the most conservative value that can be generated depending on the data collected.



Costs analysis of the recommended BAT

Capital costs include the cost of purchase, transportation and installation of the of air pollution control device were found to be equivalent to SDG 55,000. Operating costs include direct cost of operation, maintenance, salaries.. etc. As stated by the key staff of the company, there were no incremental operational costs recorded as a result of the integration of air pollution device i.e. operational cost after the installation of the APCD remains unchanged; therefore, the operational costs were not included in the analysis.

From the table above the total benefit is equal to SDG 1,938,000

Net benefit = B –C = SDG 1,883,000

Cost benefit ratio (C/B) = 0.028

Findings of the CBA

The findings from the cost benefit analysis demonstrate that introduction of APCD to the existing facility generates a cost to benefit ratio of 0.028 .which is less than 1, hence there is strong economic justification for introducing APCD for the existing asphalt mixing facility.

Generally it is more economical to incorporate the pollution control equipment at the design stage rather to add the equipment at a later stage.

3.6.2 Open burning

Generally waste separation is recommended as environmentally sound waste management alternatives to reduce the volume of waste to be burned. Generally from environmental perspective material recycling is however always preferred compared to incineration and landfill. However, the recyclables that will be separated can be sold directly to scrap traders or recyclers for reprocessing

It was not possible to get the full data required to conduct quantitative analysis for the recommended BAT. The available data was used to build a cost benefit scenario for a quantitative analysis.

To facilitate the analysis and to obtain required data Traffic Company is taken as an example for the adoption of the recommended BAT/BEP. The company is a private company working in waste collection in Port Sudan city. The daily total volume of waste collected by the company is 60 tones on the average which represents more than half of the total volume of waste in the city. The company covers a large part of the city including households waste, commercial/ market waste, streets...etc. The waste itself is composed

of: Organic matter, paper and cartons, glass, metals, wood, plastic, textiles and leather.

Although the Company is fully equipped, it needs to increase its capital to offset the purchase of new machineries and employment of new workers to enter in the process of waste separation, The incremental costs include capital costs and running costs. This incremental cost will be balanced against the generated benefits.

Capital costs: include the cost of additional machineries (see annex 5 in addition to awareness campaigns which will be conduct for one year (the first year of the project). Incremental capital cost is calculated to be \$2,615,000. These costs are happened once at the start of the program (fixed costs).

Running costs include the wages of additional workers and drivers which is calculated to \$90,000 in addition to fuel and maintenance costs for new machineries. These variable costs will occur every year.

Benefits: The company is expected to generate benefit in the second year, these are inform of recyclables that will be sorted and sold for reprocessing including plastic, carton, papers iron, Aluminum and other metals as illustrated in annex 4. These benefits will continue for years to come. For example a project of 10 years life span will generate a net benefit equal to \$9,660,139 with cost benefit ratio equal to 0.27 the discount rate is assumed to be 8%.

Other benefits: The total volume of waste can be reduced to about 5-10 % and therefore the emissions will be reduced. Consequently health and environmental impacts will be reduced to the minimum. In addition to that awareness program will cover about 90% of the population. These benefits will continue for years to come.

However, the conservative estimates for cost and benefit are used, wherever ranges of values occur, the upper end of the range is used for cost calculation while the lower value (end) of the range is used in the case of calculation of benefit. For instant, the upper value of the wage of workers is used while, the lower amounts of different kinds of recyclables that will be sorted and their prices are used (see annex 4 and 5).

Findings:

- ✚ Waste separation project will continue to generate a less than one cost benefit ratio over years.
- ✚ BAT/BEP has resulted in many important benefits. Even though some of these benefits cannot be assigned values and therefore excluded from the analysis, the cost benefit ratio is feasible.

Conclusion

The study comes up with the following findings:

Increasing awareness among different group of the society and among decision makers is crucial for ensuring public participation in addressing persistent organic pollutants (POPs). Dissemination of appropriate and most relevant information to different groups using appropriate tools of information will help in the effective implementation of BAT/BEP.

The CBA process can help local staff to consider the economic implications of their work. The result from cost benefit analysis give broad input to decision making by authorities , companies, politician and private sectors

References

- 1- Ali, M.A., Adam A.M. and Sitnour H. M. (2010), Inventory for identification and quantification of dioxins and furans releases in Sudanese Red Sea coast. Khartoum.
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- 4- Osman, M. S., Kamal, O. M., Adel, A. M., Nahid, A.O., Hanan, M., A Abedelmuniem, K. G., and Gassan M. A. (2002). Sudan coastal profile. Preparation of Integrated Management plan for the Coastal Zone. Strategic Action Program (SAP) in the Red sea and Gulf of Aden. Sudan.
- 5- UNEP (2007). Guidance on socio economic assessment for national implementation plan development and implementation under the Stockholm Convention. [http:// chm.pops.int./program/NIP](http://chm.pops.int./program/NIP).
- 6- Environment Canada Advisory Group (2002) Final Report for Multi-pollutant Emission Reduction for the Hot-Mix Asphalt Sector
- 7- Federal Highway Administration, USA Department of transportation, Office of Pavement Technology : Program Long-Life Asphalt Pavements for the 21stCenturym Hot Mix Asphalt Technical Conference Feb,2010
- 8- LENTEC Asphalt Mixing Plants, <http://www.lintec-gmbh>.

Consultation and visits

- Asphalt mixing Companies
- Commercial chamber
- Department of Industry
- Faculty of Marine Science
- Faculty of Natural Resources
- Port Sudan hospital
- Locality
- Ministry of Health
- Port Sudan Madianaty (NGO)
- Proot newspaper
- Radio and TV.
- Red Sea State Center for Environment
- State Ministry of Environment
- Sudanese Environmental Conservation Society in the state
- Traffic Company

Annexes

Annex I.

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Asphalt mixing plants

Preliminary survey form

- 1- Sr. No: ...1.....
- 2- Factory name : Port Engineering C0
- 3- Factory address : Port Sudan , Tel.0311830005, Fax: 0311821250
Engineer in charge Dak Paolo Malwak, Mobil 012377164
- 4- Starting production date: since March 2003.
- 5- Site (GBS)

Altitude:

Latitude : Longitude

- 6-

Northern neighbor: municipal waste dumping area

Southern neighbour: ring road and Althagr Asphalt Mixing Co. & Nahdda residential area

Eastern neighbour:

.....

Western neighbour: Alnasr Contractor Asphalt Mixing plant

.....

- 7- Area: 65000 sq m

- 8- What is the main product of the factory? Asphalt mixture

.....

.....

- 9- What are the raw materials used?.(

type quantity per year ...

aggregates , asphalt and limestone 40,000 ton per year

.....

- 10- Number of batches per day2...batch duration (seasonally)

.....

....

- 11- Type of operation :continuous...

- 12- Production capacity per unit :100 tons per hour

- 13- What is the quantity produced? 400 tons / day

.....

- 14- What are the types of fuel used? Diesel and sometimes Bunker C-oil

.....

15- What is the quantity used? 2500L/ day

16- What are the production steps:/processes? 1- store aggregates and asphalt 2- loading into plant 3- heating 4- mixing and 5- discharge into trucks

17- Machines :

Type
Number : one

18- Machine safety precautions (operational or fencing)? Yes.....

19- Type of furnace: rotary

20- Furnace temperature: 150-170 °C

21- Is there any air pollution control system? bag filters

22- Is there any type of heat recovery system?yes.....

23- If yes specify : in the heat exchange + bag filter unit

24- What is the volume of the chimney off gases? NA

25- What is the temperature of the released gases? 100 °C

26- What is the number of workers:

	Men	Women	Children (teenagers)
Permanent			
Temporary	54	1	0
In production sites	20		
total	54	1	

27- Is there a pre-employment medical examination? Yes() No(x)

28- Is there a periodical medical examination? Yes() No(x)

If yes, after how long?

29- Is there any recorded occupational disease(s)? No... (x)

30- Yes.....: NumberType
No.....

31- Is there any recorded accident(s)?

- Yes.....: Number ...4.....Type injuries

- No.....

32- What are the expected health hazards?

- **Chemical ... (combustion gases + silica dust + asphalt)**
.....
 - **Physical (heat -radiation-light- from working under different weather conditions –noise from machines)**
 - **Mechanical risk of unsafe machinery working condition**
.....
 - **Ergonomics heavy loads (barrels) the standing working condition for long hours**
.....
- 33- **Is there any type of personal protective equipment/clothes?**
Yes overalls and boots
.....
- 34- **Are the workers using these equipment? Yes.....**
.....
- 35- **Is there any type of workers education or training on safe work performance?**
Yes.....
- 36- **Are there facilities for washing? .**
Hand washing basin :and bathrooms
- 37- **Is there any place for changing clothes**
Yes.....
- 38- **Type of wastes generated:**
a) **solid: empty asphalt barrels) how is it disposed? Sold**
b) **gaseous: number of chimneys 2..... Chimney height...13m.....**

Annex II

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Asphalt Mixing plants Preliminary survey form

- 1- Sr. No: ...2.....
- 2- Factory name : Elthager Engineering Asphalt Mixing Plant
Contract: Engineer Ahmed Mohamed Tahir,
Mobil : 00249912505413. e-mail: ataher90@gmail.com
- 3- Factory address : Port Sudan, Sudan
.....
- 4- Starting production date:
Site Daralsalam- west to tissaa- kabary
(GBS).....
- 5- Northern neighbour : open area
Southern neighbour: Yathrib residential area
Western neighbour: ring road
Eastern neighbour: Port Engineering CoAsphalt Mixing Plant Portsudan-
Khartoum
- 6- Area: 60000 m²
- 7- What is the main product of the factory?
Asphalt concrete mix
- 8- What are the raw materials used? gravel- sand- asphalt
quantity: 50,000 tons per year
- 9- Number of shifts per day 1 , duration 12hours
- 10- Type of operation: intermittent
- 11- Production capacity per unit: 100 tons per hour.
- 12- What is the quantity produced? 850 tons / day
- 13- What are the types of fuel used? Gasoil
- 14- What is the quantity used? 1000 L per day
- 15- What are the production steps:/processes? Heating asphalt to between 180-
200C , heating gravel to and sand then spraying asphalt to the gravel and
mixing
- 16- Machines :
DSP Asphalt mixer . Number: one only
- 17- Machine safety precautions (operational or fencing)? Yes.....
- 18- Type of furnace: rotary
- 19- Furnace temperature max. 200C
- 20- Is there any air pollution control system? Yes ,dust traps
- 21- Is there any type of heat recovery system? .. No.....
- 22- If yes specify
- 23- What is the volume of the chimney off gases? NA.....
- 24- What is the temperature of the released gases?
- 25- What is the number of workers:

	Men	Women	Children (teenagers)
Permanent	6	-	-
Temporary	8	-	-
In production sites	16	-	-
total	30	-	-

26- Is there a pre-employment medical examination? Yes

27- Is there a periodical medical examination? Yes

If yes, after how long? 6 monthes

28- Is there any recorded occupational disease(s)? No... ()

29- If yes.....: NumberType

30- Is there any recorded accident(s)? No.....

31- What are the expected health hazards?

- Chemical

- Physical (heat-noise-radiation-light-ventilation)

- Mechanical

- Ergonomics

32- Is there any type of personal protective equipment/clothes?

Yes

33- Are the workers using these equipment?

Yes.....

34- Is there any type of workers education or training on safe work performance?

Yes.....

35- Are there facilities for washing?

Yes.....

Hand washing basin and Bathrooms

36- Is there any place for changing clothes

Yes.....

37- Type of wastes generated:

a) solid :asphalt empty barrels which is sold

b) gaseous: number of chimneys2..... Chimney height.....

Annex III

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Asphalt Mixing plants Preliminary survey form

- 1- Sr. No: ...3.....
- 2- Factory name :Alnasr General for
Contracts.....
- 3- Factory address :Kasara Area behind the Port Engineering
Company.....
.....
.....
- 4- Starting production date:
.....
- 5- Site
(GBS).....
...
Northern neighbour :...open area
.....
Southern neighbour :...open area
.....
Eastern neighbour: Port Engineering
Company.....
Western neighbour: open area
.....
- 6- Area:60000 square meter
.....
.....
- 7- What is the main product of the factory?asphaltic mixture
.....
.....
- 8- What are the raw materials used?.(
type quantity per year
.....
.....
.....
- 9- Number of batches per day ...one.....batch duration 8hrs
.....
.....
- 10- Type of operation intermittent
.....
- 11- Production capacity per unit 300 T per day
- 12- What is the quantity produced? 250 T per day
.....

13- What are the types of fuel used?electricity and gasoline

14- What is the quantity used? Per shift/ day /month/year

Gasoline for the grinder and mixer :7000 per day

15- What are the production steps:/processes?

:

16- Machines :

Type(Number)mixing station (1) and electricity generators (2)

17- Machine safety precautions (operational or fencing)?

Yes.....No.....

18- Type of furnace rotary

19- Furnace temperature...150 °C

20- Is there any air pollution control system? (chimney with 4m height

21- Is there any type of heat recovery system?no.....

22- If yes specify

23- What is the volume of the chimney off gases?

24- What is the temperature of the released gases?

25- What is the number of workers:

	Men	Women	Children (teenagers)
Permanent	4		
Temporary	8		
In production sites			
total	12		

26- Is there a pre-employment medical examination?

Yes() No(x)

27- Is there a periodical medical examination?

Yes() No(x)

If yes, after how long?

28- Is there any recorded occupational disease(s)?

- No... (x)
- 29- Yes.....: NumberType
No.....
- 30- Is there any recorded accident(s)? no
- Yes.....: NumberType
- No.....
- 31- What are the expected health hazards?
- Chemical
- Physical (heat-noise-radiation-light-ventilation) x
.....
- Mechanical x
- Ergonomics.....
- 32- Is there any type of personal protective equipment/clothes?
YesNo...x only masks.....
- 33- Are the workers using these equipment?
Yes..... (x) No..... ().
- 34- Is there any type of workers education or training on safe work performance?
Yes..... () No..... ().
- 35- Are there facilities for washing? .
Hand washing basin :Yes..... (x) No..... ()
Bathrooms ()
- 36- Is there any place for changing clothes
Yes..... () No..... ().
- 37- Type of wastes generated:
a) gaseous: number of chimneys ...1..... Chimney height...4 m
.....
b) liquid pretreated? Yes..... () No..... ().
how is it disposed? On site... () connected to public sewer ... ()
collected and transferred by tankers ()

c) solid: empty barrels ... () how is it disposed? sold

Annex IV

بسم الله الرحمن الرحيم

استبيان المسح البيئي لتقويم بيئة العمل وتلوث البيئة بمؤسسات جمع النفايات

الرقم المتسلسل:

1- اسم الشركة/المؤسسة:

.....
.....
.....

2- العنوان المصنع:

.....
.....
.....

3- نوع النفايات التي يتم جمعها:

.....
.....
.....

4- الموقع التي يتم الجمع منها:

.....
.....

5- ما كمية النفايات المتولدة في المواقع في اليوم: بالشخص

بالمنزل بالمستشفى

6- طاقة الجمع والتحويل للشركة يوميا (ب) شهريا (ج) سنويا

7- ما هي الكمية التي تجمع وترحل؟ (ا) يوميا (ب) شهريا (ج) سنويا

8- عدد العربات؟

9- نوع العربات

10- ما نوع عملية الجمع والتحويل؟

متصلة متقطعة

11- كم عدد الواردات في اليوم؟

كم زمن الوردية الواحدة

12- هل النفايات التي يتم جمعها وتحويلها تكون مفروزة؟

13- لفرز النفايات هل سنكزن هنالك تكلفة اضافية؟

14- كم ستكون التكلفة و ما اوجهها؟

.....

15- المواقع التي ترحل لها النفايات ؟

16- ماهي كيفية التخلص النهائي بالمواقع التي ترحل لها النفايات؟

17- هل تعتقد انها هي الوسيلة المثلى للتخلص من هذه النفايات؟

18- إذا تقرر مثلا تغيير طريقة التخلص السطحي والحرق المكشوف المتبعة حاليا للطر في المرادم القياسية, في رأيكم :

19- كم ستكون التكلفة التقديرية اللازمة لذلك مع التفصيل

20- ماهي الموصفات اللازم لذلك

21- كم عدد العمال بالمصنع؟.....

احداث	نساء	رجال	
			مؤقتين
			دائمين
			داخل صالة الإنتاج
			الجملة

22- هل هنالك كشف قبل الاستخدام للعاملين : (ا) نعم (ب) لا

23- هل يتلقى العاملون كشف دوري؟ (ا) نعم (ب) لا
 بعد كم من الزمن؟

24- هل هنالك أي أمراض مهنية تم رصدها ؟ ما نوعها؟

25- هل هنالك أي حوادث وقعت للعاملين بالشركة؟

ما نوعها؟

ما نتائجها؟

26- ماهي المخاطر المهنية المتوقعة بالشركة؟

(ا) طبيعية

(ب) كيميائية

(ج) جيوية

(د) إجهاد عضلي

27- هل هنالك أي نوع من الملابس الواقية؟ (حدد).....

- هل يستعمل العمال هذه الملابس؟ -28
- هل هنالك أي نوع من تدريب العاملين علي التنفيذ السليم للعمل؟ -29
-
- هل هنالك مرافق للغسيل؟ (ا) أحواض أيدي (ب) حمامات -30
- هل هنالك حجرة لتغيير الملابس؟ (ا) نعم (ب) لا -31

Annex v

بسم الله الرحمن الرحيم

استمارة التقييم الاقتصادى والاجتماعى للملوثات العضوية التابنة

1- الاسم..... 2-التعليم..... 3- المهنة.....
4- أفراد الأسرة

المهنة	التعليم	العمر	الاسم

2- هل هنالك مصادر دخل أخرى؟ نعم لا

3- هذه كانت الاجابة بنعم اذكرها

4- الممتلكات : منزل (مواد البناء) راديو تلفزيون ثلاحة أخرى (اذكرها)

5- هل لديك اراضى زراعية المساحة

6- هل لديك حيوانات؟ نعم لا

7- اذا كانت الاجابة بنعم كم عددها وما قيمتها

8- هل هنالك امراض يعانى منها أى من أفراد الأسرة؟

9- اذا كانت الاجابة بنعم اذكرها

10- هل ترك بعض الأطفال من داخل الأسرة مدارسهم بسبب هذه الأمراض؟

11- هل هنالك فقدان فى الدخل نتيجة هذه الأمراض؟

12- اذا كانت الاجابة بنعم وضح : 1- ترك العمل 2- الوفاة 3-نفقات العلاج 4-خرى

(أذكرها)

13- ماذا يعنى لك حرق النفايات فى الأماكن المكشوفة؟

14- هل تعرف شئ عن الأثار السالبة لحرق النفايات فى الأماكن المكشوفة؟

15- اذا كانت الاجابة بنعم اذكرها؟

16- هل يمكن أن تساهم فى تقليل هذ المخاطر؟

- 17- هل يمكنك القيام بدفع أى تكاليف لتقليل هذه المخاطر؟
 18- ما رأيك اذا تم استبدال حرق النفايات فى الأماكن المفتوحة بطريقة أخرى؟
 19- هل تعرف شئى عن أثار السالبة لصناعة أو خلط الأسفلت؟
 20- اذا كانت الاجابة بنعم اذكرها؟
 21- ماذا تعرف الملوثات العضوية الثابتة (مصادرها وأثارها)؟
 22- ما المعلومات المراد معرفتها؟
 23- ماهى هى أحسن الوسائل لتوصيل هذه المعلومات؟

Annex 2

Population number in the impacted area (target group)

Locality: Port Sudan

Administrative Unit: Port Sudan- South

Area: EL Kassara

Total population	Male ≥ 16	Female ≥ 16	Male 0-15	Female 0-15
1543	495	390	350	308

Source: Central Bureau of Statistics Khartoum

Annex 3

Educational level of households' heads and household incomes

Education level	Number	Number of household
Illiterate	18	
Khalwa, primary and intermediate	8	
Secondary	5	
University	3	

Source: the survey on socio economic and public participation assessment

Annex4

Amount/ volume of recyclables to be recovered from the waste on daily basis

Recyclable	Amount/volume (tones)	price	Total benefit
Plastic	4-6	\$ 350-600	\$504,000
Carton	4-6	\$250	360,000
Papers	5-8	\$150	\$270,000
Iron	2-3	\$ 250 -400	\$180,000
waste	18	\$50-150	\$324,000
Aluminum	2-3	\$800	\$576,000
Copper	2-3	\$ 50-100	\$36,000

Source: key staff of the company staff

Annex 5

Incremental costs (capital and running costs):

Item	Quantity/number	price	Total cost
trucks	4	\$60,000- \$100,000	\$ 240,000
Containers	2000	\$1000	\$2,000,000

Loader	2	\$65,000	\$130,000
Grader	1	\$70,000	\$70,000
digger	1	\$65,000	\$65,000
Motorcycles	15	\$666	\$10,000
Awareness campaigns	12	\$8333	\$100,000
Workers	50	\$840-\$1200	\$60,000
Drivers	15	\$1200-\$2000	\$30,000
Fuel			28,080
maintenance			\$10,000

Source: key staff of the company staff