Department of the Environment
Industry Profile

Oil refineries
and bulk storage of crude oil and petroleum products

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Contaminated Land and
Liabilities Division

Industry Profiles, together with the Contaminated Land Research Report series, are financed under the Department of the Environment's contaminated land research programme.

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The Department's Contaminated Land Research Report series deals with information needed to assess risks; procedures for categorising and assessing risks; and evaluation and selection of remedial measures.

General guidance on assessing contaminated land and developing remedial solutions which is complementary to the Department's publications is provided by the Construction Industry Research and Information Association (CIRIA).

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DOE Industry Profile

Oil refineries and bulk storage of crude oil and petroleum products

This profile is based on work by Aspinwall and Company Limited and Consultants in Environmental Sciences Limited and was prepared for publication by the Building Research Establishment.

Preface

DOE Industry Profiles provide developers, local authorities and anyone else interested in contaminated land, with information on the processes, materials and wastes associated with individual industries. They are not definitive studies but they introduce some of the technical considerations that need to be borne in mind at the start of an investigation for possible contamination.

Every site is unique. Investigation of a site should begin with documentary research to establish past uses. Information on the site's history helps to focus a more detailed investigation. This knowledge needs to be supplemented by information on the type of contamination that may be present and where on site it may be found. Profiles give information on the contamination which might be associated with specific industries, factors that affect the likely presence of contamination, the effect of mobility of contaminants and guidance on potential contaminants.

The date when industrial practices first commenced on a site and its location are important clues in establishing the types of operations that may have taken place, so each profile provides a summary of the history of the industry and its likely geographical spread within the United Kingdom.

Profiles should be read with the following reservations in mind:

- individual sites will not necessarily have all of the characteristics described in the profile of that industry;
- practices can vary between sites and change over time;
- as practices change, problems of possible contamination may also change;
- the profile may refer to practices which are no longer followed, and may omit current practices which avoid contamination.

The risks presented by contaminated sites depend on the nature of the contaminants, the targets to which they are a potential threat (such as humans or groundwater) and the routes or pathways by which they reach these targets. The current or proposed use of a site and its environmental setting are crucial in deciding whether treatment is necessary and if so, the methods to be used. Some sites may not need treatment.

The information in profiles may help in carrying out Control of Substances Hazardous to Health (COSHH) assessments for work on contaminated land - see Health and Safety Guidance Note HS(G) 66 *Protection of workers and the general public during the development of contaminated land,* Health and Safety Executive, 1991, and *A guide to safe working practices for contaminated sites,* Construction Industry Research and Information Association, 1995.

Note: the chemical names given to substances in this profile are often not the modern chemical nomenclature, but the names used historically for those substances.

Oil refineries and bulk storage of crude oil and petroleum products

1. Background

This profile covers the refining of crude oil into saleable petroleum products by physical and chemical processes and the storage of crude, refined and finished oil products.

Crude oil is the basic raw material upon which all refinery processes are founded. Crude oils are primarily complex mixtures of hydrocarbons, ranging from dissolved gases to compounds which are solid at ambient temperature, but they also contain compounds with small amounts of oxygen, nitrogen and sulphur and traces of metals (eg vanadium, nickel and iron). Crude oils from different sources demonstrate considerable variation in physico-chemical properties (eg in terms of colour, odour, viscosity, content of sulphur and volatiles).

The principal products of oil refineries are:

refinery gas
LPG (liquid petroleum gas)
naphtha
motor spirit
aviation fuel
kerosene
gas oil/diesel
fuel oil
lubricants and waxes
bitumen and coke.

1.1 History of petroleum refining

The practice of refining predates the petroleum industry itself and began with simple distillation of many raw materials in Europe in the 18th Century. The word 'petroleum' was used for shale oil and similar rock oils long before the drilling of the first petroleum well in 1859. Mineral oils derived from oil bearing shales were first exploited in the United Kingdom on a small scale for lamp oil (kerosene) in the early 19th Century. James Young of Scotland was granted British patents in 1847 for his process of distilling oil from bituminous shale and common coal.

Oil shales of significant oil production capacity occur in England and Scotland, with smaller quantities in Wales and Ireland. In Scotland the industry was concentrated in Mid and West Lothian and production peaked in the 1870s; the Kimmeridge Shales, widely distributed in the South East of England and especially in Dorset, were worked from 1848. The last oil shale works in Britain closed in 1964.

A major increase in the demand for petroleum products, largely fuel oil for ships and gasoline (petrol) for motor vehicles, occurred in the early 20th Century. At this time, most crude oil was refined abroad at source, and significant growth of the United Kingdom oil refining industry did not occur until after the Second World War. The United Kingdom petrochemicals industry emerged in the 1950s, but its growth

was initially restricted by a lack of raw materials and the existence of a well established coal-based chemical industry. During the 1960s the industry rapidly developed in response to a growing demand for new materials (plastics, synthetic rubber and fibres) which led to a decline in the production of coal-based feedstocks.

Oil refining has been carried out at relatively few locations in the United Kingdom. The location of oil refineries is largely dictated by proximity to deep water ports and product markets. Until the mid-1970s, crude oil was imported into the United Kingdom from abroad. This stimulated the construction of refineries at major ports, such as at Fawley near Southampton and at Milford Haven in Wales. The advent of North Sea oil did not result in the building of new refineries because of the ease with which the oil could still be shipped to existing coastal refineries.

The United Kingdom refinery capacity over the period 1938-1994 is shown in Table 1. Refinery capacity reached a peak in the 1980s, but the number of refineries has declined since 1970 and fell from 23 in 1970 to 13 in 1994. The cessation of refinery operations as a whole at a particular site does not necessarily mean site closure. There may be residual operations at the site such as specialist processing, blending or use as an oil or product terminal.

Most refineries currently in operation in the United Kingdom are on sites that have been developed over periods of 15-40 years. The following sections of this profile refer to modern refineries and operational practice.

There is a need for the storage of oil and products in tank farms at a number of stages in the oil import, refining and product distribution cycle. Oil is delivered to refineries either by supertanker or pipeline (in the case of refineries receiving oil from North Sea fields). In both cases there is a need for operational storage at the refinery in order to secure feedstock supplies. In some cases, the oil for a particular refinery is fed to a crude oil terminal some distance from the refinery.

Crude oil storage capacity at a refinery could be of the order of hundreds of thousands of tonnes. In addition, there will also be buffer storage at crude oil terminals remote from the refinery to which the oil is delivered. The largest oil terminal in the United Kingdom is that at Sullom Voe in the Shetland Islands, which receives oil from a number of North Sea oil fields to the North East and from which oil is off-loaded into tankers. There are a further three terminals, two in Scotland and one on Teesside, receiving oil from North Sea fields by pipeline.

There is further substantial storage of oil products within a refinery in the form of intermediate storage between successive refinery processes and the final storage of finished products. The latter may be at a refinery or at a separate dedicated tank farm site. In addition there is subsequent storage of products at further stages in the distribution cycle.

Table 1: United Kingdom crude oil refinery capacity

(Source: Institute of Petroleum 1994)

Company	Location	Completion	Thousand tonnes at 31 December each year				
			1938	1950	1970	1980	1994
Esso Petroleum Co Ltd	Fawley, Hants Milford Haven, Pembrokeshire[7]	1921 1960	700 –	1100 –	16500 6300	19200 8700	15000 –
Shell UK Ltd	Stanlow, Cheshire Shell Haven, Essex Teesport, Cleveland[8] Ardrossan, Ayrshire[9] Heysham, Lancs[3]	1924 1916 1968 1928 1948	– – – – –	1200 2000 – 150 1800	10750 1000 6500 275 1950	12300 8500 5200 275 –	12500 4300 – – –
Lindsey Oil Refinery Ltd	Killingholme, South Humberside[11]	1969	–	–	7000	9400	9400
Texaco Ltd	Pembroke, Pembrokeshire	1964	–	–	5900	9000	9100
BP Oil Ltd	Grangemouth, Stirlingshire Llandarcy, Glamorgan[10] Isle of Grain, Kent[6] Belfast, Ulster[6] Pumpherston, Lothian[1]	1924 1921 1953 1964 1884	360 360 – – 150	1750 2850 – – 160	7000 8000 10000 1500 –	8600 5500 10400 1500 –	8900 – – – –
Mobil Oil Co Ltd	Coryton, Essex	1953	–	–	7000	9000	8800
Conoco	Killingholme, South Humberside	1969	–	–	9500	6500	6600
Elf Oil UK Ltd/Murco Petroleum Ltd[12]	Milford Haven, Pembrokeshire	1973	–	–	–	5400	5500
Gulf Oil (GB) Ltd	Milford Haven, Pembrokeshire	1968	–	–	4000	5000	5600
Phillips-Imperial Petroleum Ltd	North Tees, Cleveland	1963	–	–	5000	5000	5000
Eastham Refinery Ltd	Eastham, Cheshire	1966	–	–	400	600	1100
Nynas UKAB[13]	Dundee, Angus	1935	-	25	85	350	500
Burmah Oil Trading Ltd	Ellesmere Port, Cheshire[5] Barton, Lancs[2]	1934 1938	100 100	120 130	250 175	1500 –	– –
Berry Wiggins & Co Ltd	Kingsnorth, Kent[4] Weaste, Lancs[2]	1930 1932	70 60	95 70	285 170	– –	– –
TOTAL CAPACITY			1900	11450	112540	131925	92900[14]
TOTAL NUMBER			8	13	23	20	13

[1]Closed down 1964 (December)
[2]Closed down 1972
[3]Closed down 1976
[4]Closed down 1977
[5]Closed down 1981 (December)
[6]Closed down 1982
[7]Closed down 1983
[8]Closed down 1984
[9]Closed down 1985
[10]Half capacity closed end 1985, remainder January 1986
[11]Joint Fina/Total plant
[12]During 1990 Elf Oil acquired Amoco's Milford Haven Refinery
[13]Briggs Oil acquired by AB Nynas Petroleum August 1992
[14]Includes Carless Solvents, Harwich, figures not available before 1990

2. Activities

2.1 Oil shale industry

The semi-solid asphalt-like material present in oil shale was converted into crude oil in a process of distillation in retorts. The subsequent refining process effectively resulted in cracking of the heavy materials into lighter oils. Refining carried out in Scotland was based on small batches of material in small stills to produce a wide range of products and involving high losses.

2.2 Modern refining

Modern oil refining essentially involves two categories of processing, the physical separation of the raw material into a range of homogeneous petroleum fractions and the subsequent chemical conversion of certain fractions to alter the product yield and improve product quality. Physical processes include distillation and blending; chemical processes include cracking, coking, reforming, alkylation, polymerisation, isomerisation and hydrogen treatment.

Refineries are classified according to the complexity of their process operations into four categories:

Category 1	Topping/reforming is the simplest and provides basic crude distillation and catalytic reforming.
Category 2	Cracking is the addition of a major cracking process to the basic topping/reforming refining.
Category 3	Lubricating oil refineries have the addition of lubricating oil manufacture to Category 2.
Category 4	Comprise Category 2 and/or 3 refineries with the addition of a petrochemical plant. These operations produce specific chemical compounds such as aromatics, alcohols and ketones, and are usually carried out at a separate site adjacent to the refinery.

2.2.1 Primary distillation process

Crude oil entering the refinery undergoes primary separation by continuous atmospheric distillation to yield a variety of homogeneous fractions boiling over a wide range. These typically include the following:

gases
naphtha
kerosene
gas oil
residue.

2.2.2 Refining and secondary processes

Additional fractions and different boiling ranges may be required at different refineries depending on the primary products desired, eg motor spirit (gasoline) or petrochemical feedstocks. The residue from primary distillation may be used as fuel but is more often vacuum distilled to produce distillates for cracker feedstock or

lubricating oil manufacture. The residue from vacuum distillation may be used as a fuel oil blend stock or for the production of bitumen.

The product yield from a refinery is dependent upon the composition of the crude oil, the technology of the refinery and market demands. The yield is adapted to market requirements by secondary conversion processes, principally cracking and reforming.

The cracking process involves the breakdown of heavy fractions, typically heavy vacuum distillates, into lighter fractions such as gas oil and motor spirit by the use of:

heat (thermal cracking or coking)
catalysts to increase the rate of reaction (catalytic cracking)
a catalyst and hydrogen (hydrocracking), where the hydrogen is used to suppress coke formation.

The catalytic reforming process brings about molecular rearrangement and is used to convert low octane naphthas into high octane blending components for use in either motor spirit or as a petrochemical feedstock high in aromatic content.

Other conversion operations undertaken in refineries include:

hydrogen-based treatment to remove sulphur, nitrogen or oxygen contaminants from process streams and to saturate olefinic compounds

alkylation, involving the reaction of isobutane with olefins (formed by catalytic cracking) in the presence of a mineral acid (eg hydrofluoric acid or sulphuric acid) to produce a high octane alkylate

catalytic isomerisation of n-butane, n-pentane and n-hexane using typically an aluminium chloride catalyst.

Lubricating oil and petrochemical refining processes also employ a wide range of organic solvents and catalysts in a variety of physical and chemical refining processes.

2.2.3 Chemicals and additives

Refineries use a large number of chemicals and additives in their process plants and for blending into the finished products. Some of these may be classified as potential contaminants including the following:

catalysts (metals, metal compounds, acids)
caustic chemicals
laboratory chemicals
organic and inorganic acids
organo-lead compounds
oxygenates (used as octane enhancers)
solvents.

Refinery plans and other records will show whether any of the processes involved the use of such materials and the areas of potential contamination.

2.3 Storage

Oil products are transported to a number of primary terminals, which are owned and operated by the oil companies, in key industrial areas or centres of population. Many of these are located on the coast and receive oil products delivered by tanker either from the United Kingdom refineries or possibly other refineries in Europe operated by the oil company concerned. Where terminals are inland, without suitable river access, the transfer of products is by pipeline. Other major users of oil products, such as airports, are also supplied by pipeline delivery to their particular storage tank farms. Capacities of primary terminals are likely to be in the order of tens of thousands of tonnes.

The oil products are transferred from the primary terminals, usually by road, to secondary distribution centres, which are operated by the suppliers of oil products to the ultimate user and from which the local deliveries are made. These centres may be operated either by the oil companies or by independent operators of whom there are a fairly large number; for example in 1993 the retail motor spirit market was served by more than 60 major suppliers. Centres may involve one or more oil products for example motor spirit, diesel, kerosene and fuel oil. Storage capacity is usually in the order of thousands of tonnes.

2.4 Wastes

2.4.1 Wastes from oil shale production

The low yields of oil from oil shale (0.1-0.4 m^3 per tonne of shale) meant that there was a considerable quantity of waste material per unit output of oil. The quantity of spent shale amounted to almost the same as the volume of raw shale put through the retorts. However, the quantity of petroleum products produced from oil shale was low, and the volume of waste which was produced is not generally considered to be of significance.

2.4.2 Wastes from oil refining

Oil refining produces gaseous, liquid and solid waste streams. Wastewater streams containing free oil and solids are treated on site by various processes such as gravity separation, flotation and chemical coagulation. These processes yield free oil and/or sludges that are oily and of high water content, which are dewatered prior to disposal.

Removal of impurities from refinery products using sodium hydroxide (caustic soda) produces a strong liquid alkaline waste containing phenols, cyanides and sulphur containing compounds, such as sulphides and mercaptides, frequently in very high concentrations. Alkylation and acid treatment processes produce strong mineral acid wastes (up to 85-90% acid) and acid sludges.

In modern refineries a large proportion of waste is treated or recycled internally and thereby recovered for re-use or burned as fuel. The total quantity of waste requiring disposal is therefore small. Wastes requiring off-site disposal include spent catalysts, oily sludges (or residues after burning) and water treatment sludges.

2.4.3 Wastes from oil storage

Tanks for the storage of the more volatile petroleum products are subject to licensing under the Petroleum (Consolidation) Act 1928 (amended). The tanks must be inspected for integrity on a programmed basis. Other oil storage tanks will

generally also be inspected on a routine basis. Where remedial works are necessary, tanks will need to be emptied, cleaned and rendered gas-free to ensure safe working conditions.

These tank-cleaning operations may generate oily sludges for disposal. Storage of crude oil gives rise to accumulation of sediment containing inorganic salts, iron and aluminium compounds and heavy organic solids. Sludges from tanks used for the storage of leaded motor spirit contain tetraethyl lead used as an anti-knock additive.

3. Contamination

The contaminants on a site will largely depend on the history of the site and on the range of materials produced there. Potential contaminants are listed in the Annex and the probable locations on site of the main groups of contaminants are shown in Table 2. It is most unlikely that any one site will contain all of the contaminants listed. It is recommended that an appropriate site investigation be carried out to determine the exact nature of the contamination associated with individual sites.

3.1 Factors affecting contamination

The major contamination of soil on a refinery or tank farm site is likely to be from oil. The hydrocarbon fraction could vary from light (eg motor spirit) to very heavy (eg residual oil or lubricating oil).

There is the potential for soil contamination both in the process plant and storage sections of a refinery or in a tank farm. Records of the history of the refinery should be used to pinpoint locations where contamination is likely, eg drainage system channels and sumps, retention ponds, waste storage and on-site disposal areas. The principal locations of the key groups of contaminants are given in Table 2.

On-site waste disposal could have occurred on old sites with available open ground, typically around the periphery of the works or close to storage tank farms or any wastewater treatment plant. Sludge drying beds and settling lagoons may also have been located in the vicinity of the effluent treatment plants. Leaks from tanks, pipelines, effluent drains and sumps may have resulted in localised contamination, as may storage and handling areas for solid materials (eg coke and sulphur). Contamination may also be found in connection with existing infrastructure, such as underground storage tanks and pipelines.

Asbestos wastes may have arisen from its use in insulation. Asbestos may be found in association with parts of the refinery equipment, eg tanks, pipes and boilers, or as a result of on-site disposal of asbestos. Electrical transformers may, depending upon the age of the installation, be a source of polychlorinated biphenyls (PCBs).

3.2 Migration of contaminants

The migration of contaminants is dependent upon their physical and/or chemical characteristics and upon the hydrogeological and geological characteristics of the site. Low viscosity liquid and gaseous hydrocarbons are highly mobile and may migrate from point sources to contaminate a wide area. Unless trapped in impermeable strata or in existing infrastructure, the gaseous substances will have

evaporated fairly rapidly from their original point of deposition or disposal. Viscous liquids and semi-solid tars are less mobile, but also flow and therefore may also migrate.

Liquids released at the surface or leaking from an underground structure will flow down through the ground under the influence of gravity. Some hydrocarbons will be adsorbed onto soil particles and retained in soil pores. On encountering groundwater, the liquid will typically spread out on the surface of the water and migrate laterally, preferentially in the direction of groundwater flow. The volatile components will diffuse into the overlying soil and migrate as a vapour front ahead of the free product. Vapour emissions from contaminated land could accumulate in poorly ventilated spaces and present a health and explosion hazard.

Insoluble liquids which are denser than water will sink through the groundwater until they encounter an impermeable barrier, where they will spread out and possibly continue to migrate in the direction of groundwater flow. Soluble components (such as phenols) will dissolve in the groundwater and migrate in the direction of groundwater flow. Soluble inorganic contaminants deposited on the surface or in the unsaturated zone may be leached by rainwater infiltration and also enter underlying groundwater.

Metal contamination is likely to be localised. The movement of metals through soil is reduced by the presence of organic matter and by solubility limitations. However, low pH conditions caused by the presence of mineral acids could enhance the mobility of some metals. Metals attenuated in soils at, or close to, the surface may be transported by wind action.

Mineral acids will migrate within soil-water. The buffering capacity of most soils will neutralise acidity to some degree. However, soluble mineral acid anions, such as nitrate or chloride, can migrate freely through the soil.

Generally, the higher the organic matter and particularly clay content of the soil the greater the degree of adsorption of organic compounds and hence the lower their mobility. The greatest degree of contaminant migration will occur in coarse-grained sands and gravels with little organic content.

Some organic contaminants will biodegrade naturally in soils, although the rate of degradation will depend upon the environmental conditions. However, asbestos, metals and most other inorganic contaminants are not biodegradable.

Wind dispersal of contaminated soil may be a further transport mechanism where there is gross surface contamination by some of the less mobile contaminants, particularly metals and asbestos.

PCBs are highly persistent and fat soluble, possibly leading to accumulation in food chains.

4. Sources of further information

4.1 Organisations

For further information concerning the oil refining industry in the United Kingdom, the following organisations should be consulted:

The Institute of Petroleum
61 New Cavendish Street
London
W1M 8AR

The International Petroleum Industry Environmental Conservation Association (IPIECA)
First Floor
2 College Hill
London
EC4R 2RA

The Petroleum Industries Study Group for Conservation of Clean Air and Water — Europe (CONCAWE)
Madouplein 1
B1030 Brussels
Belgium

The UK Petroleum Industry Association Limited (UKPIA)
9 Kingsway
London
WC2B 6XH

4.2 Sources of information concerning the activities described in this profile

Beychok M R. *Aqueous wastes from petroleum and petrochemical plants.* John Wiley and Sons, 1967.

Goldstein R F and Waddams L A. *The petroleum chemicals industry.* E and F N Spon Limited, 1967.

Hardie D W F and Davidson Pratt J. *A history of the modern British chemical industry.* Pergamon Press, 1969.

Institute of Petroleum. *Code of practice for the investigation and mitigation of possible petroleum-based land contamination.* IOP, London. John Wiley and Sons, Chichester, 1993.

Molle W and Egbert W. *Oil refineries and petrochemical Industries in western Europe.* Gower Publishing Company, 1984.

Nemerow N L. *Liquid waste of industry.* Addison-Wesley Publishing Company, 1971.

Royal Dutch Shell. *Petroleum handbook.* Sixth Edition, Elsevier, 1983.

Wiseman P. *An introduction to industrial organic chemistry.* Second Edition, Applied Science Publishers Limited, 1979.

Case study including information relevant to this Industry Profile:

Paul V. *Bibliography of case studies on contaminated land: investigation, remediation and redevelopment.* Garston, Building Research Establishment, 1995.

Information on researching the history of sites may be found in:

Department of the Environment. *Documentary research on industrial sites.* DOE, 1994.

4.3 Health, safety and environmental risks

The Notes issued by the Chief Inspector of Her Majesty's Inspectorate of Pollution (HMIP) provide guidance for the processes prescribed for integrated pollution control in Regulations made under the Environmental Protection Act 1990. Series 4 of the Process Guidance Notes covers many aspects of the Chemical Industry Sector. Of particular relevance is:

Her Majesty's Inspectorate of Pollution. *Petroleum processes. Crude oil refineries.* Chief Inspector's Guidance to Inspectors. Process Guidance Note IPR I/15. HMSO, London 1992.

The Control of Substances Hazardous to Health (COSHH) Regulations 1994 and the Management of Health and Safety at Work Regulations 1992 are available from HMSO. Information on relevant health and safety legislation and approved codes of practice published by HSE publications are available from Health and Safety Executive Books, PO Box 1999, Sudbury, Suffolk, CO10 6FS (telephone 01787 881165), as well as HMSO and other retailers.

Information on the health, safety and environmental hazards associated with individual contaminants mentioned in this profile may be obtained from the following sources:

Howard P H. *Handbook of environmental fate and exposure data for organic chemicals.* Vols I and II. USA, Lewis Publishers, 1990.

Sax N and Lewis R. *Hazardous chemicals desk reference.* New York, Van Nostrand Reinhold Company, 1987.

Verschueren K. *Handbook of environmental data on organic chemicals.* 2nd Edition. New York, Van Nostrand Reinhold Company, 1983.

4.4 Waste disposal and remediation options

Useful information may be obtained from the Department of the Environment series of Waste Management Papers, which contain details of the nature of industrial waste arisings, their treatment and disposal. A current list of titles in this series is available from HMSO Publications Centre, PO Box 276, London SW8 5DT. Of particular relevance is:

> **Department of the Environment.** *Tarry and distillation wastes and other chemical based residues.* Waste Management Paper 13. HMSO, London 1981.

Publications containing information on the remedial treatments and site clean-up options available for contaminated land sites, prepared with the support of the Department of the Environment's Research programmes, can be obtained from National Environmental Technology Centre Library, F6, Culham, Abingdon, Oxfordshire, OX14 3DB.

A full list of current titles of Government publications on all aspects of contaminated land can be obtained from LEQ4 Division, Room A238, Department of the Environment, Romney House, 43 Marsham Street, London SW1P 3PY.

Advice on the assessment and remediation of contaminated land is contained in guidance published by the Construction Industry Research and Information Association (CIRIA), 6 Storey's Gate, Westminster, London, SW1P 3AU.

Annex Potential contaminants

The chemical compounds and other materials listed below generally reflect those associated with the industry and which have the potential to contaminate the ground. The list is not exhaustive; neither does it imply that all these chemicals might be present nor that they have caused contamination.

Oil refineries

Despite the wide range of potential contaminants listed, the major contamination is likely to be from hydrocarbons.

Hydrocarbons	crude oil naphtha motor fuel aviation fuel kerosene gas oil/diesel fuel oil lubricants waxes bitumen coke sludges containing hydrocarbons
Other organic compounds	organo-lead compounds (particularly tetraethyl and tetramethyl lead) organo-nitrogen compounds organo-sulphur compounds methyl tertiary butyl ether tertiary amyl methyl ether phenolic compounds organic acids, including naphthenic acids aliphatic/aromatic hydrocarbons alcohols glycols aldehydes ketones nitriles polychlorinated biphenyls (PCBs) solvents for lubricating oil production eg furfural phenol toluene
Inorganic elements and compounds	mineral acids alkalis cyanides sulphur sulphides

Metals, metalloids and their compounds	aluminium cobalt copper iron lead molybdenum nickel noble metals vanadium
Others	asbestos

Storage facilities

Hydrocarbons	crude oil naphtha motor fuel aviation fuel kerosene gas oil/diesel fuel oil lubricants sludges containing hydrocarbons
Other organic compounds	organo-lead compounds (particularly tetraethyl and tetramethyl lead) methyl tertiary butyl ether tertiary amyl methyl ether polychlorinated biphenyls (PCBs)
Others	asbestos

Table 2 Main groups of contaminants and their probable locations

Oil refineries and bulk storage of crude oil and petroleum products

Main groups of contaminants	Location									
	Process buildings and building fabric	Raw material storage	Process areas	Pipelines and pumps	Intermediate and product storage facilities	Waste storage areas	Drainage systems	Wastewater treatment plants	Electrical trans-former areas	Terminals and distribution centres
Metals, metalloids and their compounds		■	■		■	■				
Inorganic compounds		■	■		■	■	■	■		■
Hydrocarbons		■	■	■	■	■	■	■		■
Other organic compounds		■	■	■	■	■	■	■		■
Asbestos	■									
Polychlorinated biphenyls (PCBs)									■	

Shaded boxes indicate areas where contamination is most likely to occur.

Recycled paper

DOE Industry Profiles

Airports
Animal and animal products processing works
Asbestos manufacturing works
Ceramics, cement and asphalt manufacturing works
Chemical works: coatings (paints and printing inks) manufacturing works
Chemical works: cosmetics and toiletries manufacturing works
Chemical works: disinfectants manufacturing works
Chemical works: explosives, propellants and pyrotechnics manufacturing works
Chemical works: fertiliser manufacturing works
Chemical works: fine chemicals manufacturing works
Chemical works: inorganic chemicals manufacturing works
Chemical works: linoleum, vinyl and bitumen-based floor covering manufacturing works
Chemical works: mastics, sealants, adhesives and roofing felt manufacturing works
Chemical works: organic chemicals manufacturing works
Chemical works: pesticides manufacturing works
Chemical works: pharmaceuticals manufacturing works
Chemical works: rubber processing works (including works manufacturing tyres or other rubber products)
Chemical works: soap and detergent manufacturing works
Dockyards and dockland
Engineering works: aircraft manufacturing works
Engineering works: electrical and electronic equipment manufacturing works (including works manufacturing equipment containing PCBs)
Engineering works: mechanical engineering and ordnance works
Engineering works: railway engineering works
Engineering works: shipbuilding, repair and shipbreaking (including naval shipyards)
Engineering works: vehicle manufacturing works
Gas works, coke works and other coal carbonisation plants
Metal manufacturing, refining and finishing works: electroplating and other metal finishing works
Metal manufacturing, refining and finishing works: iron and steelworks
Metal manufacturing, refining and finishing works: lead works
Metal manufacturing, refining and finishing works: non-ferrous metal works (excluding lead works)
Metal manufacturing, refining and finishing works: precious metal recovery works
Oil refineries and bulk storage of crude oil and petroleum products
Power stations (excluding nuclear power stations)
Pulp and paper manufacturing works
Railway land
Road vehicle fuelling, service and repair: garages and filling stations
Road vehicle fuelling, service and repair: transport and haulage centres
Sewage works and sewage farms
Textile works and dye works
Timber products manufacturing works
Timber treatment works
Waste recycling, treatment and disposal sites: drum and tank cleaning and recycling plants
Waste recycling, treatment and disposal sites: hazardous waste treatment plants
Waste recycling, treatment and disposal sites: landfills and other waste treatment or waste disposal sites
Waste recycling, treatment and disposal sites: metal recycling sites
Waste recycling, treatment and disposal sites: solvent recovery works
Profile of miscellaneous industries incorporating:
- Charcoal works
- Dry-cleaners
- Fibreglass and fibreglass resins manufacturing works
- Glass manufacturing works
- Photographic processing industry
- Printing and bookbinding works

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