Department of the Environment
Industry Profile

Chemical works

cosmetics and toiletries manufacturing works

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Contaminated Land and
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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

Chemical works: cosmetics and toiletries manufacturing works

This profile is based on work by Dames and Moore International 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.

Chemical works: cosmetics and toiletries manufacturing works

1. Background

A wide range of products is made by the cosmetics and toiletries industry. For the purposes of this profile, the products of the industry are divided into three groups:

personal hygiene, skin care, hair care and colour cosmetics
perfumes
dental products.

The use of make up and perfume in the form of incense and ointments was introduced into Britain from the East at the time of the Crusades. By the 18th Century the use of cosmetics and toiletries was no longer confined to the court but had spread to nearly all social classes.

Until the 1850s, toiletries were manufactured by small firms, often located in central London. The main products were perfumes, soaps, toiletries and dental products. The Great Exhibition of 1851, where there were over 331 exhibitors in the soap and perfumery section from the United Kingdom alone, stimulated the industry's expansion. Firms began to develop large-scale production techniques and to seek larger sites, often out of city centres.

By the 1880s, a range of face preparations had been put on to the market by firms such as Rimmel and Boots. In 1908, Helena Rubenstein came to Britain from the United States of America, to establish her beauty salon and cosmetics business which specialised in skin products. She was soon followed by Elizabeth Arden. Max Factor revolutionised film make up in the 1900s. The twist-up lipstick was patented in 1915.

From the beginning of the 20th Century the use of synthetic chemicals, particularly in the perfume industry, became increasingly popular. The famous perfume Chanel No. 5 was successfully launched in 1921 as the first fragrance created by the use of synthetic organic chemicals.

There was a rapid increase in the use of cosmetics between the two World Wars, with a temporary halt during the Second World War.

Today, well over 100 companies manufacture cosmetics and toiletries in the United Kingdom. Perfume manufacturers number about half that of cosmetics and toiletries manufacturers. Manufacturing facilities are spread throughout the country, but the greatest concentration of manufacturers is still in the London area, and in particular in West London.

2. Processes

2.1 Nature of the raw materials

It is outside the scope of this profile to give a complete list of all the substances and their production, but a summary of the main groups is presented in the following sections. The colouring agents, preservatives and ultraviolet filters that cosmetic products may contain are limited by law. Further details can be found in a number of dictionaries of cosmetics and books on formulations (see Section 4). Examples which may be potential contaminants are listed in the Annex.

The manufacture of the chemicals which form the raw materials for the formulation of most cosmetics and toiletries is carried out by major chemical industries and is dealt with in separate profiles, as is the manufacture of soap and detergents (see Section 4).

2.1.1 Personal hygiene, skin care, hair care and colour cosmetics

Common constituents include the following:

Surfactants	Substances which lower the surface tension of water and other liquids, enabling the removal of dirt and grease eg alkyl ether sulphonates.
Oils	Base for active ingredient in some liquid products. May be mineral oils eg liquid paraffin, natural oils (eg castor oil) or synthetic oils (eg isopropyl myristate).
Waxes	Base for active ingredient in some solid products such as stick deodorants. May be natural or synthetic eg paraffin wax.
Cream bases	Base for active ingredients in cream products. Include fatty alcohols (eg cetyl alcohol), polyolesters (eg glycol monostearate) and fatty acids.
Emulsifiers	Substances which stabilise emulsions eg alkyl sulphates (water-in-oil emulsifier) and polysorbate 80 (oil-in-water emulsifier).
Humectants	Agents promoting water retention.
Plasticisers	Additives to preserve the flexibility of a substance.
Anti-microbial agents	Additives which have anti-bacterial/anti-microbial activity eg quaternary ammonium compounds.
Propellants	Propel active ingredients in aerosol products eg historically, chlorofluorocarbons (CFCs); more recently, pump gases such as propane.

The active ingredients of the main products are described in the following sections.

Personal hygiene products
The active ingredients in anti-perspirants are usually salts of aluminium or zirconium. Zirconium, which is the more effective ingredient, cannot be used in aerosols or sprays, as it should not be inhaled.

In deodorants, the active ingredients are anti-bacterial agents such as quaternary ammonium salts or triclosan. Essential oils are usually included, which also have anti-microbial properties. The active ingredients are suspended in a wax (solid sticks), oil (roll-ons) or solvent (aerosols/sprays).

Depilatory agents can be either physical agents, for example waxes formulated from rosin and beeswax, or chemical agents, which include sulphides or substituted mercaptans. Calcium thioglycollate in a strongly alkaline medium is the most widely used depilatory agent, although thioglycollic acid and its sodium and potassium compounds are increasingly being used.

Bath oils spread or disperse in water and usually contain surface-active agents that solubilise the oily components or disperse them. The oily fraction usually contains vegetable oil, lanolin, a lower fatty alcohol, a synthetic glyceride or mineral oil. Foaming bath oils are based on suitable surfactants blended with colour, perfume and foam stabiliser.

Shaving creams are soft soaps formulated with potassium hydroxide, salts of saturated or unsaturated fatty acids, and sodium hydroxide. Gel shaving creams are aqueous gels that are soap based and contain a volatile solvent such as pentane.

Skin care products
Skin cleansers and emollients (softening/moisturising agents) consist of creams, lotions or water-in-oil/oil-in-water emulsions. Cold creams are emulsions with sodium cerotate as the emulsifier. Vanishing creams can be considered to be emulsions of a free fatty acid, usually stearic acid in a non-alkaline medium. Sunscreens contain physical or chemical barriers to ultraviolet radiation.

Hair care products
The main constituents of shampoos are:

detergents
thickeners
foam stabilisers and boosters
perfumes
preservatives
dilutants (usually water)
pearlisers/opacifiers
colouring agents
other agents eg conditioning agents or anti-dandruff agents such as quaternary
ammonium compounds.

The main constituents of conditioners are similar to those in shampoos but additional ingredients include polymers, agents that add body to hair, auxiliary emulsifiers and oily components.

Hairsprays generally consist of polymers to provide hold, such as polyvinyl pyrrolidone (PVP), solvents (usually ethanol), plasticisers, neutralisers and perfume.

Colour cosmetics
Powder products, such as face powders, eyeshadows and blushers, generally consist of talc, pigments, pearl agents, liquid binders and preservatives.

Eye shadows use carbon black, ultramarine blue and iron oxides for pigments. The base of the cream shadows is usually beeswax, mineral oil, lanolin or petrolatum, ie petroleum jelly.

Lipsticks consist of a solid fatty base with a dissolved and suspended colourant. Bromo acids (bromo-derivatives of fluorescein) may be used to produce indelibility in the applied film.

Because mascara is used close to the eye, ingredients are strictly limited by law. The colourants are limited to natural dyes, inorganic and carbon pigments.

Nail polish generally consists of a resin (nitrocellulose or dinitrocellulose), plasticiser and pigments suspended in a volatile solvent. Lacquer removers are made from a number of solvents, for example acetone. Cuticle removers usually consist of dilute solutions of alkali in water with a humectant, for example glycerol.

2.1.2 Perfumes

The basic odoriferous components of perfumes number 4000-6000, of which about 100 are frequently used. Examples include benzyl acetate, cedar oil, geraniol, lavender oil and vanillin.

There are two groups of odoriferous raw materials: natural (which are plant and animal extracts) and synthetic (generally derived from crude oil or turpentine). Originally nearly all products used in perfumery were of natural origin. Today, many modern perfumes are a blend of synthetic and natural substances.

The constituents of a typical perfume are shown below:

Solvents	Usually highly refined ethyl alcohol mixed with varying amounts of water.
Fixatives	These are substances which have lower volatility than the other components including: animal fixatives eg civet, musk, ambergris oily plant fixatives eg castor oil resinous plant fixatives eg terpenes, labdanum, gum benzoin synthetic fixatives (esters with high boiling points) eg glyceryl diacetate, benzyl benzoate, coumarin, essential oil fixatives eg clary, sage, sandalwood.
Odoriferous elements	Essential oils (see Section 2.3.3 for details) come from plants eg rose oil, orange flower oil, clove oil. Isolates are chemicals isolated from essential oils eg eugenol from clove oil. Synthetics and semi-synthetics.

2.1.3 Dental products

The main constituents of toothpastes and toothpowders are:

Active agents	fluoride anti-plaque/anti-gingivitis agents anti-microbial/preservative agents anti-calculus agents.
Other materials	abrasive flavours humectants thickeners/gelling agents surfactants preservatives (rarely used today) colours bleaches essential oils detergents.

There are two main formulation types: low abrasive/high humectant and high abrasive/low humectant.

Oral rinses have anti-microbial properties and contain agents such as chlorinated phenols, thymol, quaternary ammonium compounds, hydrogen peroxide or hexachlorophene, together with flavours. They are either aqueous solutions, aerosol pumps, or concentrates of speciality formulations which require dilution before use.

Tooth whiteners contain carbamide peroxide which reacts with water to release hydrogen peroxide.

Denture cleaners consist of bleaching agents/oxidising agents, such as sodium perborate or sodium percarbonate, together with an electrolyte, usually sodium chloride, and an alkali building agent, such as sodium bicarbonate or sodium carbonate.

2.2 Transportation, delivery and storage of raw materials

The methods of handling raw materials, products and wastes vary between facilities and between the different products being manufactured. A typical cosmetics manufacturer will require solvents, oils, fuel, fats, surfactants, pigments and a range of other additives (see Section 2.1 and Annex). Perfume manufacturers generally require a wider range of solvents and organic precursors than cosmetics manufacturers who buy in ready-made perfumes.

The organic and inorganic substances used are generally supplied (in liquid or solid form) in tankers or in drums ranging from 10 kg to 200 litres. Materials are delivered by lorry or tanker and are usually unloaded in a loading bay. Bulk fluids are usually pumped directly into bulk storage tanks. Drums are often unloaded into warehouses or drum stores using fork-lift trucks. Materials such as flammable perfumes, which are typically supplied in 10 kg containers, are generally stored in a separate flammable store.

Ethanol, propylene glycol and similar materials used in bulk are usually stored in large (approximately 20 000 litre) tanks of single-walled stainless steel. Mineral oil and heating oil are normally supplied in bulk by tankers which off-load to bulk storage tanks.

Raw materials are generally transferred from the warehouses and stores to the production facility on a daily basis in quantities sufficient for one or two days production.

2.3 Manufacturing processes

The cosmetics and toiletries industry uses a vast number of compounds, but relatively simple manufacturing processes.

2.3.1 Personal hygiene, skin care, hair care and colour cosmetics

Solids such as pigments and powders are milled, the oil and water phases are mixed separately and then all the ingredients are mixed together, with or without heat. The product may then be filtered before being measured into bottles, pots or aerosols etc.

There are three basic mechanisms of mixing: bulk flow (eg shear mixing, cutting, folding, tumbling), convective and diffusive mixing. Solids and pastes tend to be mixed by bulk flow processes; liquids by all three mechanisms.

Emulsions and liquids, which include most skin care, hair care, personal hygiene products and some colour cosmetics, are manufactured by either batch processing or continuous processing.

Batch processing comprises the shear mixing of the ingredients, usually with a high shear turbine or rotor-stator device and a high flow, low shear mixing device.

During continuous processing the two phases of the emulsion are mixed separately. Both phases are pumped into an in-line pre-mixer and then through a homogeniser. The emulsion is then pumped into a storage vessel or filling vessel.

The manufacture of nail polish, face powder and blusher illustrate the processes that are used.

Nail polish

This involves the high shear mixing of highly flammable and volatile materials. Buildings and equipment must be fire resistant as explosions have been known to occur. The pigments are blended with nitrocellulose and a plasticiser and ground through a triple roll mill, dried and chipped. Because of the hazardous nature of this process, many cosmetics manufacturers buy in the chips ready made. The chips are then blended and dissolved in a nitrocellulose solution using a high shear mixing blade under flame-proof conditions. When the colour is uniform, solvents are added and the viscosity is adjusted.

Face powder and blusher

The pigments are milled, usually mixed with talc and pulverised with a hammer mill. The ingredients, except the pearls and liquid oils, are added together and blended. When the latter are uniformly dispersed, the oil phase is added, usually via a central mixing bar which sprays the liquid phase onto the powder. Pearlescent

material is then added if required. Some powders are compressed when filled into containers in which they are sold.

2.3.2 Perfumes

The first stage in the manufacture of perfumes involves the production of the odoriferous component. The actual perfume is manufactured, or compounded, by blending processes which involve the batch weighing of the ingredients and mixing with heating and cooling, followed by filtering.

Production of natural odoriferous compounds

The main processes used to produce natural odoriferous compounds are expression, distillation and extraction, using enfleurage, maceration or volatile solvents.

Juice is squeezed from fruit (expression) by one of two methods: the ecuelle process, in which the fruit is rolled in a hollow vessel with spiked walls and the machine process, in which the fruit is spiked and squeezed. Once collected, the juice is clarified.

Distillation is usually performed with steam. Stills of copper, tin-lined copper or stainless steel are used with condensers of various types. A separator divides the oily and aqueous layers. The aqueous layer of the distillate, which may contain valuable constituents, is usually pumped back into the still.

Enfleurage is cold fat extraction, used to obtain a few delicate flower perfumes such as jasmine and violet. The fat used for this process is a highly purified mix of tallow and lard with gum benzoin as the preservative. This method is no longer used on a commercial basis.

Extraction with volatile solvents is the most common process used today to obtain natural odoriferous components of perfumes. The solvent usually employed is highly purified petroleum ether. Benzene was often used in the past. The extraction equipment consists of stills for fractionating the solvent, drums for extracting essential oils from the flowers and stills for concentrating the flower-oil solutions.

Production of synthetic or semi-synthetic odoriferous compounds

Constituents which are chemically synthesised from natural materials are classified as semi-synthetics. Those synthesised from man-made materials are synthetics. The main types of reactions utilised for the manufacture of synthetic odoriferous compounds are listed below:

Oxidation	This is carried out usually with manganese dioxide, chromic acid, oxygen or air, eg the manufacture of vanillin using nitrobenzene as the oxidising agent.
Condensation	Used in the manufacture of coumarin, ionone and cinnamic aldehyde.
Hydrogenation	Hydrogenation is the principal reaction used in large scale production of fragrances.
Alkylation	Used, for example, in the synthesis of phenylethyl alcohol from benzene and ethylene oxide.

Esterification	Used, for example, in the synthesis of benzyl benzoate, benzyl acetate, amyl salicylate and methyl salicylate.
Nitration	This is used in the synthesis of artificial musks.

Blending
The compounding of perfumes to produce concentrates in bulk is simple but must be performed with great precision. Generally, solids are added to the solvent and dissolved using high speed stirring, with or without heat. The mixture is cooled and the remaining ingredients are added. Firstly, the more volatile compounds are added, followed by the resins, the more stable aromatic and finally, any remaining ingredients. The solution is filtered to remove any solids.

2.3.3 Dental products

These are manufactured using similar methods to other emulsions and pastes previously described. In general, the manufacture of toothpaste involves the hydration of the gelling agent by its addition, in solid form, to glycerine and water, followed by vigorous agitation. The abrasive powder is then incorporated using a variety of types of heavy-duty mixing vessels. The final mix is performed under vacuum conditions to de-aerate the product. The surfactants and flavour are added last of all.

Toothpowders are manufactured automatically, semi-automatically or in batches. Most involve the simple mixing of all the ingredients in one vessel and then de-aerating.

The ingredients of oral rinses are simply dissolved in water and the final product is filtered.

2.4 Nature and transfer of finished products

The finished products from the manufacture of cosmetics and toiletries are generally sales units such as bottles, tubes of lotions and creams, pots of powder, pencils and other similar items. Handling and storage practices depend on the specific nature of the final products. The products are likely to be stored on pallets or in boxes in warehouses, until they are transferred to a loading area by fork-lift truck and dispatched by lorry.

The finished product from the perfume manufacturing process may either be sales units, that is small bottles of perfume or aerosols, or small drums, typically 10 kg in size, of perfume concentrate for use in the manufacture of other products, in particular toiletries. Again, these products will generally be stored in warehouses until loaded on to lorries for dispatch.

2.5 Ancillary activities

Most cosmetics and perfume manufacturers have a quality control testing laboratory on site and some may also have product development laboratories. A wide range of organic and inorganic laboratory reagents are used in these activities, but in very small quantities. However, it is possible that larger volumes of laboratory reagents may be kept in stock on site.

There may be power-generating facilities on site. Generally, oil is used as the fuel today, but coal and gas may have been used in the past.

The manufacture of cosmetics and perfumes requires the use of very pure water in the formulations. Therefore, mains water is usually de-ionised, sterilised and filtered on site. Sodium hydroxide and hydrochloric acid are usually used in the ion exchange process for the regeneration of ion exchange resin.

2.6 Waste management

Wastes are generally either recycled or taken off site for disposal.

Non-hazardous liquid wastes may be discharged to foul sewer, in agreement with local trade discharge consents.

Hazardous wastes may include chlorinated and non-chlorinated organic solvents. Other liquid or solid residues from chemical processes may be corrosive, flammable or have the potential to contaminate the environment. Solvent and other liquid waste is typically bulked separately on site into 25 litre containers and stored in warehouses until collected by contractors for removal to incinerators, for solvent recovery, or to other waste disposal facilities. Solid wastes are generally incinerated.

Small quantities of biological waste may arise from the laboratories. Such wastes include culture dishes and microscope slides used during microbiological quality analysis and bacteriological count tests. These are likely to be non-infectious and non-hazardous, although contamination with opportunistic pathogens is possible. They are usually disposed of by off-site incineration.

Used oil is generated by maintenance activities such as machine lubrication/degreasing. This is generally stored in the warehouse until collected by contractors for incineration.

Non-hazardous wastes include rejected product, paper packaging, general waste and solid botanical product residues in equipment used for the extraction of essential oils. These are usually transported off site for landfilling.

Empty containers are either reused or disposed of as non-hazardous waste to landfill.

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 1. 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

Contamination on any present or past cosmetics or toiletries manufacturing site depends upon the type of product manufactured there and any prior use of the site.

The main sites of potential contamination are around bulk storage areas (particularly unbunded areas), pipework and pumps, handling areas and, to a lesser extent, production areas.

Contamination may occur at locations of effluent vessels, pipework and inadequately-contained waste storage areas or where wastes were stored in direct contact with the ground. Surface water soakaways on any site with a long history of industrial use are potential areas of contamination. On-site landfills used for waste disposal may also be contaminated.

Organic solvents will be of most concern as they are used in extraction, synthesis, separation and purification processes. Solvent contamination is most likely to occur through spillage and leakage around bulk storage and loading areas and, to a lesser degree, in production areas and distribution pipework.

Acids and alkalis are used in water purification processes and effluent treatment. Contamination is most likely in storage areas for these materials and associated pipework. Acid spillage near buildings may affect the integrity of concrete/cements used in foundations and drain connections. Corrosion of drains may also occur.

Contamination by fuels may occur near fuel storage areas and from pipework associated with fuel oil delivery.

Asbestos may have been used for lagging or insulation of pipes and boilers, for roofing or cladding of buildings and in specific process applications where fire proofing is necessary, eg nail polish manufacture. Decommissioning of plant or buildings may have resulted in contamination of the site by asbestos fibres.

Where on-site power generation exists, there may be contamination from polychlorinated biphenyls (PCBs) where these were used as dielectric fluids in transformers or capacitors.

3.2 Migration and persistence of contaminants

3.2.1 Solvents and oils

Relatively small amounts of solvent pose a considerable threat to water resources. The magnitude of the risk to groundwater depends on the depth of the water-table, the soil structure and it's properties. Generally, the higher the natural organic matter and clay content within the soil, the greater the adsorption of solvents and the lower their mobility. Conversely, the greatest migration of contaminants will occur in coarse-grained sands and gravels with little organic matter.

The soluble components will dissolve in the groundwater and migrate in the direction of groundwater flow. The less soluble compounds which become adsorbed on to clay or natural organic matter will provide on-going sources of water pollution, long after the original source has been removed, by continuing to allow the contaminant to desorb into the soil-water.

Alcohols and ketones are commonly used solvents in the cosmetics, toiletries and perfumery manufacturing processes. These are water-soluble and highly mobile and have a high potential for surface and groundwater contamination.

The aqueous solubilities of non-chlorinated solvents are variable. Although toluene and benzene have relatively low solubilities, they may be persistent due to unfavourable environmental conditions for their biodegradation.

Although the aqueous solubilities of chlorinated solvents are generally low, they can contaminate drinking water at very low concentrations. The insoluble solvents that are less dense than water will float on the water-table surface. However, chlorinated solvents are more dense than water and will tend to migrate to the bottom of aquifers. Their migration may be opposite to the general groundwater flow. Chlorinated solvents are persistent, they degrade slowly and only under specific conditions. Various intermediates form as a result of their degradation.

Solvents may provide the opportunity for groundwater contamination by other materials which have low solubilities in water but are readily soluble in solvents.

Vapour produced by volatile solvents may migrate through unsaturated soils and can subsequently dissolve into the groundwater. If vapours accumulate in poorly ventilated, confined spaces, they can present a fire or explosion hazard.

Mineral and fuel oils may move through the soil in a similar way to solvents, and may present an immediate and long-term threat to water supplies. Much of the lower boiling point fraction, particularly below C_{12}, will have been lost through volatilisation.

Natural biodegradation may result in significant removal of oils, particularly those of lower molecular weight. The alkanes (paraffins) are generally biodegradable under favourable conditions. The iso-alkanes and cycloalkanes degrade at a much slower rate. Highly branched (and multi-ringed) cycloalkanes and high boiling point (heavy) fractions, will tend to persist in soil.

Biodegradation processes in soils can be influenced by a number of factors, namely moisture content, oxygen concentration and pH, acting separately or in combination. For example, low moisture content reduces microbiological activity, while high moisture content can reduce oxygen penetration and possibly lead to anaerobic soil conditions. Such conditions enhance the biodegradation of some materials, eg chlorinated compounds, while aerobic conditions are needed to biodegrade many oils. Also, low pHs tend to reduce the bacterial population and encourage fungal activity; at pHs lower than 5, microbiological activity is much reduced. The presence of anti-microbial agents, which are central to the cosmetics industry, and heavy metals also inhibits micro-organisms. As a result of these factors, at high concentrations in soil, even relatively non-persistent compounds may not biodegrade readily.

Natural and synthetic oils encompass naturally occurring products; many are potentially biodegradable in soil, although the rate of degradation may be slow, particularly for insoluble materials.

3.2.2 Metals and metal compounds

This group of compounds includes a range of inorganic salts of zinc, iron, aluminium, magnesium and zirconium. The aqueous solubility of metal salts will depend upon the compound involved. In general, sulphates, nitrates and chlorides are likely to be soluble whereas sulphides and oxides are generally insoluble. Most zirconium compounds in common use are insoluble. Iron oxides are unlikely to be a problem unless gross contamination has taken place. Although many of the compounds within this group are coloured, soil contamination is unlikely to be identifiable visually.

The movement of metals through the soil is significantly retarded by the presence of clay minerals and natural organic matter. The solubility of most metals increases under acidic conditions.

Metal contaminants are not biodegradable, although micro-organisms may mineralise some organo-metallic complexes, thereby increasing metal mobility.

3.2.3 Surfactants

Surfactants have significant aqueous solubilities and are likely to be relatively mobile within the environment. They enhance the mobility of hydrophobic contaminants such as oils.

3.2.4 Fats, triglycerides and derivatives

Fatty alcohols tend to be insoluble or immiscible with water, but soluble or miscible with alcohols and many organic solvents. They tend to be moderately persistent.

The compounds in this category are essentially natural products. They are generally subject to slow degradation in soil; the most persistent compounds being those which are least soluble, with high boiling points.

Fatty acids such as oleic and palmitic acids are insoluble in water. Stearic acid and caproic acid are relatively soluble in water (340 mg/l at 25°C and 11 000 mg/l at 20°C respectively). Although the solubilities of fatty alcohols are generally low, their potential for causing harm to the aquatic environment is high, due to their adverse effect on the oxygen content of the water. Only a small quantity is required to be present in water for it to have an adverse effect on the aquatic environment.

3.2.5 Other compounds

Acids and alkalis are corrosive and a spillage can enhance the mobility of other contaminants.

Asbestos is not soluble or biodegradable. Wind dispersion of contaminated soil may be a further transport mechanism where there is gross surface contamination by some of the less mobile contaminants such as asbestos and metals.

Polychlorinated biphenyls do not biodegrade. They have low solubility in water, but have a propensity to accumulate in fatty tissues and can enter food chains.

4. Sources of further information

4.1 Organisations

For further information concerning the cosmetics and toiletries industry in the United Kingdom, the following organisations should be consulted:

British Fragrance Association
6 Catherine Street
London
WC2B 5JJ

The Cosmetic Toiletry and Perfumery Association Limited
35 Dover Street
London
W1X 3RA

4.2 Sources of information concerning the activities described in this profile

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Williams D F and Schmitt W H. *Chemistry and technology of the cosmetics and toiletries industry.* Blackie, 1992.

Winter R. *A consumers' dictionary of cosmetic ingredients.* Third Edition, Crown Publishers, New York, 1989.

United Kingdom regulations relevant to the manufacture of cosmetics and toiletries:

Cosmetic Products (Safety) Regulations of 1984 (SI 1984/1260 and SI 1989/2235).

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

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

4.3 Related DOE Industry Profiles

Chemical works: disinfectants manufacturing works
Chemical works: fine chemicals manufacturing works
Chemical works: inorganic chemicals manufacturing works
Chemical works: organic chemicals manufacturing works
Chemical works: pharmaceuticals manufacturing works
Chemical works: soap and detergent manufacturing works
Waste recycling, treatment and disposal sites: solvent recovery works

4.4 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. *Pharmaceutical Processes.* Chief Inspector's Guidance to Inspectors, Process Guidance Note IPR 4/9. London, HMSO, 1993.

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.

4.5 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.

Publications containing information on the treatment options available for the remediation of contaminated land sites, prepared with the support of the Department of the Environment's Research Programme, 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 CLL Division, Room A323, 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.

Materials associated with personal hygiene, skin care, hair care and colour cosmetics products

Metallic and metalloid compounds	aluminium salts aluminium stearates iron oxides titanium dioxide zinc oxide zirconium salts eg sodium zirconium
Alkalis	sodium hydroxide potassium hydroxide
Inorganic compounds	chlorides sulphides boric acid
Solvents (non-chlorinated)	acetone ethyl alcohol
Other organic compounds	primary surfactants eg alkyl sulphonates ionic surfactants eg alkyl ether carboxylates amphoteric surfactants eg alkyl betaines non-ionic surfactants eg ethoxylates cationic surfactants eg alkyl quaternary ammonium salts fatty alcohols fatty acids liquid paraffin polyethylene glycols and associated salts alkonal amides glycol esters quaternary ammonium compounds substituted mercaptans

Perfumes

Metallic compounds	manganese dioxide chromic acid
Solvents (non-chlorinated)	alkanes eg dimethyl butane petyroleum ether aromatics eg benzene toluene esters eg benzyl benzoate benzyl acetate

Solvents (chlorinated)	1,2- dichloroethane
Other organic compounds	nitrobenzene

Dental care products

Metallic and metalloid compounds	aluminium hydroxide stannous fluoride zinc citrate
Inorganic compounds	fluorides phosphates
Organic compounds	monochlorophenols dichlorophenols iodophenols quaternary ammonium compounds

General contaminants

Acids and alkalis	hydrochloric sodium hydroxide
Solvents (non-chlorinated)	ethyl alcohol isopropyl alcohol benzene toluene propylene glycol
Solvents (chlorinated)	eg 1,2- dichloroethane (ethylene dichloride)
Lubricating oils	
Fuels	fuel oil coal/coke
Polychlorinated biphenyls (PCBs)	
Asbestos	

Table 1 Main groups of contaminants and their probable locations

Chemical works: cosmetics and toiletries manufacturing works

Main groups of contaminants	Sub-groups	Location								
		Transportation, delivery and storage	Manufacturing processes			Waste management processes	Laboratories	Fuel storage	Water purification	Electricity substations/ transformers areas
			1	2	3					
Metals, metalloids and their compounds		■	■	■	■		■			
Acids and alkalis		■	■	■		■	■		■	
Organic materials	surfactants	■	■		■		■			
	thickeners	■	■		■		■			
	foam stabilisers	■	■				■			
	pearlescent agents	■	■							
	conditioning agents	■	■				■			
	fatty alcohols	■	■				■			
	fatty acids	■	■				■			
	waxes	■	■				■			
	cream bases	■	■				■			
	emulsifiers	■	■				■			
	humectents	■	■		■		■			
	plasticisers	■	■				■			
	aerosol propellants	■	■				■			
	anti-microbial agents	■	■		■		■			
	sunscreens	■	■				■			
	dentifrice agents	■			■		■			
	mineral oils	■	■			■	■			
	depilatory agents	■	■				■			
	fixatives			■	■		■			
	lubricating oils	■	■	■		■				
	perfume synthesis chemicals	■		■		■	■			

Table 1 Main groups of contaminants and their probable locations (continued)

Chemical works: cosmetics and toiletries manufacturing works

Main groups of contaminants	Sub-groups	Location								
		Transportation, delivery and storage	Manufacturing processes			Waste management processes	Laboratories	Fuel storage/ pipework	Water purification	Electricity substations/ transformers areas
			1	2	3					
Solvents		■	■	■	■	■	■			
Polycyclic aromatic hydrocarbons (PAHs)			■	■	■	■				
Fuel oils, coal		■				■	■	■		
Polychlorinated biphenyls (PCBs)										■
Asbestos[4]						■		■		

[1] Materials associated with personal hygiene, skin care, hair care and colour cosmetic products manufacture.
[2] Materials associated with perfume manufacture.
[3] Materials associated with dental care manufacture.
[4] May also be associated with building fabric, as cladding or roofing.

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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