

Lytag Ltd
Drax Power Station
Selby
North Yorkshire
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Date: 13th July 2018
Test Report Ref. STR: 478019a

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LABORATORY TEST REPORT

TEST REQUIREMENTS:

Interpretation of chemical data with respect to Dangerous Substances regarding compliance with the Construction Products Directive (CPD), for use in conjunction with future CE Markings

SAMPLE DETAILS:

Certificate of sampling received:	No
Laboratory Ref. No:	S59811
Client Ref. No:	8/14mm
Date and Time of Sampling:	Unknown
Date of Receipt at Lab:	15/08/2016
Date of Start of Test.:	06/09/2016
Sampling Location:	Unknown
Name of Source:	Unknown
Method of Sampling:	Unknown
Sampled By:	Client
Aggregate Type and Nominal Size:	8/14mm
Target Specification:	N/A

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The work was carried out by our accredited, competent, sub contracted laboratory.


(✓) N Dumbarton
Aggregate Laboratory Manager

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REQUIREMENTS**Date of Requisition****05/07/18**

<u>Client Sample Ref</u>	<u>Required Analysis</u>
S/N S59811 8/14mm	Interpretation of chemical data with respect to Dangerous Substances regarding compliance with the Construction Products Directive (CPD), for use in conjunction with future CE Markings

* Dangerous Substances – chemical analysis to determine leachable List I and List II, and other potentially harmful parameters (tabulated in the Appendix of this report).

Date of Completion**05/07/18**

Introduction to the EC Construction Products Directive (CPD)

As part of the implementation of the EC Construction Products Directive (CPD 89/106/EEC), a diverse range of harmonised European standards and technical approvals for construction products have been drawn up by the respective bodies. In addition to the traditional requirements, such as stability and reaction to fire, the provisions of the CPD also require that equal consideration be given to hygiene, health and environmental protection as essential requirements.

Transposing the Essential Requirement No. 3 into technical specifications

In terms of the Essential Requirement No. 3 "Hygiene, Health and the Environment", the Construction Products Directive and the more specific Interpretative Document No. 3 require that Building users and the immediate environment shall not be endangered by the construction works. A tiered approach should be taken in order to take full account of the Essential Requirement No. 3 in the technical specifications. In order to evaluate the possible release of dangerous substances knowledge on both the chemical composition and structure as well as on the planned use of the products in construction works (e.g. direct or no contact with indoor air) are required. In this way, it is, for instance, quite possible to recognise application areas that present no risk to health or the environment, even for a product classified as "critical". Taking into account the composition and area of application, the mandated construction products should be classified into products that, due to existing experience, can be deemed as obviously harmless and for which no additional tests are required (WFT products – Without Further Testing) and products for which the health and environmentally relevant effects can only be evaluated by using specific individual tests as part of approval procedures. For products falling between these two cases, which are therefore subject to standards, stipulations should be made in the standards that ensure that a risk for users and the environment can be excluded with a sufficient degree of certainty. The following table (Table 1) summarises the product descriptors and necessary action to evaluate the potential impact on health and the environment.

Table 1 : Product Descriptors and Actions to comply with CPD

WFT products	Standardised products	Products subject to approval
• Composition can be precisely specified • Release behaviour known • Well proven products → no further testing necessary	• Composition can be described • Possible reduction of the range of chemical constituents • Specification of the dangerous substances to be tested possible → analysis of the release of dangerous substances necessary. Declaration of the results in CE mark.	• Large range of applied substances • Innovative products: release behaviour unknown • Use of waste materials without long-term experience → analysis of the release of dangerous substances based on information on the chemical composition of the product.

CPD, the Protection of occupants, neighbours and environment, and CE Markings

Construction Products Directive (CPD) and Construction Products Regulation (CPR) contain a chapter on hygiene, health and the environment which, in general terms, declares that any construction work must not pose any harm to hygiene or health of occupants or neighbours, among others by giving-off of toxic gas, or by presence of dangerous particles or gases in the air.

This requirement is discussed more in detail in Essential Requirement III and Interpretative document III, proposing to prevent such risk by, among others, "eliminating or limiting the use of materials which may release pollutants, and the use of which results in concentrations greater than acceptable limits". More specific proposals can be read in an Annex to Interpretative document No. 3 and a Guidance paper H, mainly meant for writers of technical specifications.

As all other elements of both laws, the purpose is not to influence the level of protection - the purpose is to harmonize technical description of products, for facilitating cross-border trade. The plan is that a CE label will be accompanied by performance classes that cover all national regulations in Europe. Then each EU member state can specify which performance classes a product shall fulfil for being accepted on that national market. The intention is that this CE marking will substitute any national law.

As Construction Products Directive (CPD) is no direct law in EU Member States, these have adopted CPD in different manners. There is available a database of national legislation related to CPD. In contrast to that, Construction Products Regulation (CPR) is binding in all EU member states without needing national adaptation, from 1st July 2013.

Three general principles can be drawn from the scope of the CPD, and the link between the CPD and provisions on Dangerous Substances:

1. Aside from the protection of people (occupants and neighbours), it is only the immediate environment that falls within the scope of the CPD. Wider environmental aspects, such as destruction of the ozone layer, are not covered. Although the term "immediate" is not defined in the interpretative documents, it can be taken to mean those parts of the environment that are influenced by direct effects of the products or works in question.
2. To conform with the scope of the CPD the harmonised approach relating to dangerous substances is limited to "works in use". Other phases in the life cycle of a product, i.e. its excavation or production stages, during the Building process, during demolition, waste disposal, incineration or waste reuse (except where reuse is as a construction product in the sense of the CPD) are not considered for harmonisation under the CPD.
In addition, activities such as maintenance, replacement or other construction activities carried out during the normal life of a Building might cause dangerous substances to arise from products already installed in the works. These activities are considered to be outside the scope of the CPD. It is the responsibility of the Member States to make procedural provisions if, on the basis of knowledge of the process or product involved, such activities are likely to lead to potentially harmful situations. Of course, any construction products used, for example for replacement, remain within the scope of the CPD.
3. The requirement on products is expressed either as emission or migration of dangerous substances or radiation, during normal (i.e. foreseeable) use. It is, therefore, when possible, the release of substances, that is the characteristic to be controlled. However, even if it is not the content of the dangerous substance itself in the product that should be controlled, this might be the only practicable solution

Overview of potential Dangerous Substances associated with Construction Materials

Dangerous Substances are toxic substances that pose the greatest risk of harm to the environment and human health. Dangerous substances can potentially harm human health, aquatic life and water quality and include certain industrial chemicals, pesticides and metals. Their origin is not restricted to sewage and trade discharges, but include water borne substances leached from, for example, contaminated land, old mines. Rainwater runoff from roads and some industrial sites can also release dangerous substances into watercourses. The predominant Dangerous Substances that are potentially associated with various construction materials are tabulated below (Table 2).

Table 2 : Dangerous Substances potentially associated with Construction Materials

Construction Material	Potential Dangerous Substance
Cement – manufactured without waste usage	Leachable Heavy Metals
Cement – manufactured with the use of wastes	Leachable Heavy Metals; leachable organic substances such as PAH, dioxins/furans, phenols
Aggregate – natural	Leachable Heavy Metals
Aggregate – manufactured (e.g. blastfurnace slag)	Leachable Heavy Metals
Aggregate, lightweight – natural or manufactured	Leachable Heavy Metals
Aggregate – recycled	Leachable Heavy Metals; leachable organic substances such as PAH, dioxins/furans, phenols
Concrete Addition – Fillers	Leachable Heavy Metals
Concrete Addition – Pigments	Leachable Heavy Metals
Concrete Addition – Fly Ash	Leachable Heavy Metals; leachable organic substances such as PAH, dioxins/furans, phenols
Concrete Addition – Silica Fume	Leachable Heavy Metals
Concrete Admixture - <i>Plasticisers and liquefiers; Retarders, sealants and injection aids; Accelerators; Air-entraining agents and stabilisers:</i>	Leachable Alkali Metals; leachable Dissolved Organic Carbon (DOC)

Dangerous Substances Directive

The Dangerous Substances Directive (DSD) (76/464/EEC) and its 'daughter' directives controlled discharges that were liable to contain dangerous substances and that go to inland, coastal and territorial surface waters. The directive specified two lists of Dangerous Substances:

- **List I**, which comprises those substances which are particularly toxic, persistent, and which may tend to accumulate in the environment; and
- **List II**, which encompasses substances whose effects are still toxic, but less serious.

The directive required that pollution by List I substances was eliminated, and pollution by List II substances was minimized. All discharges that were liable to contain dangerous substances were authorised. The directive also specified some requirements for environmental monitoring.

The Environment Agency defined pollution by dangerous substances as exceedence of Environmental Quality Standards (EQSs) in the water; the EQS of a substance was based on the toxicity of the substance. The EQS defined a concentration in the water below which the substance would not have a polluting effect or cause harm to plants and animals. If the concentration in the water is less than the EQS, pollution was deemed to have been effectively eliminated. The 'daughter' directives set the EQSs for List I substances across Europe. Each country in the EU was required to set its own EQSs for List II substances.

EU Water Framework Directive

The EC Water Framework Directive (Water FD), which came into force on 22nd December 2000, established a new, integrated approach to the protection, improvement and sustainable use of Europe's rivers, lakes, estuaries, coastal waters and groundwater.

The Directive introduced two key changes to the way the water environment must be managed across the European Community.

The first related to the types of environmental objectives that must be delivered. Previous European water legislation set objectives to protect particular uses of the water environment from the effects of pollution and to protect the water environment itself from especially dangerous chemical substances. These types of objectives are taken forward in the Directive's provisions for Protected Areas and Priority Substances respectively.

However, the Directive also introduced new, broader ecological objectives, designed to protect and, where necessary, restore the structure and function of aquatic ecosystems themselves, and thereby safeguard the sustainable use of water resources. Future success in managing Europe's water environment will be judged principally by the achievement of these ecological goals.

The second key change was the introduction of a river basin management planning system. This is the key mechanism for ensuring the integrated management of: groundwater; rivers; canals; lakes; reservoirs; estuaries and other brackish waters; coastal waters; and the water needs of terrestrial ecosystems that depend on groundwater, such as wetlands.

The planning system will provide the decision-making framework within which costs and benefits can be properly taken into account when setting environmental objectives, and proportionate and cost-effective combinations of measures to achieve the objectives can be designed and implemented. It will also provide new opportunities for anyone to become actively involved in shaping the management of river basin districts – neighbouring river catchments, together with their associated stretches of coastal waters.

Environmental Permitting (England and Wales) Regulations 2010**The Groundwater Directives**

These Directives require that inputs (discharges) of pollutants to groundwater are either prevented or limited, to avoid or control groundwater pollution. In so doing such measures should also prevent the deterioration of the chemical status of groundwater bodies and avoid (environmentally) significant and sustained upward trends in the concentration of pollutants in groundwater.

Definitions relevant to the requirements of the Groundwater Directives**HAZARDOUS SUBSTANCE**

The List I and List II groupings of substances under the Groundwater Directive (GWD) and 1998 Regulations no longer apply. Substances are instead treated as either 'hazardous substances' (initially broadly equating to the former List I) or non-hazardous pollutants' (analogous to the former List II, but potentially applying to all other pollutants)

'Hazardous substance' is defined in Article 2(29) of the Water FD as meaning substances or groups of substances that are toxic, persistent and liable to bio-accumulate, and other substances or groups of substances which give rise to an equivalent level of concern. Article 6.1 of the Groundwater Daughter Directive 2006 (GWDD) adds an indicative list to this description by reference to list of pollutants in Annex VIII to Water Framework Directive. This comprises a combination of List I substances from the GWD (and the annex to the 1998 Regulations) and any other substances which meet the criteria for persistence, toxicity and bioaccumulation taking into account those substances listed in Water Framework Directive Annex VIII. List I substances are effectively a (large) subset of the potentially wider group of hazardous substances. For the purpose of clarity the Environment Agency is required to maintain and publish a list of hazardous substances.

The identification of hazardous substances will be the responsibility of the Environment Agency on the recommendation of the Joint Agencies Groundwater Directive Advisory Group (JAGDAG). JAGDAG comprises a committee of experts drawn from the UK environment agencies, research and consultancy interests, the water industry and various other sector interests. In the absence of formal JAGDAG determinations the Environment Agency may make preliminary determinations to enable it to fulfil its statutory duties. All such interim determinations should be referred to JAGDAG for prompt review.

The GWD and the 1998 Groundwater Regulations required Member States and competent authorities to determine which substances or compounds could be removed from List I in the light of the risks posed by their intrinsic properties. The GWDD requires a different approach by which Member States or their competent authorities determine which substances should be determined as hazardous on the basis of their toxicity, persistence and capacity to bio-accumulate – i.e. positive determination rather than removal from a pre-determined list. This provides greater flexibility to include substances within, or alternatively exclude them from, the 'hazardous' category. In practice substances which have been determined as List I will continue to be regarded as hazardous and will only be reviewed if new evidence becomes available. Due to their nature, it is considered that all radioactive substances are hazardous substances.

NON HAZARDOUS POLLUTANT

There are no longer specified lists of substances over which control may be exercised under the GWDD and the Regulations. All substances which are not determined to be hazardous are potentially non-hazardous pollutants. This enables control to be exercised over polluting substances which have hitherto been beyond control purely because, regardless of their impact, they were not listed in the GWD. In practice the Environment Agency will need to deal with substances which are current priorities of concern. It is clearly not necessary to expand the field to include all other substances in all circumstances unless they are liable to cause pollution.

'DIRECT DISCHARGE' INTO GROUNDWATER

The definition of 'direct discharge' to groundwater in the Water Framework Directive refers to discharge of pollutants into groundwater "...without percolation throughout the soil or subsoil". A discharge can be regarded as direct, i.e. there is no percolation, for example:

- where it is made into an open man made structure such as a shaft, borehole or well which extends down to or into the water table,
- where it is made into a natural feature such as a swallow hole via uninterrupted cascade or very rapidly down open, vertical or near vertical conduits,
- where leachate arising from the deposit of any waste material below the water table moves into surrounding ground without the presence of a natural geological barrier or engineered barrier constructed to relevant standards.

A discharge is indirect, i.e. percolation does occur, for example:

- where it is made into a natural feature and the connection between the surface and the saturated zone is tortuous, i.e. gradual rather than a cascade;
- when a discharge infiltrates a natural soil or rock via a soakaway, drainage field or other similar feature – provided an unsaturated zone is maintained;
- where leachate arising from deposit of any waste material below the water table moves into surrounding ground across a natural geological barrier or engineered barrier constructed to relevant standards.

In practice the Environment Agency may need to determine on a case by case basis whether a discharge is direct or not and may issue technical guidance on its approach to this assessment.

Prevention of inputs of hazardous substances

The European Commission issued Common Implementation Strategy guidance on the implementation of the Water Framework Directive and the GWDD, by way of clarification. (CIS Guidance Note No. 17 – Guidance on preventing or limiting direct and indirect inputs in the context of the Groundwater Directive 2006/118/EC, section 3.4.)

This guidance states *"The broadening of controls on pollutants by the WFD noted above, is now balanced by a series of exemptions introduced by the GWDD (Article 6.3). It is indeed not technically feasible to stop all inputs of hazardous substances, and some small inputs are environmentally insignificant and therefore do not present a risk to groundwater. Without these exemptions, the "prevent" requirement would imply an onerous and sometimes unfeasible task. Each exemption applies to both the 'prevent' and the 'limit' objective (both hazardous and non-hazardous substances) but must not override other more stringent requirements in other EC legislation.*

To "prevent" an input into groundwater means: taking all measures deemed necessary and reasonable to avoid the entry of hazardous substances into groundwater and to avoid any significant increase in concentration in the groundwater, even at a local scale. "Reasonable" means technically feasible without involving disproportionate costs. How to define "disproportionate costs" depends on the local circumstances".

Note that the CIS guidance outlines what Member States should do. In practice this will be achieved via a combination of the actions by regulatory authorities and the regulated. Reference to measures below is to both actions by the Environment Agency and those actions (technical precautions) that the Environment Agency should seek from operators via conditions on permits or notices. The purpose of this guidance is to explain how the CIS guidance should be applied – it does not seek to prescribe the actions in any specific case (the Environment Agency may issue its own guidance for such purposes).

The CIS interpretation of “prevent” recognises that there is a practical limit to what realistically can be achieved within the overall context of aiming to avoid the introduction of all hazardous substances into groundwater. It is possible to deploy only those measures which are technically feasible and proportionate, including in terms of cost.

An input of hazardous substances would be prevented, for example, if:

- there is no discernible concentration of a hazardous substance in the discharge. This would also clearly come within the exemption under paragraph 3(3)(b) of Schedule 22, with only limited assessment needed to make this judgement; or
- there are no discernible concentrations of hazardous substances attributable to the discharge in groundwater immediately down-gradient of the discharge zone, subject to adequate monitoring (or in the case of new discharges a detailed predictive hydro-geological impact assessment); or
- there are (or are predicted to be) discernible concentrations of hazardous substances in the groundwater down-gradient of the discharge zone attributable to the discharge but all of the following conditions apply:
 - (a) concentrations will not result in any actual pollution or a significant risk of pollution in the future; and
 - (b) there is no progressive increase in the concentration of hazardous substances outside the immediate discharge zone, i.e. there will be no statistically and environmentally significant and sustained upward trend or significant increasing frequency in pollutant “spikes”; and
 - (c) all necessary and reasonable measures to avoid the entry of hazardous substances into groundwater have been taken (see below).

NECESSARY AND REASONABLE MEASURES

Assessment of necessary measures must be preceded by investigation to determine pathways and is a site-specific judgement.

A reasonable measure would be one where the necessary technical precautions to prevent inputs to groundwater are technically feasible, not disproportionately costly and are within the control of the operator. Such measures could include: source control, alteration of discharge mechanism, treatment of the discharge, interception or diversion of contaminated groundwater, and diversion of the discharge to another disposal route. For new developments this could include simply not conducting the activity in a location where valuable groundwater resources would be particularly vulnerable to inputs of hazardous substances. Any measures taken should not result in a net environmental disbenefit.

If there is actual pollution, or a substantial risk of such pollution, remedial measures must be taken. Cost-benefit assessment is not a factor in deciding *whether* to take action in such cases but may be a consideration in determining *which* precautions are necessary.

Reference :

*Environmental Permitting Guidance Groundwater Activities
For the Environmental Permitting (England and Wales) Regulations 2010
December 2010 Version 1.0*

SUMMARY OF GROUNDWATER ISSUES

The Groundwater Directives aim to protect groundwater from pollution.

The existing Groundwater Directive (80/68/EEC) aims to protect groundwater from pollution by controlling discharges and disposals of certain dangerous substances to groundwater. In the UK, the directive is implemented through the Environmental Permitting Regulations (EPR) 2010.

Under these regulations, groundwater is protected by preventing or limiting the inputs of polluting substances into groundwater. Substances controlled under these regulations fall into two categories:

- **Hazardous** substances are the most toxic and must be prevented from entering groundwater. Substances in this list may be disposed of to the ground, under a permit, but must not reach groundwater. They include pesticides, sheep dip, solvents, hydrocarbons, mercury, cadmium and cyanide. Hazardous substances replace the previous List 1 substances which came under the Groundwater Regulations 1998.
- **Non-hazardous pollutants** are less dangerous, and can be discharged to groundwater under a permit, but must not cause pollution. Examples include sewage, trade effluent and most wastes. Non-hazardous pollutants include any substance capable of causing pollution and the list is much wider than the previous List 2 substances. For example, nitrate is included as a pollutant but it was excluded from List 2 in the Groundwater Regulations 1998.

Future Groundwater Directive

Under Article 17 of the Water Framework Directive, the European Commission (EC) was required to propose specific measures to prevent and control groundwater pollution and achieve good groundwater chemical status. These measures include criteria for assessing the chemical status of groundwater and for identifying trends in pollution of groundwater bodies. In order to fulfil the requirement, the Commission adopted the Directive on the protection of groundwater against pollution and deterioration on 22 November 2006. Under this new Directive the member states are required to publish a list of substances that they consider to be hazardous substances on the basis of their intrinsic properties. Hazardous substances effectively replace the previous List 1 substances under the old Groundwater Directive (80/68/EEC).

Hazardous substances must be prevented from entering groundwater. A non-hazardous pollutant is defined in Environmental Permitting Regulations (EPR) (2010) as any pollutant other than a hazardous substance. The classification of substances as hazardous or non-hazardous is relevant in all cases where regulation of an input of pollutants to groundwater (a "groundwater activity") is required by the EPR 2010.

JAGDAG (Joint Agencies Groundwater Directive Advisory Group) has been reconvened to provide a cost-effective mechanism for making UK wide determinations and to facilitate EC reporting requirements.

The existing Groundwater Directive is to be repealed by the Water Framework Directive 2000/60/EC (WFD) in 2013.

WATER QUALITY ASSESSMENT AND INTERPRETATION

Contemporary guidelines for parameter assessments were documented as Environmental Quality Standards (EQS) (Environment Agency). Where contaminant parameters were not included in EQS listings, contemporary Drinking Water criteria could be utilised as guideline concentrations. Assessment of soil and other solid materials may be assessed by preparation of a suitable leachate (e.g. as detailed in BS EN 1744-3:2002).

Results: DANGEROUS SUBSTANCES ANALYSIS – S/N S59811

<u>Leachable Compounds of Concern</u>	<u>S59811 8/14mm</u>
pH	7.80
HEAVY METALS:	
Antimony (dissolved) (µg Sb/l)	2.60
Arsenic (dissolved) (µg As/l)	65.00
Barium (dissolved) (µg Ba/l)	110.00
Cadmium (dissolved) (µg Cd/l)	0.04
Chromium (dissolved) (µg Cr/l)	0.57
Copper (dissolved) (µg Cu/l)	< 0.4
Lead (dissolved) (µg Pb/l)	< 0.09
Mercury (dissolved) (µg Hg/l)	< 0.01
Molybdenum (dissolved) (µg Mo/l)	36
Nickel (dissolved) (µg Ni/l)	< 0.5
Selenium (dissolved) (µg Se/l)	9.00
Zinc (dissolved) (µg Zn/l)	< 1.3
ANIONS	
Chloride (mg Cl/l)	5.60
Fluoride (mg F/l)	< 0.1
Sulphate (mg SO ₄ /l)	91.00
PAHs	
Naphthalene (µg/l)	< 0.01
Acenaphthylene (µg/l)	< 0.01
Acenaphthene (µg/l)	< 0.01
Fluorene (µg/l)	< 0.01
Phenanthrene (µg/l)	< 0.01
Anthracene (µg/l)	< 0.01
Fluoranthene (µg/l)	< 0.01
Pyrene (µg/l)	< 0.01
Benzo[a]anthracene (µg/l)	< 0.01
Chrysene (µg/l)	< 0.01
Benzo[b]fluoranthene (µg/l) (µg/l)	< 0.01
Benzo[k]fluoranthene (µg/l)	< 0.01
Benzo[a]pyrene (µg/l)	< 0.01
Indeno[1,2,3-cd]pyrene (µg/l)	< 0.01
Dibenzo[a,h]anthracene (µg/l)	< 0.01
Benzo[g,h,i]perylene (µg/l)	< 0.01
OTHER ORGANICS	
Phenol (µg/l)	<0.50
Dissolved Organic Carbon (mg/l)	3.00

Interpretation: DANGEROUS SUBSTANCES ASSESSMENT - S/N S59811

The sample referenced S/N S59811 8/14mm was subjected to leachate preparation in accordance with BS EN 1744-3:2002. The generated leachate was analysed to determine the potential Dangerous Substances contents, which were subsequently compared to relevant criteria (e.g. published Environmental Quality Standards (EQS), Water Supply Regulations 2010).

Most heavy metal parameters analysed comply with the most stringent criteria (EQS limits, Water Supply limits, etc), some being present at less than analytical detection limits. Whilst the level of Arsenic exceeded such criteria, the dilution effect of the receiving water would result in an overall insignificant risk of harm to the aqueous environment.

All Inorganic anion parameters analysed comply with the most stringent criteria (EQS limits, Water Supply limits, etc).

All Polycyclic Aromatic Hydrocarbon (PAH) parameters comply with the most stringent criteria (EQS limits, Water Supply limits, etc), several species analysed being present at less than analytical detection limits.

Leachable Phenol was present at less than analytical detection limits.

Dissolved Organic Carbon was present at a level considered to pose an insignificant risk of harm to the aqueous environment.

Conclusions:

The sample referenced S/N S59811 8/14mm was subjected to leachate preparation in accordance with BS EN 1744-3:2002. The generated leachate was analysed to determine the potential Dangerous Substances contents, which were compared to relevant criteria (e.g. published Environmental Quality Standards (EQS), Water Supply Regulations 2010). It must be noted that the EQS are the concentrations of leached parameters contained within the receiving water – not the parameter concentration of the leachate; the dilution effect of the receiving water must be taken into account when assessing the overall risk of leachable parameters to the aqueous environment. Therefore, the identified leachate concentrations would be subject to further dilution in the environment, typically at least 100 fold.

Most inorganic and all organic parameters analysed comply with the most stringent criteria (EQS limits, Water Supply limits, etc); however, the analysed leachate concentration of arsenic exceeded such criteria. Nevertheless, the dilution effect of the receiving water would result in an overall insignificant risk of harm to the aqueous environment.

The results of analysis demonstrate that the leachate generated by sample referenced S59811 8/14mm complies with the Dangerous Substances Directive (DSD) (76/464/EEC) and its 'daughter' directives, and also the Construction Products Directive (CPD 89/106/EEC), Essential Requirement No. 3 "Hygiene, Health and the Environment".

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ORIGINAL LIST I DANGEROUS SUBSTANCES (as a guide)

Environmental Quality Standards (EQS) for List I Dangerous Substances, EC Dangerous Substances Directive (76/464/EEC)

<u>LIST I Dangerous Substances</u>	<u>EQS (annual average)</u>	
	<u>All Freshwater</u>	<u>Coastal and estuarine</u>
Mercury (total) (µg Hg/l)	1	N/A
Mercury (dissolved) (µg Hg/l)	N/A	0.3
Cadmium (total) (µg Cd/l)	5	N/A
Cadmium (dissolved) (µg Cd/l)	N/A	2.5
Tetrachloromethane (µg/l)	12	12
Total DDT (µg/l)	0.025	0.025
Pentachlorophenol (µg/l)	2	2
Aldrin (µg/l)	0.01	0.01
Endrin (µg/l)	0.005	0.005
Total 'Drins' (µg/l)	0.03	0.03
Hexachlorobenzene (µg/l)	0.03	0.03
Hexachlorobutadiene (µg/l)	0.1	0.1
Trichloromethane (µg/l)	12	12
1,2-Dichloroethane (µg/l)	10	10
Trichloroethene (µg/l)	10	10
Tetrachloroethene (µg/l)	10	10
Trichlorobenzene (µg/l)	0.4	0.4

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ORIGINAL LIST II DANGEROUS SUBSTANCES (as a guide)

Environmental Quality Standards (EQS) for List II Dangerous Substances, EC Dangerous Substances Directive (76/464/EEC)

<u>LIST II Dangerous Substances</u>	<u>EQS (annual average, unless cited)</u>	
	<u>All Freshwater</u>	<u>Coastal and estuarine</u>
1,1,1-Trichloroethane (µg/l)	100	100
1,1,2-Trichloroethane (µg/l)	400	300
2,4-D (ester) (µg/l)	1	1
2,4-D (non-ester) (µg/l)	40	40
2,4-Dichlorophenol (µg/l)	20	20
2-Chlorophenol (µg/l)	50	50
4-Chloro-3-methylphenol (µg/l)	40	40
Arsenic (dissolved) (µg As/l)	50	25
Atrazine & Simazine (µg/l)	2	2
Azinphos-methyl (µg/l)	0.01	0.01
Bentazone (µg/l)	500	500
Benzene (µg/l)	30	30
Biphenyl (µg/l)	25	25
Boron (dissolved) (µg/l)	2000	7000
Chloronitrotoluenes (µg/l)	10	10
Chromium (dissolved) (µg/l)	Hardness related [†]	15
Copper (dissolved) (µg/l)	Hardness related [†]	5
Cyfluthrin (µg/l)	0.001 (95 th percentile)	0.001 (95 th percentile)

† Parameter freshwater EQS related to Hardness of receiving water (see table 4b)

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ORIGINAL LIST II DANGEROUS SUBSTANCES (as a guide) (continued)

Environmental Quality Standards (EQS) for List II Dangerous Substances, EC Dangerous Substances Directive (76/464/EEC)

<u>LIST II Dangerous Substances</u>	<u>EQS (annual average, unless cited)</u>	
	<u>All Freshwater</u>	<u>Coastal and estuarine</u>
Demeton (µg/l)	0.5	0.5
Dichlorvos (µg/l)	0.001	0.04 (0.6 maximum)
Dimethoate (µg/l)	1	1
Endosulphan (µg/l)	0.003	0.003
Fenitrothion (µg/l)	0.01	0.01
Fluocifuron (µg/l)	1 (95 th percentile)	1 (95 th percentile)
Iron (dissolved) (µg Fe/l)	1000	1000
Lead (dissolved) (µg Pb/l)	Hardness related [†]	25
Linuron (µg/l)	2	2
Malathion (µg/l)	0.01	0.02
Mecoprop (µg/l)	20	20
Mevinphos (µg/l)	0.02 Maximum	-
Naphthalene (µg/l)	10	5
Nickel (dissolved) (µg Ni/l)	Hardness related [†]	30
Omethoate (µg/l)	0.01	-
PCSDs (µg/l)	0.05 (95 th percentile)	0.01 (95 th percentile)
Permethrin (µg/l)	0.01 (95 th percentile)	0.01 (95 th percentile)
pH	6 – 9 (95 th percentile)	6 – 8.5 (95 th percentile)

† Parameter freshwater EQS related to Hardness of receiving water (see table 4b)

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ORIGINAL LIST II DANGEROUS SUBSTANCES (as a guide) (continued)

Environmental Quality Standards (EQS) for List II Dangerous Substances, EC Dangerous Substances Directive (76/464/EEC)

<u>LIST II Dangerous Substances</u>	<u>EQS (annual average, unless cited)</u>	
	<u>All Freshwater</u>	<u>Coastal and estuarine</u>
Sulcofuron (µg/l)	25 (95th percentile)	25 (95th percentile)
Toluene (µg/l)	50	40
Triazaphos (µg/l)	0.005	0.002
Tributyltin (µg/l)	0.02 Maximum	0.002 Maximum
Trifluralin (µg/l)	0.1	0.1
Triphenyltin (µg/l)	0.02 Maximum	0.008 Maximum
Vanadium (dissolved) (µg V/l)	Hardness related[†]	100
Xylene (all isomers) (µg/l)	30	30
Zinc (total) (µg Zn/l)	Hardness related[†]	40

† Parameter freshwater EQS related to Hardness of receiving water (see table 4b)

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ORIGINAL LIST II DANGEROUS SUBSTANCES (as a guide) (continued)

**Environmental Quality Standards (EQS) for hardness related List II Dangerous Substances,
EC Dangerous Substances Directive (76/464/EEC)**

<u>LIST II Dangerous Substances</u>	<u>EQS (annual average, unless cited)</u>					
	WATER Hardness (mg/l CaCO₃)					
	0-50	>50-100	>100-150	>150-200	>200-250	>250
<i>Freshwaters, suitable for all fish life</i>						
Copper (dissolved) (µg Cu/l)	1	6	10	10	10	28
Copper (dissolved) (µg Cu/l) (95 th percentile)	5	22	40	40	40	112
Nickel (dissolved) (µg Ni/l)	50	100	150	150	200	200
Vanadium (dissolved) (µg V/l)	20	20	20	20	60	60
<i>Freshwaters, suitable for Salmonid (coarse) fish</i>						
Chromium (dissolved) (µg Cr/l)	5	10	20	20	50	50
Lead (dissolved) (µg Pb/l)	4	10	10	20	20	20
Zinc (total) (µg Zn/l)	8	50	75	75	75	125
Zinc (total) (µg Zn/l) (95 th percentile)	30	200	300	300	300	500
<i>Freshwaters, suitable for Cyprinid (game) fish</i>						
Lead (dissolved) (µg Pb/l)	50	125	125	250	250	250
Zinc (total) (µg Zn/l)	75	175	250	250	250	500
Zinc (total) (µg Zn/l) (95 th percentile)	300	700	1000	1000	1000	2000

DRINKING WATER LIMITS - CHEMICAL PARAMETERS (Water Supply (Water Quality) Regulations 2010)

Part I: Directive requirements

Item	Parameters	Concentration or Value (max)	Measurement Units	NOTES
1	Acrylamide (i)	0.1	µg/l	(i) The parametric value refers to the residual monomer concentration in the water as calculated according to specifications of the maximum release from the corresponding polymer in contact with the water. This is controlled by product specification. (ii) See also regulation 6(6). (iii) See also regulation 4(2)(d). (iv) See the definition of "pesticides and related products" in regulation 2. (v) The parametric value applies to each individual pesticide. (vi) "Pesticides: Total" means the sum of the concentrations of the individual pesticides detected and quantified in the monitoring procedure. (vii) The specified compounds are: — benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene. The parametric value applies to the sum of the concentrations of the individual compounds detected and quantified in the monitoring process. (viii) The parametric value applies to the sum of the concentrations of the individual compounds detected and quantified in the monitoring process. (ix) The specified compounds are: — chloroform, bromoform, dibromochloromethane, bromodichloromethane. The parametric value applies to the sum of the concentrations of the individual compounds detected and quantified in the monitoring process.
2	Antimony	5	µg Sb/l	
3	Arsenic	10	µg As/l	
4	Benzene	1	µg/l	
5	Benzo(a)pyrene	0.010	µg/l	
6	Boron	1	mg B/l	
7	Bromate	10	µg BrO ₃ /l	
8	Cadmium	5	µg Cd/l	
9	Chromium	50	µg Cr/l	
10	Copper (ii)	2	mg Cu/l	
11	Cyanide	50	µg CN/l	
12	1, 2 dichloroethane	3	µg/l	
13	Epichlorohydrin	0.1	µg/l	
14	Fluoride	1.5	mg F/l	
15	Lead (ii) 25/12/03 - 25/12/13	(a) 25	µg Pb/l	
	on and after 25/12/13	(b) 10	µg Pb/l	
16	Mercury	1	µg Hg/l	
17	Nickel (ii)	20	µg Ni/l	
18	Nitrate (iii)	50	mg NO ₃ /l	
19	Nitrite (iii)	0.5	mg NO ₂ /l	
20	Pesticides (iv) (v)			
	Aldrin	0.03	µg/l	
	Dieldrin	0.03	µg/l	
	Heptachlor	0.03	µg/l	
	Heptachlor epoxide	0.03	µg/l	
	other pesticides	0.1	µg/l	
21	Pesticides: Total (vi)	0.5	µg/l	
22	Polycyclic aromatic hydrocarbons (vii)	0.1	µg/l	
23	Selenium	10	µg Se/l	
24	Tetrachloroethene and Trichloroethene (viii)	10	µg/l	
25	Trihalomethanes: Total (ix)	100	µg/l	
26	Vinyl chloride	0.5	µg/l	

DRINKING WATER LIMITS - CHEMICAL PARAMETERS (Water Supply (Water Quality) Regulations 2010) (continued)
Part II: National requirements

Item	Parameters	Concentration or Value (max unless otherwise stated)	Measurement Units	NOTES
1	Aluminium	200	µg Al/l	(i) The water should not be aggressive.
2	Colour	20	mg/l Pt/Co	
3	Iron	200	µg Fe/l	
4	Manganese	50	µg Mn/l	
5	Odour	Acceptable to consumers; no abnormal change	Dilution number	
6	Sodium	200	mg Na/l	
7	Taste	Acceptable to consumers; no abnormal change	Dilution number	
8	Tetrachloromethane	3	µg/l	
9	Turbidity	4	NTU	
INDICATOR PARAMETERS				
Item	Parameters	Specification Concentration or Value (max) or State	Measurement Units	
1	Ammonium	0.5	mg NH ₄ /l	
2	Chloride (i)	250	mg Cl/l	
6	Conductivity (i)	2500	µS/cm at 20°C	
7	Hydrogen ion	9.5	pH value	
		6.5 (minimum)	pH value	
8	Sulphate (i)	250	mg SO ₄ /l	
10	Total organic carbon (TOC)	No abnormal change	mg C/l	
12	Turbidity	1	NTU	

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UK SULPHATE CLASSIFICATIONS AND LIMITS

BRE Special Digest 1 (SD1 : 2005), 3rd Edition : 17 June 2005

<u>SULPHATE CLASS</u>	<u>LIMITS *</u>
DS-1	<500 (mg/l SO ₄)
DS-2	500 – 1500 (mg/l SO ₄)
DS-3	1600 – 3000 (mg/l SO ₄)
DS-4	3100 – 6000 (mg/l SO ₄)
DS-5	>6000 (mg/l SO ₄)

** The limits for sulphate classes are based on 2:1 water/soil extraction test.*

UK SULPHATE CLASSIFICATIONS AND LIMITS

TRL Report TRL447 "Sulphate specification for structural backfills" Limits

TRL447	WS	OS
<i>recommended limits</i>	1500 mg/l SO ₄	0.3 %SO ₄

WS – Water-soluble Sulphate, mg/l SO₄

OS – Oxidisable Sulphides, % SO₄

END OF REPORT