WRAS
Water Regulations Advisory Scheme

INFORMATION AND GUIDANCE NOTE

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The Selection of Materials for Water Supply Pipes to be Laid in Contaminated Land

Contents

1. Introduction

This Information and Guidance Note provides information for designers and installers who are faced with the proposed installation of water supply pipes in land which may be contaminated. It provides some guidance on the selection of suitable pipeline materials to comply with the current regulations and to prevent water supply pipelines failing prematurely due to contamination. The available information on the effects of different contaminants on pipe materials is incomplete, but research work funded by the Water Industry is underway which should provide additional information by 2004.

Maintaining the integrity of water supply systems has been a cause for concern for many years to water suppliers, developers and customers, particularly where pipelines have required replacement before the expiry of their design life. Where this has occurred, failures have generally been caused by internal or external corrosion or mechanical damage. However, permeation and accelerated deterioration of the pipe material can occur due to chemical reaction between the pipe and contaminants in the ground in which it is laid. This can also lead to premature failures, resulting in leakage and loss of water quality.

The Water Supply Industry has advised designers and installers of water services of these risks for many years and by means of Water Supply Byelaws, advisory leaflets and advice in the field, it has attempted to avoid these problems occurring. However, with the increased use of potentially contaminated building development sites and the ever present risk of contamination by, for example, the escape of hydrocarbon fuels, the Water Suppliers have re-stated their advice.

A range of materials is available and careful selection, design and installation is required to ensure that pipelines are satisfactorily installed and meet the requirements of the Water Supply (Water Fittings) Regulations 1999 in England and Wales, the Byelaws 2000 in Scotland and the Northern Ireland Water Regulations. These contain broadly similar technical requirements and will be referred to collectively as Regulations in this Note.

The Regulations apply to underground pipes on premises including the service pipe i.e. that part of the supply pipe connecting the water main to premises which is the responsibility of the premises owner. However, the advice in this Information and Guidance Note is equally valid for the selection of water mains which are the responsibility of the Water Suppliers.

2. Background

The Regulations include a requirement to use only suitable materials when laying water pipes and the laying of unprotected water supply pipes through contaminated land is not permitted. In the past most new pipes were laid in 'greenfield sites', hence contaminated land was not generally a significant problem. Recently the large-scale re-development of brownfield sites which may contain contaminants results in the problems becoming more significant. The Government estimates there are over 50,000 contaminated sites in the UK and that by 2021, 60% of new homes will be built on brownfield sites.

Water supply pipes are at risk not only from contaminants in the re-development site but also from the surrounding land, where the movement of groundwater through the soil may result in the effects of contaminants in adjacent ground needing to be taken into account.

Water supply pipes are typically laid at a minimum depth of 750 mm. This is within the normal depth of investigation and remediation required under the planning regulations for residential developments. However, developers and Water Suppliers should check that the results of normal site investigations required as part of the planning process are adequate as indicators of contamination when designing water services.

3. Responsibilities

As with all aspects of the Regulations, meeting the requirements regarding the design and material selection for water supply pipes is strictly the responsibility of the installer and user. In the installation of new supply pipes e.g. as part of the development of new premises, the user is often represented by the developer, architect or building contractor, who will require approval from the local Water Supplier at the design stage. The users or their agents will notify the local Water Supplier of their proposals, including a plan, details of the project (including materials), and the risks of contamination. The Water Supplier will respond once the site has been evaluated, either approving the scheme, seeking amendments or requiring further information.

The Water Supplier has a statutory duty to enforce the Regulations to ensure that problems are dealt with at the design stage and throughout the project.

4. Principles of material selection

The selection of suitable pipeline materials depends upon the following steps:

- *Identification of former uses of the site or other potential sources of contaminants.*
- *Study site contamination investigation reports and proposals for remediation.*
- *Consider the probability of, and type of, potential contaminants.*
- *Assess risks to conventional water pipe materials.*
- *Selection of alternative materials, if required.*
- *Agreement with developer to proceed.*
- *Review suitability of materials in light of any contaminants found during installation.*

4.1 CONTAMINANT THRESHOLD CONCENTRATIONS

In order to assess the risks to conventional pipe material of the contaminants found on the site, criteria are required for concentrations which would be of significance. However, there is a shortage of relevant data currently available on these concentrations. Guidance documents published by the Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) for assessing the significance of contaminants for their effects on health of users of the site are often referred to, but these are not directly relevant to the selection of pipeline materials. In the UK, the Environment Agency has undertaking research on guidelines (the Contaminated Land Environmental Assessment (CLEA)), available via its website, but this does not directly relate to the effects of contaminants on pipe selection.

The Water Industry is funding research through UK Water Industry Research Ltd. (UKWIR) on a project entitled 'Pipe Materials Selection and Specification for use in Contaminated Land' which is expected to report in 2004. The results of this project should be taken into account when they are available.

Based upon recommendations of the Foundation for Water Research guidance notes (FR 0448: Laying potable water pipelines in contaminated ground, 1994), a table of threshold values for various contaminants has been drawn up (Table 1). Where soil concentrations exceed these threshold values, it is likely that special consideration of material selection will be required. It should be noted, however, that the FWR guidance included caveats that

(i) the list was far from comprehensive, with other potential contaminants known, but without information on their critical concentrations;

(ii) that soil sampling may not be the most appropriate method for establishing concentrations;

(iii) that some organic contaminants were known to have a greater effect on polyethylene (PE) pipes when present in mixtures than singly.

CONTAMINANT		Material selection 'threshold' level mg/kg dried soil
Corrosion		
Sulphate	(SO_4)	2000
Sulphur	(S)	5000
Sulphide	(S)	250
pH		less than pH5 greater than pH 8
Toxic substances		
Antimony	(Sb)	10
Arsenic	(As)	10*
Cadmium	(Cd)	3
Chromium (hexavalent)	(Cr)	25
Chromium (total)	(Cr)	600
Cyanide (free)	(CN)	25*
Cyanide (complexed)	(CN)	250*
Lead	(Pb)	500
Mercury	(Hg)	1
Selenium	(Se)	3
Thiocyanate	(SCN)	50
Organic contaminants		
Coal Tar		50
Cyclohexane extractable		50
Phenol		5
Poly Aromatic Hydrocarbons		50
Toluene extractable		50
Petroleum Hydrocarbons		50

Table 1: Threshold concentrations of contaminants in soils affecting material selection

* It is not recommended that water pipes should be laid in sites where these substances are identified or suspected.

4.2 ALTERNATIVE APPROACH TO USING THRESHOLD CONCENTRATIONS

An alternative strategy is to adopt a precautionary approach, recognising the potential which different contaminants have for causing problems, the difficulty in determining acceptable contaminant concentrations and the disruption and very considerable additional expense involved to remedy problems to installed pipes if it turns out that unsuitable materials were in fact selected. Taking these factors into account, it is reasonable to assume that if contaminants are present above background concentrations, problems will arise and therefore materials should be selected accordingly. In cases where there is uncertainty, this approach is recommended by the Water Suppliers.

5. Processing an application

To deal with issues identified the following text should be read in conjunction with the 'flow chart' (Figure 1) which outlines specific steps to evaluate the suitability of materials for potable water pipes on development sites.

5.1 CONSIDERATION OF POTENTIAL CONTAMINATION

The evaluation process commences to assess if relevant contaminants are likely to be present. (Flow Chart box 1).

5.1.1 Contaminants arising from the previous use of the site.

Information on potential contaminants can be gained by investigating the former uses of sites, using local knowledge, land registry records, old local maps and by reference to the contaminated land registers held by local authorities. Information may also be held by the Environment Agency, whose local offices should be contacted.

CORROSIVE CONTAMINANTS
Acids, acid soluble sulphate, elemental sulphur, alkalis (e.g. lime, sodium hydroxide), sulphide.

ORGANIC CONTAMINANTS
Solvents (e.g. chlorinated solvents), phenols, poly-aromatic hydrocarbons, poly-chlorinated biphenyls (PCBs), cyclohexane and toluene extractable material, petroleum hydrocarbons.

TOXIC SUBSTANCES
Antimony, arsenic, cadmium, chromium, mercury, lead, selenium, cyanide.

FLAMMABLE POTENTIAL
Methane.

USE	PROBABILITY	CONTAMINANT TYPE
Chemical works	High	Toxic, Corrosive, Organic
Vehicle repair garages, fuel storage and filling stations	High	Organic
Gas works	High	Toxic, Corrosive, Organic
Hazardous waste treatment	High	Toxic, Corrosive, Organic
Landfill sites	High	Toxic, Corrosive, Organic, Flammable
Paper manufacturing	High	Toxic, Corrosive, Organic
Print works	High	Organic
Railway yards	High	Toxic, Corrosive, Organic
Scrap yards	High	Toxic, Corrosive, Organic
Tanneries	High	Toxic, Corrosive, Organic
Timber products	High	Toxic, Organic
Docks	Medium	Toxic, Corrosive, Organic
Electrical equipment manufacture	Medium	Organic
Engineering works	Medium	Toxic, Organic
Paint manufacture	Medium	Toxic, Organic , Flammable
Agriculture/allotments	Low	Toxic, Organic , Flammable
Beverage distilleries	Low	Toxic, Organic
Food processing	Low	Toxic, Organic

Table 2: Contaminant types commonly resulting from previous site use

Table 2 shows potential contaminants associated with sites used for different industrial purposes, but the list is not exhaustive.

5.2 SITE INVESTIGATION

For detailed information about the nature and concentrations of possible contaminants which could affect the selection of pipe materials, a site investigation would normally be required. This may already have been carried out for other purposes and Water Suppliers should be supplied with details as part of the notification (section 3) [Flow Chart box 2). British Standard BS 10175: 2001: 'Investigation of potentially contaminated sites – Code of Practice' contains guidance on the design, sampling, testing, analysis and reporting of site investigations of all potentially contaminated sites and also of land with naturally enhanced concentrations of potentially harmful substances. In making detailed assessments of contaminant concentrations, it is important that the assessment must be carried out by a suitably qualified person e.g. a scientist experienced in assessment of environmental contaminants.

Where contamination on the site has been, or is to be, treated or removed for other reasons, it is necessary to assess whether this remediation will have eliminated any threat of contamination to water pipes (Flow Chart box 3). This should take into account the possibility of contaminants remaining (perhaps at a depth which is acceptable for other purposes) which could migrate to bring them into contact with the water pipe. Contaminants dissolving or mixing with fluctuating groundwater levels, which subsequently come into contact with the pipe, is one possibility.

As a separate matter, attention must be given to concentrations of contaminants which, if exceeded, will require special consideration in relation to the health and safety of operatives working on the installation, but this Information and Guidance Note does not attempt to address these health and safety aspects.

5.3 ASSESSMENT OF CONTAMINATION RISK

Where the assessment of the results of site investigations indicated that there is a risk of contaminants remaining in soil in which it is proposed to lay water pipes, the concentrations of contaminants should be compared with the threshold values which are thought to present problems for pipes of different materials (Flow Chart box 4). Alternatively, the precautionary approach (section 4.2) should be adopted.

5.4 SELECTION OF SUITABLE PIPE MATERIAL

The range of pipe materials available includes the following:

5.4.1 Metallic pipes including ductile iron and copper.

Where metallic pipes, joints and fittings require protection against corrosive contaminants, they should be wrapped in an impregnated material such as 'Densoclad 70' with a 55% overlap of successive turns. Copper pipe supplied with a factory-applied plastic coating will also be suitable for corrosive situations, but special attention should be given to joints, which may need to be protected by over-wrapping with Densoclad or similar.

5.4.2 **Polythene/aluminium/polythene** (PE/Al/PE) compound pipe relies upon the impermeable aluminium barrier to prevent organic contaminants permeating though it, whilst the outer polythene layer protects the aluminium from corrosive environments. Special attention is required for joints, which may need to be over-wrapped with aluminium foil protected by Densoclad tape.

Special attention is drawn to the requirements of curved ducts for bringing compound pipes into buildings etc. Ducts need to be adequately designed to allow for the reduced flexibility of compound pipes compared to conventional polythene pipes.

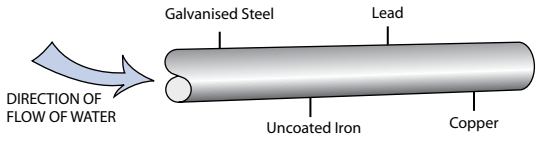
5.4.3 With knowledge of the contaminants, suitable pipe materials can be selected (Flow Chart box 6) by reference to Table 3.

TYPE OF CONTAMINANT	SUITABLE PIPE MATERIAL
None	No special requirements
Flammable	METALLIC – in the absence of corrosive contaminants. WRAPPED IRON – if corrosive and flammable contaminants are present.
Toxic	METALLIC OR PLASTIC – but see Note 1
Organic	METALLIC (iron, copper) or PE/Al/PE
Corrosive	PLASTIC PIPE, PLASTIC COATED COPPER or WRAPPED IRON
Organic and Corrosive	WRAPPED IRON or PE/Al/PE

Table 3: Materials suitable for use with different contaminants

Note 1: Following recommendations of the Foundation for Water Research guidance notes, (FWR 1994), the laying of water pipes across any land where arsenic or cyanide are identified or suspected is unacceptable without site remediation.

5.4.4 Where pipes of different metallic materials are to be installed, suitable precautions must be taken to ensure that corrosion through galvanic action cannot take place, either through direct or indirect action. Direct action can be prevented by the insertion of electrically non-conducting material between dissimilar metals. Indirect action will be limited if installation of different metals conforms to the following order in the direction of flow.



5.4.5 Public water mains and Regulation 25 approval. It must be noted that where pipes are to be adopted as part of the public water distribution system by the Water Supplier, the Water Supply (Water Quality) Regulations require that all materials which come into contact with water for public supply are specifically approved for that purpose (Regulation 25 Approval). A list of approved materials is published by the Drinking Water Inspectorate and is separately listed in the WRAS Water Fittings and Materials Directory. A material which only has WRAS Approved Product status is not sufficient for use for public water mains.

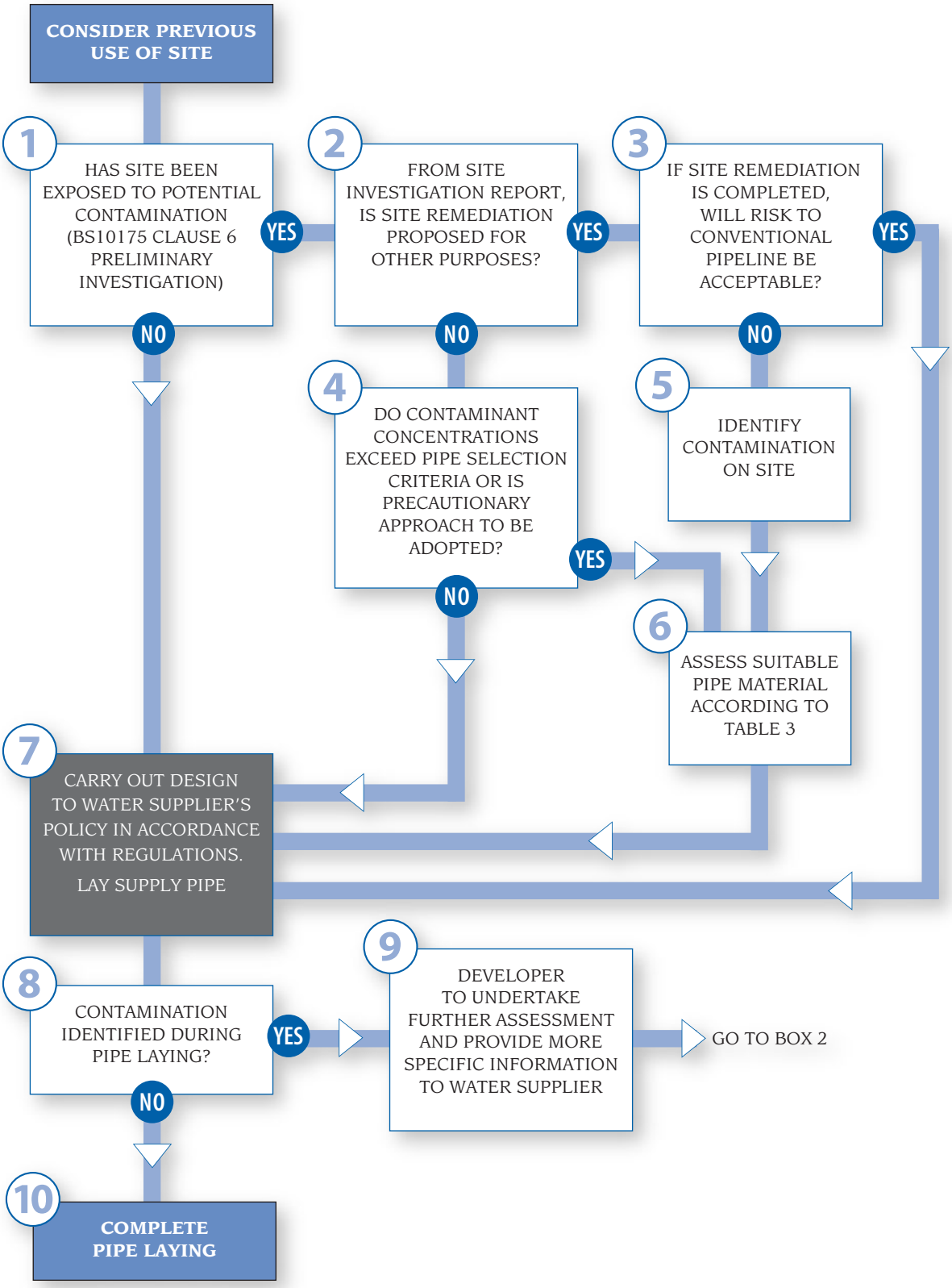


Figure 1: **Investigation of contaminated land for pipe material selection and installation**

5.5 CHECKS DURING PIPE INSTALLATION

Where, during the progress of the development, previously undetected contaminants are located or localised spillages have occurred (e.g. fuel oil), remediation or pipeline redesign may be required (Flow Chart box 8). The developer should undertake a detailed re-assessment of the selection of materials for at least that part of the installation (Flow Chart box 9 and 2) and should inform the Water Supplier of the findings.

6. Other general precautions

6.1 FOUL SOAKAWAYS OR CESSPITS

Ideally the route of a proposed pipeline should not cross the site of a current or former foul soakaway or cesspit, but where this is unavoidable, remediation or special provisions will be required. If possible the pipe should be installed without below-ground joints or fittings to reduce the risk of contaminants entering the pipe through leaking joints.

6.2 SPILLAGE OF HYDROCARBON FUELS

A well known cause of contamination of drinking water is the permeation of polythene water pipes by petrol or diesel fuel, heating oil or other organic chemicals which have either entered the ground by leakage from storage tanks, accidental spillages or by disposal in unsuitable places. This includes the loss of petrol from underground storage tanks at filling stations and leakage from vehicles parked on drives or as a result of road accidents. A number of recent incidents were summarised by Goodfellow and others, (2002).

No water supply pipes should be installed in locations where spillages can reasonably be foreseen, such as petrol station forecourts, near fuel storage tanks, vehicle dismantling or workshop areas or railway sidings. Where this is impracticable, water pipes must be suitably protected against ingress or permeation.

Where leakage of hydrocarbon fuels occurs into the ground it is important that the authority responsible for environmental protection and the Water Supplier are informed as soon as possible. This will allow the possibility of recovery of the fuel before it disperses too widely and risks affecting water pipes or the wider environment. In England and Wales the environmental authority is the Environment Agency; in Scotland it is the Scottish Environmental Protection Agency.

7. Further Information

Further copies and technical information may be obtained from:

The Water Regulations Advisory Scheme,
Unit 30, Fern Close
Pen-y-Fan Industrial Estate
Oakdale, Newport, Gwent NP11 3EH

Tel: 01495 248454
Fax: 01495 249234
E-mail: info@wras.co.uk
Website: www.wras.co.uk

Local Water Supplier

See local telephone directory, local Yellow Pages or the WRAS website.

Environment Agency or Scottish Environment Protection Agency

See local telephone directory or local Yellow Pages.

REFERENCES

British Standard BS 10175 : 2001: Investigation of potentially contaminated sites – Code of Practice

FWR 1994. Laying potable water pipelines in contaminated ground - Guidance Notes. Foundation for Water Research. FR 0448, 1994.

Goodfellow, F., Ouki, D., and Murray, V. 2002. 'Permeation of organic chemicals through plastic water supply pipes'. Journal of the Chartered Institute of Environmental Management, **16**, pp85 – 89.