

Sewerage —

Part 4: Guide to design and construction of outfalls

UDC 628.241.2

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This British Standard, having been prepared under the direction of the Civil Engineering and Building Structures Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 December 1987

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First published, as CP 2005, December 1968
First Part revision, as BS 8005-4, December 1987

The following BSI references relate to the work on this standard:
Committee reference CSB/5
Draft for comment 84/11184 DC

ISBN 0 580 15993 0

Amendments issued since publication

Amd. No.	Date of issue	Comments

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Foreword

This British Standard has been prepared under the direction of the Civil Engineering and Building Structures Standards Committee and is directed at general engineering practitioners who may either be embarking on a career in sewerage or be dealing with a particular aspect for the first time. It is not intended to be exhaustive in any field but sets out to present guidance on basic principles and good practice, indicating where a more detailed and comprehensive study may be made. BS 8005 supersedes and enhances CP 2005:1968, which is withdrawn, although some of the material incorporated is a restatement or a revision of the earlier text.

BS 8005 gives guidance on the planning, design, construction, operation and maintenance of works to convey sewage, including storm sewage, surface water and trade effluents to a sewage treatment works, tidal waters or other final place of disposal. Recommendations are given for the repair, renovation and replacement of sewers.

Many end users of this British Standard, such as governments, public authorities, sewerage authorities and consultants, issue their own recommendations and specifications for sewerage which BS 8005 is intended to complement rather than replace.

BS 8005-0 directs the reader to sources of more detailed information, particularly on important and specialized fields such as health and safety. It should be regarded as supplying essential background information for the other Parts of BS 8005.

BS 8005 is to be published in six separate Parts, as follows.

- *Part 0: Introduction and guide to data sources and documentation;*
- *Part 1: Guide to new sewerage construction;*
- *Part 2: Guide to pumping stations and pumping mains;*
- *Part 3¹⁾: Guide to sewers in tunnel;*
- *Part 4: Guide to design and construction of outfalls;*
- *Part 5¹⁾: Guide to rehabilitation of sewers.*

It has been noted that substantial one-part codes and guides take a long time to revise and if they are reviewed at infrequent intervals, they tend to become out of date quickly, especially in a field where technological development is rapid. It is intended therefore to keep a constant watch on new developments and to update BS 8005, Part by Part, as soon as the work can be justified.

BS 8301 sets out recommendations for building drainage and, while it relates generally to smaller pipelines, there is some overlap between it and BS 8005. BS 6297 gives recommendations for the design and installation of small sewage treatment works and cesspools.

Apart from Part 0, which is directed more specifically at the UK sewerage field, BS 8005 is for use both in the UK and, in appropriate circumstances, overseas.

Suggestions for the improvement of any Part of BS 8005 will be welcomed by the Secretary of CSB/5 at 2 Park Street, London W1A 2BS.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

¹⁾ In preparation.

Section 1. General

1 Scope

This Part of BS 8005 provides guidance on the design, construction, operation and maintenance of sea and other tidal outfalls (e.g. estuarial outfalls), including the sources of information available in preparatory investigations, the requirements of the installation from the environmental viewpoint and the provision of ancillary plant for storage and for pretreatment of sewage, before discharge to tidal waters for marine treatment.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

The titles of British Standards not referred to in this Part of BS 8005 but of interest as dealing with closely associated subjects are listed in Appendix A of BS 8005-1:1987.

Other publications that may be of interest are listed in Appendix B.

2 Definitions

For the purposes of this Part of BS 8005, the definitions given in BS 8005-1 apply.

3 Abbreviations

For the purposes of this Part of BS 8005 the abbreviations given in BS 8005-1 apply.

Section 2. Design

4 Principles of design, investigation and records

4.1 Principles of sewage disposal by marine treatment

4.1.1 Design objectives. The function of a tidal outfall is to discharge sewage to the sea, usually after grit removal and mechanical treatment, at a sufficient distance from the shore to ensure that the processes of dilution, dispersion and natural purification reduce the concentrations of harmful organisms and chemicals present in sewage to acceptable levels in inshore waters, particularly those used for fisheries or for recreational purposes.

4.1.2 Water quality. The inshore water quality to be achieved will be determined by the relevant authority granting a consent to the discharge, and will depend upon the local usage of the receiving water for bathing, fishing, shell fishery, cooling water abstraction, etc. For example, the EEC Directive concerning the quality of bathing waters (76/160/EEC) lays down mandatory and guide levels for faecal bacteria, pathogenic organisms and chemicals that are present in sewage. Faecal bacteria occur naturally in the human gut and are consequently present in very large numbers in sewage. They can be readily detected when dispersed in seawater and are used, therefore, to indicate the possible presence of more harmful pathogenic organisms and chemicals which tend to be present sporadically and in much smaller concentrations in sewage.

4.1.3 Self-purification of sewage. It is implicit in the design of sea outfalls that natural degradation processes take place in sea water. The parameters concerned when sewage is discharged to rivers or enclosed waters are primarily biochemical oxygen demand and suspended solids and, in some highly productive streams, the nutrient elements nitrogen and phosphorus; problems may arise because dilution is limited by the flow of river water. This is rarely the case in the sea where the load of organic material, suspended solids and nutrients can usually be assimilated with no more than a limited local effect immediately adjacent to the outfall. The principal parameter used when sewage is discharged to the sea is the concentration of faecal bacteria which is reduced not only by dilution but also by natural mortality.

4.1.4 Hydrographical investigations. To determine the optimum location for discharge, it is necessary to study the natural mixing and dispersion processes in the particular marine area into which the discharge is likely to be mixed. To this end, it may be necessary to carry out drogue tracking, dye dispersion tests, bacterial tracer studies, current metering or mathematical modelling. From this information and a knowledge of inshore winds and T_{90} periods (see 6.3.5), it is generally possible to predict the effect of a discharge on the water quality of the inshore waters.

4.1.5 Diffuser systems. To ensure that the immediate area of the discharge (which may have some amenity value for boating, water sports, etc.) is not polluted by smell, sewage slicks and solids of obvious sewage origin, it is necessary to achieve some minimum initial dilution at the sea surface over the discharge ports. Initial dilution for given water depths, sea water density, sewage density, discharge port diameter and ambient current velocity may be readily calculated (see 7.2). Subsequent dilution in a current and turbulence induced surface plume is less easily predicted and usually examined by in situ tracer tests. Careful consideration of the requirements of the optimum discharge location for dispersion is necessary to select a suitable diffuser array of single or multiple ports along the final length of the outfall pipe. In addition, careful hydraulic analysis of the flow division to the ports in the diffuser manifold and the overall head loss within the complete outfall system should be checked to ensure careful design of each element of the outfall disposal system, i.e. dispersion and die-off, initial dilution, diffuser system and outfall pipe. When a suitable outfall proposal is produced, it should be further checked to determine the effects of sea water entering the outfall system at low flows and whether any counter measures need to be adopted.

4.1.6 Pre-treatment. To protect the outfall system against blockages and to minimize visual pollution, it is necessary to provide a headworks to pre-treat, and occasionally to control the discharge of sewage. The main functions carried out at a headworks are as follows:

- a) to remove grit, which otherwise may silt up the outfall;
- b) to remove from the flow debris such as rags and plastics;
- c) to break up the faecal matter to ensure rapid dispersion and breakdown in the sea;
- d) sometimes to give further treatment, i.e. sedimentation.

Because sewage systems in coastal towns are generally located towards the seafront, headworks are by necessity sited in environmentally sensitive areas and require housing in enclosed buildings with precautions taken regarding noise, odour, safety and appearance.

The economic balance between the degree of pre-treatment on land and the length of the outfall will depend on local circumstances, but the analysis generally shows an advantage in favour of a long outfall with limited pre-treatment.

4.1.7 Approvals to be sought. Throughout the development of an outfall project, the following approvals should be sought.

a) *Statutory requirements*

- 1) Planning permission from the local Planning Authority to construct Works on land or on the foreshore (Town and Country Planning Act 1971).
- 2) Consent of Coast Protection or Sea Defence Authority to carry out work on or near their installations (Local Act or Byelaws).
- 3) Consent of MAFF, DAFS (or other appropriate body) for the construction of an outfall pipe on the sea bed (Food and Environment Protection Act 1985 — Part Two).
- 4) Consent of Department of Trade (or other appropriate body) for the construction of works below high water mark which could be a hazard to navigation. (Coast Protection Act 1949)
- 5) Consent of Water Authority or Purification Board for discharge of sewage to the sea (Control of Pollution Act 1985 — Part 2). Where the applicant is a water authority such consent is subject to the over-riding powers of the DoE and approval by MAFF.
- 6) Consent of the dock or harbour authority, or the Ministry of Defence, to construct the outfall and discharge sewage. (Local Act or Byelaw, or Defence legislation.)

b) *Other requirements*

- 1) Purchase of land and easements from landowners.
- 2) Easement from the Crown Estates Commissioners (or other appropriate body) to cross the foreshore.

4.1.8 Consultations. Consultations should be carried out with the following bodies.

a) *Obligatory* (in addition to the approvals noted in 4.1.7)

Sea Fisheries Committee

b) *Desirable*

General public
 Conservation and amenity groups
 Local councils
 Fishery interests (commercial and recreational)
 Recreational interests

4.2 Design considerations

4.2.1 Design populations and flows. The magnitude of sewage flows depend on the type of sewerage system. In older parts of coastal towns, the sewers usually operate on a combined system (see BS 8005-1), while new developments tend to have separate drainage facilities for foul sewage and surface water. Flows should be calculated in accordance with appropriate formulae (see BS 8005-1). The designer of the outfall should select a size to accommodate the existing range of flows, with provision for predictable increases resulting from development and for seasonal variations in the population and strength. The nature of discharge should be determined before design begins. Discharge should be by gravity whenever sufficient head is available (see BS 8005-1), but with pumping capacity available at other times. Auxiliary generators may be necessary to prevent flooding in the event of mains power supply failure.

4.2.2 Industrial processes. Care should be taken to ensure that sewage will not be discharged near to intakes supplying process or cooling water for industrial use, or in the vicinity of fish farming installations.

4.2.3 Nature of discharge. Most components of domestic sewage are quickly broken down (or degraded) in sea water, so that the combination of degradation and dilution renders them harmless in the salt water environment. As part of the natural cycle of growth and decay, the abundant supply of oxygen usually available in sea water stimulates biological oxidation of the sewage components. Ultraviolet light also plays an important part in killing bacteria, while currents and turbulence aid dilution and sedimentation takes place over a wide area, where decomposed material once again enters the lower level food chain.

Other substances which are more resistant to degradation, or are non-degradable, in the sea may be undesirable if discharged continuously or in large quantities. These may occur in direct discharges of industrial wastes or in trade effluents combined with domestic sewage. The contracting parties to the Paris Convention, 1974, undertake to eliminate pollution of the sea resulting from the discharge of specially noxious substances such as halogenated organic compounds, mercury, cadmium, hydrocarbons, oils and synthetic substances which resist degradation. There are also limitations on the discharge of other less persistent substances. The Council of the European Communities set similar objectives in their Directive on pollution caused by dangerous substances discharged into the aquatic environment of the Community (76/464/EEC). The Control of Pollution Act 1985 — Part 2 gives the water authorities in England and Wales powers to control all discharges to estuaries and coastal waters up to 3 miles offshore. Similar powers apply to the River Purification Authorities in Scotland. The EEC Directive on the quality of bathing waters (76/160/EEC) is particularly useful in determining the degree of marine treatment to aim for in the design of a sea outfall, as it specifies measurable bacterial concentrations (with exceedence exceptions) admissible for classified bathing waters.

4.2.4 Fisheries. Shellfish are particularly susceptible to the effects of pollutants discharged to the sea, and may be damaged by bacterial infection, toxic substances, or siltation of suspended material on their feeding grounds. The Council of European Communities Directive on the quality required of shellfish waters (79/923/EEC) provides for Member States to designate certain brackish and coastal waters to support shellfish life and growth.

Most marine organisms which live on the sea bed are relatively immobile and are thus at risk from pollutants which settle to the sea bottom. Spawning grounds for fish may be affected deleteriously by such conditions. The more mobile forms of marine life tend to avoid areas affected by noxious substances. Nevertheless, sudden releases of certain wastes may give rise to certain conditions acutely toxic to swimming fish. Depletion of dissolved oxygen in the water in restricted areas, such as estuaries, may prevent the passage of fish to and from their spawning grounds. In extreme cases, this may result in their death by asphyxiation.

Consultations with fisheries interests should take place and the appropriate bodies and statutory responsibilities are listed in 4.1.

4.2.5 Quality of receiving water. Quality criteria for the receiving water should be related to the recreational or other use made of the area. The sewage discharge should not detract from the visual aesthetic quality of the water.

Generally, this means that floatable material should be disintegrated or removed and that the formation of surface slicks, which are caused by greasy material in sewage, should be minimized by ensuring rapid dilution.

In accordance with the requirements of the EEC Directive on bathing water quality (76/160/EEC), certain bathing areas (to be designated by the Secretary of State for the Environment) are subject to numerical limits for various bacterial and chemical parameters. Similarly, the Directive on the quality required of shellfish waters (79/923/EEC) applies to certain designated waters and these are subject to specified quality criteria.

UK policy on the control of discharges is based on the concept of environmental quality objectives (the use identified for a particular body of water) and environmental quality standards (limiting concentrations of contaminants in the receiving water). Water and river purification authorities have the responsibility for setting quality objectives for their receiving waters and for determining consent conditions for discharges containing specified contaminants in relation to nationally agreed quality standards. Consultations should take place as outlined in 4.1.8.

4.3 Recorded information

4.3.1 General. Extensive use can be made of readily available recorded information during the initial study period for an outfall.

4.3.2 Hydrographic charts and records. An up-to-date chart of the coastal waters will usually be available from an agent for the sale of Admiralty Charts. Information is given on water depths, nature of the sea bed, obstructions, navigation channels, and average tidal current velocities at a few selected positions. Although this data is useful for preliminary studies, it is rarely of sufficient detail to be used for design purposes. Extensive local surveys are invariably necessary to supplement this source of information. Old charts are sometimes useful when the long-term stability of channels has to be considered. Local port authorities usually keep such records.

Charts will also give an indication of available water depths which will greatly influence initial dilution.