DEFRA

Chemicals - Preliminary Cost Effectiveness Analysis

July 2007

Entec UK Limited

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Report for

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1. Introduction

1.1 Background

The Department for Environment, Food and Rural Affairs (Defra) is in the process of undertaking preliminary cost effectiveness analyses (pCEA) for a number of UK market sectors in order to determine the potential costs associated with implementing the requirements of the Water Framework Directive (WFD) for priority substances (PS), priority hazardous substances (PHS) under Annex X of the WFD and specific pollutants (SP) under Annex VIII.

Previous and on-going pCEA work can be summarised as follows. The Water Industry via UK Water Industry Research Ltd (UKWIR) project reference WW17, and more recently via a pCEA Supporting Document, has been conducting extensive investigations into the likely quality requirements of wastewater treatment works (WwTW) effluents to comply with proposed standards under the WFD. Other influences, such as Industry, Agriculture, Non-Agricultural Diffuse Water Pollution (NADiP) and Flood Risk Management, have been the focus of similar pCEA studies. Moreover, ICF, Atkins, Entec, RPA and other consultants have undertaken a number of sampling and analysis programmes, literature reviews, regulatory impact assessments (RIA) and economic analyses to determine the likely cost and benefits of options to achieve compliance and the associated level of uncertainty.

The UKWIR WW17 project (Atkins Ltd, RPA Ltd and ICF International, 2006), which considered a cost analysis of source control versus end-of-pipe treatment to achieve the required effluent quality, considered diffuse inputs of PS and SP as well as industrial discharges to sewers. The pCEA (Atkins, 2007) examined direct industrial discharges, industrial discharges via WwTW and NADiP although only end-of-pipe costs were considered. The RIA carried out by RPA considered three options relating to the implementation of the WFD Environmental Quality Standards (EQS): 'do nothing'; meeting EQS through end-of-pipe controls; and meeting EQS as well as the requirement for cessation of PHS through end-of-pipe and other controls. Other relevant studies and consultations have included Environment Agency (EA) pollution reduction programmes (PRP) for specific pollutants, pilot Supplementary Plans and Action Plans for individual PHS, and studies of impacts of EU-wide bans, restrictions or charges for the use of specific substances. The previous work has been largely successful in identifying substances for phase out, reduction or pollution prevention, and highlighting those for which there may be concerns regarding compliance with EQS by 2015.

In order to better understand the extent and nature of the gap in water quality that needs to be tackled to achieve the WFD objectives, a number of scenarios have been developed. These help define an estimate of the starting point prior to WFD implementation ('bottom of the gap') and the uncertainty surrounding cost estimates. Measures range from those immediately applicable (e.g. already approved and funded) but at high costs and with further actions likely to be needed under WFD to those that may rely on other Directives, policies and initiatives closing the compliance gap and therefore less direct action under WFD.

The key issue is to develop alternative scenarios that encompass all likely outcomes based on the view of disproportionate costs and the certainty of achieving targets. This synthesis report considers both measures that use existing knowledge and technology to address reduction in selected chemicals (and therefore represent high certainty of achieving WFD targets) and measures that may rely on innovation, anticipated technological advances or voluntary actions (and are therefore associated with higher uncertainty).

1.2 Aims and Objectives

This report contains the results of a concentrated effort to consolidate knowledge and information from previous studies to re-define the scenarios that seek to address the gap in chemicals compliance with WFD objectives. This aims to highlight measures and their associated affordability and uncertainty, as well as the effects of phasing measures. This study has been limited by the amount of data and information that was available within the timeframe, as much of the related work is still on-going or was not completed in time to be included in this review.

It should be noted that 42 priority substances (33 PHS and PS, and another 9 SP) identified in WFD have been considered in this report, with the main focus on a selected sub-set of these substances at (medium or high) risk of invoking EQS failures in 2015. Copper and zinc have also been acknowledged as posing current compliance problems. Measures in this report generally refer to freshwater and, although they could potentially apply to both surface water and groundwater, there has been no specific consideration of groundwater issues.

The overall aim of this report is to summarise the measures previously identified in other studies and consultations, attempt to reconcile discrepancies in cost estimates, select suitable measures for each substance and sector under two broad scenarios, and estimate their affordability and the uncertainties associated with achieving WFD objectives.

Most of the measures collated in this report are based on previously conceived scenarios and categories; however the following scenarios are also introduced:

Scenario 1: Limited phasing - do everything by soonest date (unless technically infeasible).

Scenario 2: High level phased action - put off taking action where it might not be proportionate. This scenario allows time for existing measures to close the gap and may rely on more innovative measures.

In order to categorise the potential measures according to the above scenarios, there is a need to examine positive and negative trends in the usage and freshwater concentrations of the various WFD priority substances and existing (or anticipated) pressures in various sectors. The possibility of certain sectors offering increased contribution and the phasing of measures is also considered.

The objectives of this report are to:

- summarise the main trends and pressures identified within the various sectors relating to specific chemicals and substances (Section 3);
- summarise the apportionment between sectors and the identified levels of uncertainty relating to specific sectors and chemicals (Section 4);

- consider and group measures targeting chemicals in the various market sectors under the scenarios introduced above (Section 5);
- estimate the potential costs and/or affordability of selected measures under the scenarios introduced (Section 6);
- discuss measures to reduce uncertainties and any further considerations (Section 7).

Attention should be given to the assumptions made within each of the individual reference studies and reports. A list of references is given in the last section of this report. A full cost assessment of marketing and implementing the proposed measures was outside the scope of this report.

2. WFD Objectives

2.1 General Objectives

The Water Framework Directive sets out the following default objectives for the water environment:

- Prevent deterioration of the status of all surface water and groundwater bodies;
- Protect, enhance and restore all bodies of surface water and groundwater with the aim of achieving good status for surface water and groundwater by 2015.

In order to achieve good status a water body must achieve both good chemical status and good ecological status.

- Good chemical status requires achievement of all EQSs, set by the EC, for priority list substances in Annex X; for certain other pollutants set out in Annex IX [namely carbon tetrachloride, cyclodiene pesticides (aldrin, dieldrin, endrin, isodrin), DDT, tetrachloro-ethylene, trichloroethylene] and in other earlier directives (such as the Freshwater Fish Directive 78/659/EEC).
- Good ecological status requires achievement of all EQSs set at a Member State level for Specific Pollutants. In the first River Basin Planning round UKTAG are proposing that there will be standards for nine such substances. In addition, there are standards for other ecological elements (e.g. macroinvertebrates, phytoplankton and fish).

Alternative objectives cannot be set without first assessing the measures (including costs and technical feasibility) that might be needed to achieve good status by 2015. Any indicative measures and costs that are proposed in this report will not determine the costs of implementation, as these will depend on the objective setting process.

2.2 Priority List Substances

Thirty three priority list substances are identified in Annex X of the Water Framework Directive. The Directive aims to achieve the progressive reduction of discharges, emissions and losses of all priority substances. In recital 4 of Decision 2455/2001/EC it was recognised that for substances occurring naturally, or produced through natural processes, such as cadmium, mercury and PAHs, complete phase-out is impossible. The Directive anticipates that an Article 16 Priority Substances Daughter Directive will establish a date for cessation of 20 years or less within agreement of a proposal. The latest text of this daughter Directive does not contain a date for cessation to be achieved but requires that the Commission shall, by 2025, verify that emissions discharges and losses are making progress towards these targets.

The EU Presidency proposal for the daughter Directive was agreed at Environment Council on 28 June, but a second reading in European Parliament will be required before a final text is agreed. If agreement is not reached conciliation may be required. The revised proposal text will be publicly available after Environment Council.

The list of PS required by the Directive was agreed in 2001. However, under Article 16(4) of the Directive, the European Commission must review the priority list of substances in Annex X, which are used to determine good chemical status, every four years. This will next be reviewed in 2008. The European Parliament has proposed amendments to the daughter Directive that, if agreed, require the Commission to consider the addition of a further 28 substances to the priority list and the elevation of 11 existing PS to PHS status. These changes may lead to an expansion of the priority list in 2008 but the subsequent derivation of EQSs will be time consuming and thus their potential inclusion has not been considered in the pCEA.

The current proposal for the daughter Directive would introduce legally binding EQSs for 9 substances for which the UK does not currently have statutory standards.

The following aspects of the current proposal are particularly significant when assessing the costs of implementation:

- WFD Article 4 exemptions apply to the objective of achieving the EQSs, and thereby allow for less stringent objectives and extended timescales to achieve good status where measures are technically infeasible or disproportionately costly. In such cases alternative objectives can be set and the Directive allows extension of the timetable for achieving good status by up to 12 years, or to set an objective that is less stringent than good status.
- WFD Article 4 exemptions also apply to the objective of "aiming to" cease emissions, discharges and losses of PHS and progressive reduction of discharges emissions and losses of PS.
- A flexible approach to sediment and biota obligations is allowed. Rather than Member States ensuring that concentrations of PS do not increase in sediment and biota, long term trend analysis of concentrations is now proposed together with an objective, subject to WFD Article 4 provisions, to aim to ensure that concentrations of relevant PS (currently this list comprises hexachlorobenzene, hexachlorobutadiene and methyl mercury, but may be further expanded) do not significantly increase in sediment and biota.
- Natural background concentrations may now be taken into account when assessing compliance with the metal EQSs.
- EQSs apply only to bodies of water and therefore do not apply to territorial waters or small water bodies.
- The requirement for the progressive reduction of mixing zones has been removed.

2.3 Specific Pollutants

In the first River Basin Planning round UKTAG are proposing standards for nine Specific pollutants: 2,4-D ester and non-ester; chromium; cypermethrin; diazinon; dimethoate; linuron; mecoprop; phenol; and toluene.

UKTAG has also evaluated a further 9 substances as potential Specific Pollutants: 2,4-dichlorophenol; ammonia (un-ionised); arsenic; chlorine; copper; cyanide; iron; permethrin; and zinc. UKTAG proposes that the existing standards for these substances are retained in the interim period and also that existing standards for a further 12 dangerous substances are also retained on this basis. None of these substances would be designated as Specific Pollutants and they will not therefore be used in determining good ecological status.

The additional 12 substances are: bentazone, biphenyl, 4-chloro-3-methylphenol, chloronitrotoluenes, 2-chlorophenol, dichlorvos, fenitrothion, malathion, 1,1,1-trichloroethane, 1,1,2-trichloroethane, triphenyltin, and xylene. UKTAG has also considered aluminium, manganese and tetrachloroethane, for which there are no existing EQS; no formal recommendations have been made, but standards may be proposed in the future.

2.4 Other Objectives

- For both surface and groundwater bodies there is a 'no deterioration in status' objective. This aims to prevent deterioration from 'good' to 'less than good' for surface water bodies and from 'good' to 'poor' chemical status for groundwater bodies.
- For groundwater – to prevent or limit the input of pollutants into groundwater; and to aim to achieve 'good chemical status' and 'good quantitative status'. Measures to reverse significant and sustained upward pollutant trends must also be implemented. The 'prevent or limit' objective ensures that the regime established by the original groundwater directive (80/68/EEC) is maintained when it is repealed by the WFD in 2013. The main difference is the move away from listed substances (Lists I and II) to hazardous and non-hazardous substances. In practice, this results in no significant change to current regulatory practices for chemicals. If all the 'prevent or limit' requirements are met, all the other WFD objectives for groundwater quality (and some for associated ecosystems) will naturally follow. That is, the groundwater body would be at good groundwater chemical status, would not show any significant and sustained upward trends and would meet protected area requirements, including those under WFD Article 7 (Drinking Water Protected Areas).
- The WFD requires that specific Article 7 objectives should be set for each drinking water protected area where necessary. The overriding aim of Article 7 is to "ensure the necessary protection for the bodies of water identified with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water". Local objectives may vary depending on the risks within a catchment and the level of treatment already installed. For pesticides, at a national level, it is considered that the risk of exceeding 0.1 ug/l should be the benchmark for initial risk assessment since any exceedance could trigger the need for treatment. However this initial assessment will then need to be moderated by local factors including the extent of any treatment, the ability to remove different pesticides and the potential for peak values to impact plant operation. Importantly, compliance with Art 7 objectives will be assessed at the point of abstraction, not at water body level, and thus it will

be permissible for attenuation mechanisms within the catchment to be taken into account in deploying remedial measures.

3. Pressures and Trends

3.1 Extent of Pressures and Trends

Previous work has identified a number of substances for which there is a large gap or a high estimated extent of failure, and existing measures (under other Directives and initiatives) will not be sufficient to ensure EQS compliance. An EA study (*Provisional List of Substances for Regulation 16 Supplementary Plans, 2007*) has estimated the extent of failure based on current EA monitoring data held on its Water Information Management System (WIMS). Specific pollutants have been studied in a recent UKTAG report (UKTAG, 2007), which provides the likely implications of introducing (or revising) EQSs in terms of failure of standards at existing freshwater monitoring sites. There are also EA strategic assessments and other reports providing an account of emerging pollutants, and other on-going work attempting to define the risks of failure associated with certain pollutants.

The diffuse nature of the main sources of certain chemicals (e.g. pesticides in agricultural run-off, heavy metals in urban run-off and mine drainage etc) means that it is difficult for the existing monitoring network and sampling frequencies to adequately capture the impact on surface water quality. Instead existing data provide a snapshot of water quality at specific times throughout the year (due to reliance on spot sampling). Therefore, there is a significant uncertainty associated with extrapolating the monitoring data. Additional monitoring (e.g. seasonal or more frequent) may be required for substances with significant failures in order to prove/disprove compliance issues.

Additional complexity arises when considering metals; these are not created or destroyed within the natural environment but rather exist in various forms and states, some of which are more bio-available, toxic and hazardous than others. Again much of the available freshwater quality monitoring data do not differentiate between the various states and toxic forms of heavy metals. There is a wide range of sources of metals, from industrial and manufacturing processes to domestic uses and disposal of consumer goods, corrosion, agriculture, mining activities, waste disposal sites and urban/highway run-off. The use of monitoring data is further limited when considering metals, as their background concentrations tend to rely on the underlying geology and are therefore catchment specific.

Some of the above issues are summarised in Table 3.1 which details the pressures facing a number of PS, PHS and SPs, the observed (and predicted) trends in their usage and concentrations in freshwaters, and the extent of anticipated EQS failure by 2015 (indicated as *high, medium, low*) based on forecast usage and availability of water quality monitoring data. Copper and zinc have been included in this table, despite not being priority or specific pollutants, because of their potentially high extent of EQS failures.

Table 3.1 Pressures, trends and anticipated extent of failure by 2015

Substance	Pressures / Trends	Estimated Extent of EQS Failure
Alachlor (PS)	Banned and not used in UK for several years.	Expected to be *low*
Anthracene (PHS)	Present at 1% in crude coal tar. Declining diffuse inputs; creosote use restricted. Industrial sources now have to report to EA (since 2007). Detected downstream of industrial sources and old housing estates.	Likely to be *medium*, as there may be long-term legacy issues. However PPC action at coke ovens/coal tar distilleries and other source control will lower existing failures.
Atrazine (PS)	Herbicide. Failed Annex I approval. Usage cease by 2007. No current standards exceedances. Most commonly found plant protection product exceeding 0.1ug/l in groundwaters.	Expected to be *low* as shown by declining concentrations in water.
Benzene (PS)	High EQS leads to <1% exceedances. Need to ensure EQS is met at PPC sites (e.g. oil refineries) as it tends to be a localised pollutant.	Expected to be *low* as shown by current low levels of failure.
Cadmium and its compounds (PHS)	Restricted use in industry, but large diffuse sources (agriculture, mines, road runoff). Usage in phosphate detergents likely to go down (though not so for dishwasher detergents)	Likely to be *medium* due to expected ongoing use of P fertilisers and detergents in the future.
Chlorfenvinphos (PS)	Uses about to cease in UK. All usage to completely cease by 2009. No recorded exceedances.	Expected to be *low*
Chloroalkanes (C10-13) or Short Chain Chlorinated Paraffins (SCCP) (PHS)	Banned in metalworking and leather processing due to persistence, toxicity and bioaccumulation potential. It was phased-out in 2004 in metal working and fat-liquoring. Updated EU risk assessment showed the available data not adequate to justify risk reduction measures and suggested that further information and testing was necessary; as a follow-up the Commission is preparing a regulation to oblige Industry to provide the missing data. Currently, a single SCCP producer in the UK (production of 2,500 ton in 2002); main use as a plasticizer/flame retardant. Use has declined significantly in recent years as SCCPs have been proposed as Persistent Organic pollutants to be completely banned.	Expected to be *low* due to phasing out and only a single source in UK. More monitoring data needed to confirm.
Chlorpyrifos (PS)	Annex I substance and up for re-registration in the UK next year. Usage could be subject to restrictions by 2015, although still considered by PSD. No downward trends in pesticide usage surveys, but more environmentally benign compared to other insecticides. Few EQS exceedances.	Likely to be *low* due to few current exceedances. However some uncertainty over on-going usage and no authorised alternatives at present.
Chromium VI and its compounds (SP)	Used in tanning and plating industry, but also found in runoff and mine drainage. Local emission sources in the UK result in	Expected to be *medium* due to continuing usage and historic sources.

	some failures (see Table 3.2).	
Cypermethrin (SP)	Widely used insecticide (sheep-dip, agriculture and forestry); tends to sorb to sediment. Suspended in sheep dip products in England in February 2006, and subject to Sheep Dip PRP. Exceedances are often recorded (see Table 3.2) Plant Protection Uses: Listed on Annex I and products currently being re-registered at UK level.	Likely to be *low/medium* low (if its use in sheep dip remains suspended). Presently no evidence to suggest impacts from use in agriculture and forestry but this could be verified by further targeted monitoring (e.g. seasonal).
Diazinon (SP)	Organophosphorus insecticide used in veterinary applications (e.g. sheep dip). Temporarily suspended use in sheep dip in UK in 1999, but currently unrestricted. Low levels of failure (see Table 3.2), but there are localised EQS breaches in sheep farming areas (e.g. in the River Aire which receives most of the UK treated wool scouring effluent).	Expected to be *low* due to current low levels of failure (despite substantial usage). However, further monitoring data need close observation to confirm trend (Note: If cypermethrin is withdrawn then diazinon would the only alternative dip product, therefore contamination risks may go up)
1,2 dichloroethane (PS)	Usage will decline due to proposed restrictions on use in paint stripper. Less than 0.2% failures recorded.	Expected to be *low* due to restrictions in use and current low levels of failure.
Dichloromethane (PS)	A common solvent and cleaning agent. Low levels of EQS failure. Proposed restrictions on use in paint stripper.	Expected to be *low* due to restrictions in use and current low levels of failure.
Di(2-ethylhexyl) phthalate (or DEHP) (PS)	Used in textile, paper and plastics industry. Diffuse leaching from plastic pipes. Outdoor uses may be restricted in future (e.g. PVC in contact with water). Very limited monitoring to date. A UKWIR study identified significant releases from newly built housing estates.	Likely to be *medium/high* due to ubiquitous uses and uncertainty over future restrictions. Further monitoring data needed.
Dimethoate (SP)	Widely used insecticide. Listed on Annex I, with re-registration of existing products forthcoming. No information on proposed restrictions in use. No evidence of exceedances (see Table 3.2).	Likely to be *low*, but some uncertainty remains due to wide usage; further monitoring needed.
Diuron (PS)	Many amenity, urban and engineering applications. Significant decline in UK usage and subject to phase-out (UK use to cease) by 2009. Some EQS exceedances recorded, including some one off incidents which resulted in temporary closure of drinking water intakes.	Expected to be *low* due to forthcoming ban.
Endosulfan (PHS)	Formerly widely used organochlorine pesticide, but very significant decline in UK in recent years (only one company approved to use it in production). Relevant products will be phased out in June 2007, and EU-wide ban expected. No recorded exceedances.	*Low* due to falling usage and applications and phase-out.
2,4-D ester and non-ester (SP)	One of the most widely used herbicides with many agricultural and amenity uses. No information on proposed restrictions in use. Listed on Annex 1 and products have passed re-registration at UK level. Only occasional failures reported (see Table 3.2).	Uncertain but likely to be *low* as shown by few current failures (and despite heavy usage). More monitoring data are needed to confirm.
Fluoranthene (PS)	No specific controls on use. Few recorded	Likely to be *low*. Ongoing

	exceedances. See comments on PAH.	monitoring to confirm.
Hexachlorobenzene (PHS)	Worldwide ban in 2004. No recorded exceedances.	*Low*
Hexachlorobutadiene (or HCBD) (PHS)	No production in the UK or EU. May be present in the environment due to unintentional sources (e.g. landfill deposition, manufacture of solvents and chlorinated hydrocarbons). UK EQS compliance was 98.8% in 2003.	*Low* as shown by available monitoring data and falling trends
Hexachlorocyclohexane (or Lindane) (PHS)	No current uses in UK. All usage expected to cease by 2008. Persistent organic pollutant. May be available through imported products (seeds, textiles) but this will decline to zero by 2015.	Expected to be *low* due to restricted use. Availability from legacy use expected to cease, as already steadily declining trend in EU waters.
Isoproturon (PS)	Major uses as pesticide in wheat and cereals in UK; few -if any- cheaper alternatives. Listed on Annex I but failed UK re-registration process. Will be phased out (UK use to cease) by 2009. Commonly detected in surface waters but few EQS failures at current UK EQS.	*Low* due to expected restrictions/ban. Some uncertainty as EQS failures are being recorded despite reasonably high EQS.
Lead and its compounds (PS)	Numerous industrial, agricultural, and non-agricultural diffuse sources. Likely concentrations in tap water are likely to be reduced to 10 µg/l by 2015.	*Medium/high*, as it is a natural element that will always be present in diffuse sources.
Linuron (SP)	Common herbicide. No information on proposed restrictions in use. Listed on Annex I and products have passed re-registration at UK level. Very low level of failures (see Table 3.2).	Likely to be *low*, but some uncertainty remains; further monitoring data are needed
Mecoprop (SP)	Common herbicide with agricultural and amenity uses. Identified by EA as a potential substance of concern in groundwater. No information on proposed restrictions in use. Listed on Annex I and products have passed re-registration at UK level. Commonly found in surface waters but fewer failures of current UK EQS (see Table 3.2) compared to diuron and isoproturon.	Likely to be *low*, but some uncertainty remains; further monitoring data are needed.
Mercury and its compounds (PHS)	Extensive withdrawal from market (batteries, industrial discharges, electrical equipment); compulsory fitting of dental amalgam traps. UK chloralkali plant due to convert to mercury-free technology by 2020. EU mercury strategy anticipated. Exceedances recorded; some uncertainty with measurements below LOD.	Likely to be *low*/*medium*, as there will still be some usage by 2015 and also due to natural occurrence.
Napthalene (PS)	Some industrial PPC sources. ESR substance but no risks identified. Relatively few exceedances recorded. Additional control may be required.	Likely to be *low*, but some uncertainty over diffuse inputs and industrial uses needs to be resolved through more studies/monitoring data
Nickel and its compounds (PS)	Subject of ongoing ESR, but no known specific controls imposed. Some failures recorded.	Likely to be *medium* due to uncertainty over diffuse inputs, legacy issues (e.g. mine drainage) and lack of controls.
Nonylphenols (PHS)	Extensive restrictions on use. Maximum 0.1% in products as of 2005. Further	Expected to be *low* due to restrictions and declining trend.

	phasing out expected. Some exceedances, but expected to go down as restrictions are being applied.	
Octylphenols (PS)	Some restrictions expected to be imposed in future. Lower usage than nonylphenols. No evidence of EQS failures. A risk reduction strategy has been proposed by the UK.	Expected to be *low*
Polyaromatic Hydrocarbons (or PAH) (PHS)	Unintentional products; subject to air emission control. Declining trends in EU, but expected to tail off by 2015. Lack of sufficient monitoring data.	Likely to be *low* but some uncertainty due to lack of production control and some natural and diffuse inputs (e.g. runoff). Further studies/monitoring data are needed to reduce uncertainty.
Pentachlorobenzene (PHS)	No production in the UK or EU. Banned since 2001. There may be imports as wood treatment and textile preservation agent. May be present in the environment due to unintentional sources (e.g. as a contaminant in hexachlorobenzene)	Expected to be *low* due to ban, but monitoring data needed to verify.
Pentabrominated diphenylethers (or PeBDE) (PHS)	Some expected decline as it is banned from use in furniture since 2005. Low confidence in monitoring data, as these tend to report total brominated diphenylethers (penta, octa and deca).	Likely to be *low/medium* due to sources from old furniture and other diffuse sources; also very low EQS.
Pentachlorophenol (PS)	Restricted use (M&U restrictions), complete withdrawal by 2009. No evidence of failures.	Expected to be *low*
Phenol (SP)	Widely used in manufacturing and process industry. Readily biodegradable in water. No information on proposed restrictions in use. Some failures (mainly in Wales; see Table 3.2) despite relatively high EQS.	Likely to be *low*, but some uncertainty remains; further monitoring data are needed.
Simazine (PS)	Usage to cease by 2007. Commonly detected in surface waters but very few recorded failures of UK EQS.	Expected to be *low* due to phase-out. Monitoring data needed to clarify any effects due to persistence from heavy historic use.
Toluene (SP)	Extensive use in manufacturing and process industry. Biodegradable in water. No information on proposed restrictions in use. Low levels of failure.	Likely to be *low*. More monitoring data are needed to confirm.
Tributyltin (or TBT) (PHS)	Not produced in the UK (however, production in Germany, Italy and Netherlands). Banned under the Biocidal Products Directive from being marketed in the EU for biocidal purposes. Numerous potential sources to the environment, as emissions may arise from waste disposal and/or other activities that disturb stocks of TBT in the environment. Present as contaminant in PVC. Potential presence in imported goods (e.g. textiles, treated wood products). Historical sediment contamination may be a key issue for continuing EQS failure. One of the most damaging, persistent and widespread pollutants.	*High* as identified by regular EQS breaches. Historic legacy of contamination is slowly declining, but high persistence and bioaccumulation.
Trichlorobenzene (PS)	ESR substance but no known restrictions. There may legacy issues from	Expected to be *low*

	contaminated land. No failures recorded.	
Trichloromethane (Chloroform) (PS)	Present in pharmaceutical and CFC manufacturing. Unintentional by-product in pulp and paper industry. May also be generated in sewers (i.e. some potential for diffuse sources). Exceedances are commonly recorded.	Likely to be *medium/high* due to uncertainty over future restrictions, unintentional production and diffuse sources.
Trifluralin (PS)	Many current uses as herbicide for low margin crops, as it is cheap and effective. Expected to be withdrawn by 2009. Very few exceedances.	Expected to be *low*. Monitoring data to confirm, as there may be some effects from current applications and current steady trend in usage.
Copper	Many everyday uses, point and diffuse sources. Several exceedances due to low EQS, which is not reflective of the fact that copper complexing in the environment renders much of it non-bioavailable.	*High* due to continuous usage and number and type of sources.
Zinc	Used in a variety of manufacturing industries. Also in diffuse sources. Several exceedances recorded.	*Medium/high* due to continuous usage and number and type of sources.

The projected failures of Specific Pollutant standards in England and Wales, as reported by UKTAG, are presented in Table 3.2 below; very limited data were available for Scotland and Northern Ireland. The response to anticipated failures of standards will be part of the UK's Programmes of Measures developed by the Environment Agency under the WFD and will be informed by the water quality policies. Cypermethrin and phenol (in Wales only) have the highest projected extents of failure; chromium failure in saltwater sites is also notable.

Table 3.2 Projected extent of failure for Specific Pollutants in England and Wales (UKTAG, 2007)

Substance	England		Number of sites monitored	Wales		Number of sites monitored
	Face Value	*95% confidence*		*Face Value*	*95% confidence*	
			Per cent of monitored freshwater sites Not Good			
2,4-D ester and non-ester	0.4	0.0	509	0	0.0	23
Chromium	5	2	2424	7	2	236
Cypermethrin	21	1.9	316	19	0	257
Diazinon	4	1.7	485	8	1	247
Dimethoate	0.0	0.0	348	0.0	0.0	200
Linuron	0.2	0.0	480	0	0	67
Mecoprop	2.4	0.1	619	0.0	0.0	78
Phenol	1.6	0.3	681	17	6	103
Toluene	2	0.0	378	0.0	0.0	67
			Per cent of monitored salt water sites Not Good			
2,4-D ester and non-ester	0	0	77	-	-	0
Chromium	21	3	788	10	2	105
Cypermethrin	6	0	16	-	-	0
Diazinon	5	0	88	-	-	0
Dimethoate	0.0	0	114	-	-	0
Linuron	0.0	0	72	-	-	0
Mecoprop	3	0	73	-	-	0
Phenol	0	0	64	29	0	24
Toluene	0.0	0	111	0	0	3

This section has highlighted the following 11 substances as having a medium or high potential of failing WFD EQS in 2015: anthracene, cadmium, chromium, cypermethrin, DEHP, lead, mercury, nickel, TBT, trichloromethane and PeBDE. Copper and zinc, although not in the WFD priority list, are also recognised as currently causing numerous EQS failures due to their many everyday uses and number of sources.

3.2 Implications of Measures and Regulations

When forecasting the extent of failures of EQS in 2015, it should be born in mind that a number of measures, such as bans or restrictions on uses, will have a significant effect on the trends in usage of certain substances; it can therefore be reasonably expected that certain measures will help reduce the present gap between existing EQS failures and the WFD targets by 2015.

In particular most pesticides on the EU priority list are subject to be withdrawn from the EU market by 2009 as a result of review work under the Plant Protection Products Directive. The latest information on pressures and trends in pesticides, insecticides and herbicides will be contained in the pesticide report (as part of the Agriculture Sector pCEA) that is currently being compiled by the Working Group; only a draft version was available at the time of compiling this report. The draft states that the precise size of the compliance gap between the current levels of pesticides in water and the position needed in 2015 to meet WFD requirements cannot be accurately described at present due to a lack of environmental information on pesticides. The EA's surface water monitoring programme is being reviewed to give a more representative programme, and risk mapping is being undertaken to improve knowledge of the gap. In addition the European Parliament is currently seeking to extend the pesticides list by adding other substances of concern including glyphosate, its main metabolite AMPA, quinoxyfen and bentazone.

Whilst some substances are being withdrawn and will stop being detected in rivers, for the remaining ones the risk levels of contamination may go up as their percentage share of the market increases. Changes in cropping patterns as a result of CAP reform, climate change or other factors are also a major influence on the types of pesticides used and therefore the levels detected in freshwater. For example, pesticides used on oil seed rape are now being found more frequently and at higher levels as the market for biofuel crops expands. A proposed EU directive on the sustainable use of pesticides is under discussion.

Other measures that are under way, about to be implemented or under consideration include:

- Dental amalgam traps at dentist practices under Hazardous Waste Regulations.
- Phosphorus and ammonia removal at Wastewater Treatment Works as part of AMP4 and AMP5; some co-removal of priority substances may be achieved in tertiary treatment (e.g. cadmium).
- Existing Substances Regulation risk reduction strategies, e.g. EU Mercury Strategy.
- Replacement of PeDBE in new furniture (and other similar replacement actions in various household items/products).
- REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals. This applies to all substances produced or imported into the EU over 1 tonne. Substances have to be registered according to a phased timeline. Substances of most relevance to the WFD due to high toxicity or used in large volumes have to be registered by 2012. If these substances are dangerous, a chemical safety assessment has to assess the any risks from all known uses throughout the supply chain, including disposal. Risk management has to be proposed and communicated down the supply chain to address these risks. Subsequently, the most dangerous

substances have to be authorised for their use to continue. These include persistent, bioaccumulative and toxic substances (as a number of PHS are likely to be). The assumption is that these substances cannot be adequately controlled; specific uses can still be authorised on socio-economic grounds but the registrant has to bring forward plans for phasing out.

- Extension of Environmental Stewardship and English Catchment Sensitive Farming Delivery Initiative (ECSFDI) countrywide.
- Environment Agency Sector Plans setting out strategic objectives for certain sectors they regulate (e.g. chemical industry) and for certain key sectors they want to work in partnership with (e.g. retail and construction sectors).
- Revision of the Integrated Pollution Prevention Directive.
- The EC Thematic Strategy on Pesticides, which includes a proposed new Directive on the Sustainable Use of Plant Protection Products, and replacement of the existing authorisations Directive (91/414) for plant protection products with a Regulation.
- Pesticides Voluntary Initiative.
- UK Strategy for the Sustainable Use of Plant Protection Products, and its associated action plans (including one on water).
- Memorandum of Understanding with Network Rail on use of plant protection products on railways and stations.
- Development of alternative pesticides, herbicides, cleaning agents etc using less persistent and toxic substances.
- Commissioning of additional studies and monitoring programmes (by Defra, EA, UKTAG etc) to better understand the fate, toxicity and pathways of certain pollutants (e.g DEHP, heavy metals, pesticides etc) and the efficiency and affordability of treatment methods (e.g. membrane technology, Biological Aerated Filters etc).
- Measures to control accidental production/release of unintentional by-products in industry.
- UK chloralkali plant conversion to mercury-free technology (by 2020); mercury crematoria abatement.
- Possible introduction of Water Protection Zones (similar designation to Nitrate Vulnerable Zones).
- Endocrine Disruption demonstration Programme: investigating the cost and effectiveness of sewage treatment technologies to address feminisation of fish in rivers from oestrogenic steroids.

4. Apportionment and Uncertainty

This section consolidates the findings and information contained in various reports, such as the UKWIR report, Working Group pCEA reports, the UKTAG and EA PRP reports, which relate to apportionment issues between the various sectors and identified levels of uncertainty for specific substances.

Table 4.1 summarises the uses and sources of selected substances for each of the main sectors and highlights gaps in knowledge and uncertainties.

The table firstly lists substances with an identified gap or with a medium / high estimated extent of EQS failure by 2015 (see Table 3.1), followed by all remaining substances that can be considered as having good certainty of achieving EQS compliance.

Table 4.1 Sources of pollutants and uncertainties

Substance name	Industry	Water Industry – Trade effluent	Water Industry - Domestic	Non-agricultural diffuse pollution	Agricultural sources	Uncertainties / Comments
SUBSTANCES OF CONCERN (with a potentially large gap)						
Anthracene (PHS)	Coal tar production from coke ovens; coal tar distillation; carbon black manufacture using anthracene oils; industrial wood preservative (creosote)		Present in old housing (due to creosote use)	Leachate from creosote coated objects; combustion of organic matter; road runoff due to incomplete combustion of fossil fuels		The presence of anthracene in liquid effluent from coke ovens and coal tar distillation has yet to be confirmed. Although amateur use of creosote is banned, industrial use is still permitted and as a Part B PPC or non-prescribed process releases are not regulated to water. Releases of anthracene to water from creosote-treated objects and coal tar have not been quantifie. Anthracene is always detectable due to some natural inputs.
Cadmium and its compounds (PHS)	Users of phosphate; municipal solid waste incineration; combustion for power generation; other industry (pigments, metal plating, batteries); transport	Users of phosphate/detergents; traces in other industry	Domestic use of detergent phosphates; may be associated with zinc and other metals from plumbing etc	Road runoff; impurity in detergent phosphates; landfill leachate; mining and abandoned mines	Application of biosolids (sewage sludge), manures, inorganic fertilisers, industrial wastes and compost	Cd is trace contaminant of phosphate; major source of Cd to land is P fertiliser, pig manures etc – a large knowledge gap concerns the extent to which Cd is deposited on, or released to, land and transferred to the aquatic environment. Domestic sources require further investigation; Cd load from abandoned mines and closed landfills is uncertain; natural element therefore will always be present as a diffuse source (though EQS failures are decreasing)
Chromium (hexavalent) and its compounds (SP)	Extensive use in plating industry and tanning; metal finishing and alloys;	Potential waste chemical from industrial sources		Ubiquitous, found in urban runoff; mine drainage; intermittent sewer discharges		The only significant sources are anthropogenic – natural sources are insignificant. EQS speciated so certain industrial effluent (tanning and plating) will be an issue. Diffuse sources

Substance name	**Industry**	**Water Industry – Trade effluent**	**Water Industry - Domestic**	**Non-agricultural diffuse pollution**	**Agricultural sources**	**Uncertainties / Comments**
	oxidising agent and catalyst; numerous other uses					not of great concern. Decreases associated with industry are stable. Cr(III) is less toxic than Cr(VI) and its low solubility in water limits its availability. Sources are natural and anthropogenic.
Cypermethrin (SP)	Wool industry (sheep dip)				Sheep dip; other insecticide uses (e.g. forestry)	Following the suspension of cypermethrin dip products in February 2006 a fall in pollution incidents from sheep dip was observed. There are concerns permanent removal of cypermetrhin dip products may compromise pest resistance. Reintroduction of products would require tougher pollution control measures and restrictions to be put in place on farms.
Di(2-ethylhexyl)-phthalate or DEHP (PS)	Textile industry; paper and pulp manufacture; manufacture of chemicals and plastics (plasticizer in soft PVC)	Potential waste chemical from textile industry, paper and pulp manufacturing, and manufacture of plastics	Leaching from plastic products such as pipes	Leaching from plastic products such as pipes		Inconsistent treatment removal, high levels entering WwTW, ubiquitous use, and diffuse leaching sources make it a priority
Lead and its compounds (PS)	Range of manufacturing industries such as batteries, pigments, alloys, ammunition, weights, PVC stabilisers; combustion processes in industry and energy production	Potential waste chemical from a range of manufacturing industries, combustion processes and energy production	Lead in old water supply distribution pipes	Numerous diffuse sources including mine drainage; fishing weights; ammunition; landfill	Sludge, compost, fertiliser and manure application	Natural element – will always be present as a diffuse source but decreasing continuously and relatively few EQS failures; industrial inputs also declining; a large knowledge gap concerns the extent to which Pb is deposited on, or released to, land and transferred to the aquatic environment
Mercury and its	Chemical industry –	Potential waste	Tooth wear/erosion	Road run-off; disposal	Mobile machinery and	The UK chloralkali plant is due to convert to

Substance name	Industry	Water Industry – Trade effluent	Water Industry - Domestic	Non-agricultural diffuse pollution	Agricultural sources	Uncertainties / Comments
compounds (PHS)	mercury cell chloralkali installations; dental industry (dental amalgam); batteries; lighting; measurement and control equipment (thermometers); electrical control and switching equipment; coal burning/ combustion processes	chemical from a range of manufacturing industries, dental surgeries, coal burning/combustion processes	of dental amalgam fillings; also thermometers and batteries	of wastes to landfill; spillage or breakage of mercury-containing equipment. Also some natural sources.	combustion.	mercury-free technology by 2020; there are some uncertainties regarding estimation of releases. Natural sources might be significant but decreasing and relatively few EQS failures. Compulsory fitting of dental amalgam traps at dentist surgeries.
Nickel and its compounds (PS)	Manufacture of chemicals and metal products (e.g. alloys); thought to be present in more than 300,000 products. Also, combustion for industry and power generation. One UK nickel refinery.	Potential waste chemical from a wide variety of industries; combustion for industry and power generation		Leachate from nickel-coated products/landfill; runoff; mining and abandoned mines	Manure, compost and fertiliser use	A large knowledge gap concerns the extent to which Ni is deposited on, or released to, land and transferred to the aquatic environment. Ni load from abandoned mines and closed landfills is uncertain. Also some naturally occurring sources.
Pentabrominated diphenylethers (PeBDE) (PHS)	Flame retardants		Present in domestic sewage (e.g. transfer to clothes etc) from use as a fire retardant in fabrics and upholstery	Thought to be present in diffuse sources (due to legacy/historic uses)		Marketing and use now banned in the EU. Slow replacement of home furnishings will see die away with time. Very low solubility means rarely detected in water but very low EQS leads to exceedances. More likely to be an issue in biota.
Tributyltin compounds (TBT) (PHS)	Industrial processes such as stripping TBT from ship hulls; wood preservative;	Contaminant in effluent from industrial processes, such as	Potential release from use of other tin compounds (contaminated with	Boats and ships (antifouling paint) – now banned; runoff from timber yards;	May be present in sewage sludge used as fertiliser (likely to be	Extent of releases to the aquatic environment is uncertain. TBT can be present at low levels as an impurity in PVC stabilisers and catalysts. Regular EQS breaches due to historic legacy of

Substance name	Industry	Water Industry – Trade effluent	Water Industry - Domestic	Non-agricultural diffuse pollution	Agricultural sources	Uncertainties / Comments
	possible contaminant in other chemical plants. May be present in imported textiles.	textile, wood preservative, other chemical plants	TBT) in PVC in contact with water. Possible domestic releases from imported textiles (minor).	contaminated sediments; leaching from affected products/landfill sites and waste disposal	minor)	contamination and some diffuse sources; this is slowly declining, but TBT has high persistence and bioaccumulation. Present information on levels of TBT in sewage sludge and sediments is limited.
Trichloromethane (or chloroform) (PS)	Chemical intermediate in pharmaceuticals and CFC manufacture. Potential releases from pulp and paper industry due to use of chlorine as bleaching agency (and in situ synthesis). Minor use in laboratories.	Contaminant in localised industrial inputs (e.g. pharmaceuticals). Evidence that it may be generated in situ in sewers (reaction of chlorine).	Limited potential domestic uses.	Potentially present in intermittent sewage discharges (due to in situ production in sewers).		Some uncertainty over sewer inputs, future restrictions on use and unintentional uses/sources.
SUBSTANCES OF LOW CONCERN (with a small gap)						
Alachlor (PS)					Historic herbicide use	Removed from UK market for some time. Few – if any- occurrences expected.
Atrazine (PS)				Historically used as a herbicide for verge side spraying but no longer used. Its persistence means that it is still detected, especially in groundwater.	Herbicide use	Agricultural issue only, usage will cease by 2007. Persistence and heavy historical use will make die away slower. Sporadic occurrences in WwTW effluent.
Benzene (PS)	Chemical industry, including			Detected in petroleum, so may be detected as		Marketing restrictions, volatility and relatively high EQS for solvents should not place this as

Substance name	Industry	Water Industry – Trade effluent	Water Industry - Domestic	Non-agricultural diffuse pollution	Agricultural sources	Uncertainties / Comments
	unintentional presence in a number of products as a result of combustion.			a result of spillage. Natural emission sources include volcanoes and forest fires.		a priority.
Chlorfenvinphos (PS)					Agricultural use as a pesticide	To be banned from 2008, rapid decrease expected. Agricultural issue only.
Chloroalkanes C10-13 (or Short Chain Chlorinated Paraffins – SCCP) (PHS)	Metalworking fluids; leather processing (these uses have been banned since 2004); plasticizer/flame retardant	Possible contaminant in effluent from plasticizer/flame retardant production				Banned in metalworking and leather processing due to persistence, toxicity and bioaccumulation potential. Concentrations should decrease; low solubility, relatively high EQS means low priority.
Chlorpyrifos (PS)					Agricultural use as a insecticide	Under review, so not heavily restricted, not used in urban catchments. Usage expected to cease by 2009. Has applications in both major and niche markets and there are a number of crop/pest situations in which there is no currently authorised alternative. Less toxic and persistent than most insecticides.
2,4-D ester and non-ester (SP)			Some limited domestic herbicide usage	Amenity herbicide usage	Widely used herbicide	Few current EQS failures despite heavy usage. More monitoring data are needed to confirm extent of potential failure.
Diazinon (SP)			Some domestic uses, e.g. to control ants		Organophosphorus insecticide with veterinary medicine applications.	Temporarily suspended use in sheep dip in UK (1999), but currently not restricted. Woolscouring effluent presently causes some EQS breaches, but overall low levels of failure. If cypermethrin sheep dip products remain permanently suspended or banned, diazinon is the only alternative active ingredient used in dips, thus levels of use would be likely to

Substance name	Industry	Water Industry – Trade effluent	Water Industry - Domestic	Non-agricultural diffuse pollution	Agricultural sources	Uncertainties / Comments
						increase.
1,2-Dichloroethane (PS)	Manufacture of dyes, plastics (PVC production), paints (paints stripper); industrial cleaning.	Possible contaminant in effluent from manufacture of dyes, plastics, paints.	Potential domestic uses (e.g. paint stripper, dyes etc)			Proposed restrictions on use in paint stripper. Volatility and relatively high EQS for solvents should not place this as a high priority. There may be localised issues with industrial inputs.
Dichloromethane (PS)	Range of potential industries including: solvents, cleaning agents, aerosols, foam blowing agents	Potential waste chemical from a range of chemical, plastic and rubber industries.	Potential domestic uses (e.g. cleaning agents, aerosols, paint stripper etc)			Proposed restrictions on use in paint stripper. Volatility and relatively high EQS for solvents should not place this as a high priority.
Dimethoate (SP)				May be potentially present in road runoff	Widely used organophosphate insecticide	Some uncertainty remains due to wide usage. Further monitoring needed, though no evidence of exceedances.
Diuron (PS)			Domestic pesticide usage.	Amenity use as a pesticide, e.g. used as a weed killer next to railways.	Commonly used as pesticide.	Significant decline in UK usage and subject to phase-out by 2009. May be sporadic failures due to current heavy usage and lack of existing alternatives.
Endosulfan (PHS)	Only one company approved to use it in production				Widely used in the past; now minor use in UK as organochlorine pesticide.	Under review, so not heavily restricted, but limited use within UK. According to the most recent data from the Pesticides Safety Directorate (PSD), there is only one company with approval in the UK for the use of endosulfan in pesticides. Falling usage and expected phase out of relevant products to begin in 2007.
Fluoranthene (PS)	A PAH associated with combustion plants (by-product), tar-based paints,	Possibly present as by-product in trade effluent.		Associated with incomplete combustion of fossil fuels, therefore potentially found in road		No specific controls on use, but very few recorded exceedances. (Also see comments on PAH).

Substance name	**Industry**	**Water Industry – Trade effluent**	**Water Industry - Domestic**	**Non-agricultural diffuse pollution**	**Agricultural sources**	**Uncertainties / Comments**
	fluorescent and vat dyes.			runoff.		
Hexachlorobenzene (PHS)	Historic use, now banned (since 2007); unintentional by-product in PVC			Potentially present in leachate from waste sites	Contained as a contaminant in pesticides and chlorinated organics	No recorded failures. Only potential issues from contaminated land.
Hexachlorobutadiene (HCBD) (PHS)	Historic use, now banned; unintentional by-product from chlorinated hydrocarbon and solvent manufacture			Potentially present in leachate from landfills and waste sites		Very low extent of failures. Only potential issues from contaminated land.
Hexachlorocyclohexane (Lindane) (PHS)	No current uses in UK. Potentially available through imported products.				Formerly used as insecticide, now banned.	Not expected in urban catchments, potentially residuals from rural catchments. No current uses in UK. All usage expected to cease by 2008, so that should see further reductions. May be available through imported products (seeds, textiles) but this should decline to zero.
Isoproturon (PS)					Agricultural use as a pesticide (wheat and cereals)	Isoproturon is, at present, the mainstay of weed control in cereals in the UK and also the most commonly used herbicide active substance in wheat. It is considered the most effective substance for a range of pests and is inexpensive compared with alternatives. Expected to be phased out by 2009.
Linuron (SP)			Some limited domestic herbicide usage may be expected.		Commonly used herbicide	Very low levels of failure, but some uncertainty remains; further monitoring data are needed.

Substance name	Industry	Water Industry – Trade effluent	Water Industry - Domestic	Non-agricultural diffuse pollution	Agricultural sources	Uncertainties / Comments
Mecoprop (SP)			Some domestic herbicide usage.	Amenity use as a herbicide in public areas. Also, commonly identified in landfill leachate arising from inappropriate disposal (following domestic use)	Commonly used herbicide	Fewer failures than diuron and isoproturon. Sometimes present in groundwater. Some uncertainty remains; further monitoring data are needed.
Naphthalene (PS)	Typically 10% in coal tar. Potential use in chemicals and metals industries; combustion by-product; wood preservative	Potentially present as contaminant in effluent from chemicals and metals industries	Limited potential domestic uses (e.g. mothballs).	Sometimes detected in run-off; found naturally in fossil fuels		Some uncertainty as to the extent of natural/unintentional sources. Only one industry (grinding wheels manufacture) identified as posing unacceptable risk.
Nonylphenols (PHS)	Chemical intermediate; industrial detergent	Detergent and wash waters from industry		Present in runoff particularly from light industry and car washes		Extensive restrictions on use. Maximum 0.1% in products as of 2005. Further phasing out expected.
Octylphenols (PS)	Chemical intermediate; industrial detergent	Detergent and wash waters from industry		Potentially present in runoff		Lower use than NP/NPE therefore not the same magnitude of problem
Polyaromatic hydrocarbons (PAH) (PHS)	Combustion by-products; bitumen industry, metal treatment	Potential waste chemical from combustion plants and bitumen industry		Road run-off; aerial deposition; other unintentional sources		Uncertainty over extent of unintentional production. Some natural inputs mean that PAHs will always be detectable; insoluble, so more of a concern in solids/sediments; slow decrease as cleaner fuels used
Pentachlorobenzene (PHS)	Intermediate in quintozene production; unintentional sources (e.g. as a contaminant in			Leaching from contaminated land		Might be present in contaminated land – banned since 2001. It might be present in limited imports, such as wood treatment and textile preservation agent.

Substance name	**Industry**	**Water Industry – Trade effluent**	**Water Industry - Domestic**	**Non-agricultural diffuse pollution**	**Agricultural sources**	**Uncertainties / Comments**
	hexachlorobenzene)					
Pentachloropheno l (PS)	Restricted use as biocide in wood and textiles					Marketing and use restrictions make it a low priority beyond specific industrial (legacy) inputs – complete withdrawal by 2009
Phenol (SP)	Widely used in manufacturing and process industries	Possible traces in industrial trade effluent		Sometimes detected in landfill leachate.		Some uncertainty remains due to wide usage; further monitoring needed
Simazine (PS)					Agricultural use as a herbicide	Agricultural issue only. Usage expected to cease by 2009. Persistence and heavy historical use will make die away slower. Sporadic occurrences in WwTW FE.
Toluene (SP)	Extensive use in manufacturing and process industries	Possible traces in some industrial trade effluent				Low levels of current failure, but more monitoring data are needed.
Trichlorobenzene (PS)	Chemical intermediate and process solvent			Leaching from landfills/ contaminated land		Some legacy issues may be expected from contaminated land.
Trifluralin (PS)					Agricultural use as a herbicide	Agricultural issue only, expected to be withdrawn by 2009. Trifluralin is used on cereals and on a wide range of minor crops, including beans, vegetable and animal feed brassicas, carrot, lettuce, etc. Some of the alternatives are generally less effective and more expensive.

5. Measures to Meet WFD Objectives

5.1 Substances Considered

The following substances have been identified in section 3 as having the potential to cause EQS failures in 2015 (and thereby affect WFD water body classifications):

Anthracene, cadmium, chromium, cypermethrin, DEHP, lead, mercury, nickel, TBT, trichloromethane and PeBDE.

It should be noted that no specific measures for cypermethrin control have been identified or included.

It is believed that all remaining substances have a substantially smaller or no compliance gap to close, as they are subject to existing (or agreed) controls, restrictions, bans and other regulations. Trends are downward and the extent of EQS exceedances is low at present and expected to be further reduced by 2015. It should be noted that some require further investigations and monitoring data to confirm the trends and low levels of failure, as previously highlighted in Table 3.1.

5.2 Scenarios and measures

5.2.1 Limited and High Phasing Scenarios

Two broad scenarios are considered in this section, under which the various control and mitigation measures can be categorised. These are defined as follows:

Scenario 1: Limited phasing - do everything by the soonest date possible, assuming technically feasible.

The emphasis is on actions that can be implemented immediately, therefore using available and tried technology and resources; this is likely to involve best available technologies (e.g. PPC controls) and end of pipe treatment. This scenario defines the maximum investment likely to be required to achieve WFD objectives relating to chemicals.

Scenario 2: High level phased action - put off taking action where not proportionate.

This scenario acknowledges that certain measures are likely to be more beneficial with a phased implementation. This may be because it is unaffordable for certain polluters to take immediate action, or due to lack of knowledge of the compliance gap (e.g. due to lack of monitoring data or poor understanding of the fate and pathways of pollutants) or currently insufficient technology (e.g. sand filters unable to remove chemicals to EQS levels).

Scenario 2 is based on a managed risk approach where initially only obvious cost-effective measures should be implemented. It relies on initiating additional investigation and monitoring programmes to increase both the certainty of estimation of compliance gaps and the certainty about source apportionment. Very importantly it includes a higher reliance on source control measures. This scenario defines the minimum investment likely to be required to achieve WFD objectives relating to chemicals.

Measures previously proposed in consultations and sector pCEAs available at the time of this study tend to refer to specific substances or groups of substances. Measures applicable to the eleven substances considered in this study are provided in alphabetical order in Table A, Appendix A. Any related costings that were available, the uncertainty and assumptions made to arrive at these costs, as well as a ranking according to scenarios 1 and 2 are also included.

5.2.2 Overview of Measures

Table 5.1 presents an overview of the type of measures considered for each scenario and for each major source.

Table 5.1 Measures applied in scenarios

	Scenario	
Sector	**1**	**2**
Direct industrial discharges	End-of-pipe controls based on the RIA analysis.	End-of-pipe control if and where source control will not deliver the required reduction; less need for end-of-pipe and phased investment up to 2027.
Industrial discharges to STW	Possible end-of-pipe controls if cost-effective compared to end-of-pipe control on WwTWs. No specific assessment of the number of measures.	Possible end-of-pipe controls if cost-effective compared to end-of-pipe control on the WwTWs; less need for controls compared to scenario 1.
Water industry	End-of-pipe controls for WwTWs at risk based on a combination of the RIA and the pCEA work.	End-of-pipe control if and where source control will not deliver the required reduction, less need for end-of-pipe and phased investment up to 2027.
NADiP	No proposed measures as there is too much uncertainty.	Investment in sustainable drainage systems, where cost-effective.
Agricultural diffuse pollution	No specific issues with pesticides, as most will be phased out before 2015.	No specific issues with pesticides, as most will be phased out before 2015.
Port activities (e.g. sediments)	Change in dredging practice to avoid sediment release based on the updated RIA analysis.	Change in dredging practice to avoid sediment release.
Substance specific	Monitoring and investigation.	Monitoring and investigation. Source controls.

The basic assumptions for Scenario 1 include:

- End-of-pipe treatment for industrial direct discharges is based on both the RIA and the pCEA results. There are limited differences in the total costs described in section 6. Up to 100 to 150 industrial installations with direct discharges may require additional treatment.

- No measures have been included in the cost assessment regarding industrial discharges to sewer. It is possible that additional pre-treatment of industrial discharges may be more cost-effective than adding tertiary treatment to the WwTWs, however in terms of total costs this is unlikely to have a significant impact. Therefore, although this option should be explored when determining specific local solutions, it is not crucial for the pCEA to determine the extent to which additional pre-treatment may be more cost-effective.

- For the water industry, the assumption is that about 10% of all WwTWs require additional treatment. This is the assumption used in the RIA study. In the UKWIR work, Atkins has estimated that the number of works requiring extra treatment could be up to 50% for certain substances; this higher percentage was based on PeBDE. Given that the use of PeBDE has been restricted and concentrations are expected to gradually decrease, this high percentage of works at risk may be an overestimate if based only on PeBDE. Although the scenarios here do not explicitly take derogations based on disproportionate costs into account, a lower percentage of works to be equipped with additional end-of-pipe treatment has been assumed under scenario 1.

- For non-agricultural diffuse water pollution no specific action is assumed under scenario 1. The current level of knowledge does not support identification of cost-effective measures.

- For pesticides it is assumed for both scenarios that no further action will be required.

- The assumption for sediments is based on the updated RIA, where it is assumed that the ports sector and others responsible for dredging will take measures to reduce or limit the temporary release of sediments during maintenance dredging.

The basic assumptions for Scenario 2 include:

- For direct industrial discharges, it is assumed that possible investment in additional treatment is phased so that one third of the level assumed for scenario 1 is undertaken before 2015. The remaining investment is in principle phased to be done by 2021 and 2027. It is further assumed that the effects of increased certainty about the gap in compliance and the effect of source control measures reduce the need for additional investment by 50% for the next two planning cycles. This reduced requirement could be a combination of fewer works at risk and lower unit costs for treatment.

- For water industry, similar assumptions are applied to those for industrial discharges. This means that only one third of investment is to be undertaken now, while the remaining WwTWs currently at risk will be equipped with tertiary treatment at the next planning rounds. It is assumed that either the number of works at risk is reduced by 50% or the costs are reduced by 50%.

- For non-agricultural diffuse water pollution it is assumed that sustainable drainage systems are put into place where cost-effective. Although these systems, for example filter stripes or detention ponds, can reduce the load of nutrients as well as

PSs, it is assumed that they are only installed when overall cost-effective; see section 6 for cost assumptions.

- For the remaining sectors, the assumptions for scenario 2 are similar to those for scenario 1.
- For key substances additional investigation and monitoring actions are required to reduce the uncertainty about the gap. See section 6 for specific assumptions on the costs of monitoring.
- In principle additional source controls and/or acceleration of existing source control measures could be used to achieve reductions. It assumed that further source controls will be applied when assessed to be cost-effective; see section 6 for discussion on costs and cost-effectiveness.

5.2.3 Measures for Each Substance

Following consideration of the issues of pressures, trends, apportionment and previously proposed measures targeting priority chemicals, a selection of measures can be made according to Scenarios 1 and 2 on a substance by substance and sector by sector basis. This reflects some realistic actions that could be taken either in the short term to guarantee compliance by 2015 (Scenario 1), or longer term (Scenario 2) with a potential timeframe of compliance by 2027. Table 5.2 presents the selected measures on a substance by substance basis.

The costing of measures is described in section 6. It should be noted that costings were not based on a substance by substance analysis, as the key studies on cost assessment of measures (the RIA and the pCEA working group outputs) have analysed measures in broader terms and not specifically related to the Scenarios 1 and 2 or on a substance by substance basis.

Table 5.2 Potential Actions under Scenarios 1 and 2

Substance	PHS/PS/SP	Scenario 1 measures	Scenario 2 measures
ANTHRACENE (direct industrial discharges)	PHS	Upgrade effluent treatment at 7 PPC coke ovens, 1 PPC coal tar distiller.	Upgrade effluent treatment at 7 PPC coke ovens, 1 PPC coal tar distiller.
ANTHRACENE (industrial discharges to WwTW)	PHS	May have to upgrade specific WwTWs where a coke oven discharges directly to a WwTW. Bring timber treatment using creosote into Part A PPC or upgrade WwTW receiving from timber treatment works using creosote. (Small number of works using creosote in UK)	Ban remaining industrial use of creosote or ban anthracene from creosote
ANTHRACENE (domestic to WwTW)	PHS	N/A	
ANTHRACENE (NADiP)	PHS		Ban use of anthracene in creosote where the article will be in contact with water Ban all use of creosote Accept residual tail of diffuse pollution from old creosote coated articles such as garden fences Sustainable urban drainage – reduce anthracene releases as assume binds to sediment
ANTHRACENE (Agricultural)	PHS	N/A	N/A
BROMINATED DIPHENYLETHER (Pentabromodiphenylether) (direct industrial discharges)	PHS	No action required, no industrial use, manufacture or discharge Marketing and Use of this substance is banned by the EU	
BROMINATED DIPHENYLETHER (Pentabromodiphenylether) (industrial discharges	PHS	No action required, no industrial use, manufacture or discharge Marketing and Use of this substance is banned by the EU	

Substance	PHS/PS/SP	Scenario 1 measures	Scenario 2 measures
to WwTW)			
BROMINATED DIPHENYLETHER (Pentabromodiphenylether) (domestic to WwTW)	PHS	Upgrade only major WwTWs sources – see WW17	Accelerate furniture replacement program via £100 grants for the replacement of furniture containing penta, see WW17 report for details of furniture replacement; or Do nothing – wait for natural replacement of penta articles, assume all articles containing penta replaced by 2017. If localised sediment issue just wait for natural decay
BROMINATED DIPHENYLETHER (Pentabromodiphenylether) (NADiP)	PHS	None	None
CADMIUM AND ITS COMPOUNDS (direct industrial discharges)	PHS	Action at PPC sources, in order of priority, WwTW 375kg, iron and steel 40kg, organic basic chemicals 30kg.	
CADMIUM AND ITS COMPOUNDS (industrial discharges to STW)	PHS	Ban or achieve zero releases from remaining cadmium plating. (Cadmium plating already restricted by EU M&U) Action at galvanising and other works that use zinc and release cadmium as a contaminant. Look at EU RAR for markets.	Specify maximum cadmium content of zinc at a very low level
CADMIUM AND ITS COMPOUNDS (domestic to WwTW)	PHS	Ban use of phosphate in detergents – reduce releases by 17kg per year of cadmium	Require zero cadmium in phosphate used for domestic products.
CADMIUM AND ITS COMPOUNDS (NADiP)	PHS		Ban dispersive uses of zinc if it contains cadmium – car tyres? Zinc ointments and cosmetics Review releases of cadmium arising from the use of zinc and consider limitations on zinc coated articles in contact with water Specify maximum cadmium content of zinc at a very low level. Note there is a BS standard for zinc purity commercial zinc anodes quotes Cd 0.025 - 0.07%. Potentially large source, 1535t Cd in EU based on just over 2 million tonnes zinc used in EU,

Substance	PHS/PS/SP	Scenario 1 measures	Scenario 2 measures
			say 250 tonnes Cd in UK due to zinc use per year
CADMIUM AND ITS COMPOUNDS (Agricultural)	PHS	Cadmium releases from phosphate based fertiliser to surface water estimated at 7645kg per year Probably dominant source Move to 20mg/kg Cd in fertiliser standard immediately, or even tighter.	Reduce cadmium limit in fertilisers to 20mg/kg, reduces releases by 2548kg (EU proposed phased reduction Cd in fertiliser) Rely on EU RRS to eliminate risk
CHLOROALKANES C10-13 (Short Chain Chlorinated paraffins – SCCPs)	PHS	Marketing and Use of this substance is restricted by the EU – zero releases	Marketing and Use of this substance is restricted by the EU – zero releases REACH, could press for authorisation or complete phase out. Wait for listing for an EU POP, 10 year time horizon
ENDOSULFAN	PHS	Use of this PPP[1] will cease in the UK from June 2007.	Use of this PPP[2] will cease in the UK from June 2007.
HEXACHLOROBENZENE	PHS	POP – worldwide ban	POP – worldwide ban
HEXACHLOROBUTADIENE	PHS	Local issue with regard to landfill in the NW, otherwise no action.	Local issue with regard to landfill in the NW, otherwise no action.
HEXACHLOROCYCLOHEXANE (LINDANE) (direct industrial discharges)	PHS	Set zero limit on lindane in imported goods such as seeds, fleeces, cotton etc. This could be done by enforcing the POPs restriction and ensuring levels were at "unintentional trace" amounts. Possible set PPC limits at textiles and food and drink sectors	Assume die off over timescale of WFD. Lindane is subject to a worldwide ban on production, marketing and use. All use should cease within the timescale of the WFD, though there may be a legacy issue as existing lindane stocks are used by countries outside the EU.
Mercury (direct industrial discharges)	PHS	Allow Ineos Chlor to convert to mercury free production methods	Allow Ineos Chlor to convert to mercury free production

[1] PPP, Plant Protection Product such as a herbicide or pesticide

[2] PPP, Plant Protection Product such as a herbicide or pesticide

Substance	PHS/PS/SP	Scenario 1 measures	Scenario 2 measures
		2010 to 2015. Wait for all EU/UK caustic to be mercury free in the 2010 to 2015 timescale	methods 2010 to 2015. Wait for all EU/UK caustic to be mercury free in the 2010 to 2015 timescale
MERCURY AND ITS COMPOUNDS (industrial discharges to WwTW)	PHS	Clean up at WwTWs Ban use of mercury in dentistry (as per Sweden and Denmark) Enforce fitment and use of amalgam traps at dental surgeries Aggressive mercury reduction at more (all?) crematoria	Realistically wait until other mercury measures result in an 80% reduction in mercury releases. Allow for predicted 80% fall in use of mercury in dentistry over the next ten years Enforce fitment and use of amalgam traps at dental surgeries Action ongoing for mercury reduction at crematoria
MERCURY AND ITS COMPOUNDS (domestic to WwTW)	PHS	Hand in or exchange program for mercury for thermometers and barometers	Ban M&U of all articles containing mercury (happening via EU mercury strategy thermometers and barometers) Note main source mercury in teeth, release due to abrasion and excretion – no possible action to reduce in short term. Long term ban use of mercury amalgam – see previous article.
MERCURY AND ITS COMPOUNDS (NADiP)	PHS	None	None
NONYL PHENOL (direct industrial discharges)	PHS	Action at 2 PPC sites that release nonyl phenol Enforce M&U rigorously See RIA for costs of complete ban £185m	Nonyl phenol and nonyl phenol ethoxylate are subject to an EU Marketing and Use restriction and any use must be in accordance with the residual permitted uses.
NONYL PHENOL (industrial discharges to STWs)	PHS	One site, probably not an issue	Ban residual uses of nonyl phenol
NONYL PHENOL (domestic to WwTW)	PHS		Enforce M&U restriction
NONYL PHENOL (NADiP)	PHS		

Substance	PHS/PS/SP	Scenario 1 measures	Scenario 2 measures
PENTACHLOROBENZENE	PHS	No known UK production or use of this substance	No known UK production or use of this substance
POLYAROMATIC HYDROCARBONS (PAHs)	PHS	Possible additional abatement at coal fired power stations. UK air quality strategy should have costs and ideas	Normal regulatory activities, such as the implementation of PPC at combustion sources, will reduce PAH releases.
TRIBUTYLTIN COMPOUNDS (direct industrial discharges)	PHS	No sources known	
TRIBUTYLTIN COMPOUNDS (industrial discharges to sewer)	PHS	Clean up at WwTWs receiving from timber yards with TBT treated wood.	Ban the M&U of timber treated with TBT (Reported discharges of TBT from stored imported timber) Require special storage for TBT treated wood Not allowed to use TBT to treat timber in the UK (biocide directive) but timber treated with TBT can be imported.
TRIBUTYLTIN COMPOUNDS (domestic to WwTW)	PHS	Clean up at WwTWs Still may be a residual issue with surface water run off and leachate from articles containing TBT	Restrict the use of articles containing TBT in contact with water e.g. PVC with di and mono butyl tin anti oxidants Change building regulation to ban the use of articles containing TBT above trace levels in new buildings where TBT may be released to water Ban the use of any compound containing >0.1% TBT Most uses of TBT are now subject to a Marketing and Use Restriction. However, TBT may be present in imported timber, its use as a biocide (including timber treatment) is not permitted in the UK.
TRIBUTYLTIN COMPOUNDS (NADiP)	PHS	Clean up TBT contaminated sediments Active enforcement of requirement that ships should have removed or barrier coated TBT	Allow TBT levels to naturally decay
ALACHLOR	PS	No action required	Use of this Plant Protection Product is banned in the EU and all use will end before 2009.

Substance	PHS/PS/SP	Scenario 1 measures	Scenario 2 measures
ATRAZINE	PS	No action required	Use of this Plant Protection Product is banned in the EU and all use will end before 2009.
BENZENE (direct industrial discharges)	PS	Immediate action at any EA regulated industrial sources releasing benzene to water and WwTW. May already be below EQS, so may not have an issue	Investigate PPC sites for benzene releases and consider most cost effective way to eliminate releases, for example extract benzene and thereby stop benzene reaching the effluent stream. Only an issue if we are not meeting the EQS, probable that we are meeting the EQS.
BENZENE (industrial discharges to WwTW)	PS	Clean up at WwTW	Investigate PPC sites for benzene releases and consider most cost effective way to eliminate releases, for example extract benzene and thereby stop benzene reaching the effluent stream. Only an issue if we are not meeting the EQS, probable that we are meeting the EQS. No domestic sources, NADiP, bit of atmospheric deposition perhaps, trivial issue.
CHLORFENVINPHOS	PS	No action required	Use of this Plant Protection Product is banned in the EU, and all use will end before 2009.
CHLORPYRIFOS (Agricultural source only)	PS	Ban the use chlororpyrifos	Consider whether there is a surface water issue due to run off of this PPP. Guidance on use of chlororpyrifos so that no releases to water. Ban on spraying close to water courses. PSD considering the status of chlorpyrifos; discussions on re-registration of existing chlorpyrifos products with take place in 2008.
1,2-DICHLOROETHANE	PS	No action required	
DICHLOROMETHANE	PS	No action required	

Substance	PHS/PS/SP	Scenario 1 measures	Scenario 2 measures
DI(2-ETHYLHEXYL) PHTHALATE (DEHP) (direct industrial discharges)	PS	No UK manufacture or release.	
DI(2-ETHYLHEXYL) PHTHALATE (DEHP) (industrial discharges to WwTW)	PS	No UK manufacture or release.	
DI(2-ETHYLHEXYL) PHTHALATE (DEHP) (domestic to WwTW)	PS	Clean up at WwTWs Note surface water issue may remain at STWs will only treat foul water. Remove PVC containing DEHP in contact with water (disproportionate costs).	Restrict the use of articles containing DEHP in contact with water Change building regulation to ban the use of articles containing DEHP above trace levels in new buildings where DEHP may be released to water Potential voluntary agreement with building trade, EA sector plan. Restrict the M&U of DEHP - must be at EU level. UK could make an evidence based case to expand restrictions on DEHP, or REACH restrictions to authorise or phase out.
DI(2-ETHYLHEXYL) PHTHALATE (DEHP) (NADiP)	PS	Clean up at WwTWs Note surface water issue may remain at WwTWs will only treat foul water. Remove PVC containing DEHP in contact with water.	Restrict the use of articles containing DEHP in contact with water Change building regulation to ban the use of articles containing DEHP above trace levels in new buildings where DEHP may be released to water Sustainable drainage – possible DEHP removal for surface water.
DIURON	PS	No action required	Use of this Plant Protection Product is banned in the EU and all use will end before 2009
FLUORANTHENE	PS	See PAHs	See PAHs

Substance	PHS/PS/SP	Scenario 1 measures	Scenario 2 measures
ISOPROTURON	PS	No action required	Use of this PPP banned in EU, and all use will end before 2009.
LEAD AND ITS COMPOUNDS (direct industrial discharges)	PS	Clean up at WwTWs (9000kg per year) PPC action at manufacture of basic organic chemicals (6000kg per year)	
LEAD AND ITS COMPOUNDS (industrial discharges to WwTW)	PS	PPC action at manufacture of basic organic chemicals (6000kg per year)	
LEAD AND ITS COMPOUNDS (domestic to WwTW)	PS		
LEAD AND ITS COMPOUNDS (NADiP)	PS	A potentially significant source but need more data. Phosphate dosing to stop lead dissolving from domestic pipes, or remove pipes.	Ban the M&U of lead in dispersive applications which may result in a release to water.
NAPHTHALENE	PS	Same action as anthracene at PPC sites (but releases may be below the EQS so no action may be required)	Sources are coke ovens, coal tar distillation, and grinding wheel manufacture. Note one UK production plant, Koppers.
NICKEL AND ITS COMPOUNDS (direct industrial discharges)	PS	Clean up at WwTWs Possible action at PPC Part A(1) nickel refinery at Swansea	Widespread dispersive pollutant used as an alloying agent. No obvious source to hit.
NICKEL AND ITS COMPOUNDS (industrial discharges to WwTW)	PS	Clean up at WwTWs Possible action at PPC Part A(1) nickel refinery at Swansea	Widespread dispersive pollutant used as an alloying agent. No obvious source to hit.
NICKEL AND ITS COMPOUNDS (domestic to WwTW)	PS		Ban use of metal alloys containing nickel in contact with water, such as alloy heating elements (see WW17 report)
NICKEL AND ITS COMPOUNDS (NADiP)	PS		No obvious sources
OCTYLPHENOL AND (PARA-TERT-OCTYLPHENOL)	PS	No action required	No evidence of UK use of release Take forward UK Risk Reduction Strategy, PPC resin

Substance	PHS/PS/SP	Scenario 1 measures	Scenario 2 measures
			manufacturers. Check RRS.
PENTACHLOROPHENOL	PS	No action required	Pentachlorophenol is subject to an EU Marketing and Use restriction with limited exemptions until 31st December 2008. No known UK use.
SIMAZINE	PS	No action required	Use of this Plant Protection Product is banned in the EU, and all use will end before 2009
TRICHLOROBENZENES (1,2,4-TRICHLOROBENZENE)	PS	No action required	
TRICHLOROMETHANE (CHLOROFORM) (direct industrial discharges)	PS	No sources, perhaps a small amount of use in the pharmaceutical industry but unlikely to be any releases to water.	
TRICHLOROMETHANE (CHLOROFORM) (industrial discharges to WwTW)	PS	Possible release from Ineos chlor due to formation as an impurity or direct manufacture; probably zero releases as chlorinated waste would be incinerated.	
TRICHLOROMETHANE (CHLOROFORM) (domestic to WwTW)	PS	Clean up at WwTWs Ban the sale of bleach to domestic premises (assuming chloroform is generated by the reaction of bleach and organic material in domestic sewage)	Further investigate source There is no evidence at present that the source of trichloromethane in surface water is from EA regulated activities; the source of trichloromethane in water may be due to in situ synthesis from chlorine, hypochlorite and organic material. Note M&U restriction on sales of >0.1% to members of the public or use in diffuse pollution applications.
TRICHLOROMETHANE (CHLOROFORM) (NADiP)	PS	No sources	
TRIFLURALIN	PS	No action required	Use of this Plant Protection Product is banned in the EU, and all use will end before 2009

6. Cost of Measures

6.1 Cost of Measures

6.1.1 Source control measures

The costs and effects of source controls have not been systematically investigated. As part of the pCEA work and studies for the water industry, some examples of source controls have been considered. These have indicated very high costs associated with some source controls. The previous experience with source control measures under the chemicals regulation show that it is possible to reduce or restrict the use of a substance in certain applications at low costs while a complete phasing out of a substance could be very costly.

Generally, risk reduction strategies have shown varying costs of restrictions. Making an estimate of total costs of applying source control to all substances could therefore be very uncertain given the variations. The following examples show that some reduction can be achieved at low or moderate costs. EA studies indicate a cost of £0.8 million/year for the replacement of DEHP as plasticizer in UK outdoor applications, and an estimated cost of switching to low cadmium phosphate rock of £2.6 million/year compared to decadmiation of phosphate fertilisers in the region of £3.9 million/year (Pers. Comm., Mark Sinton, EA, June 2007).

As an illustrative calculation, if it is assumed that sufficient source reduction can be achieved at a cost of £1m to £4m per year per substance, total costs –assuming that 10 substances may require such additional source control measures– would amount to £10 to £40m per year.

As mentioned above, some of the previous work relating to the WW17 project has shown very high costs of source controls. As an example, for PeBDE the main current source of which is the existing stock of furniture, any additional measures to reduce that source would be very expensive. For other substances, lower costs as argued above are more likely to apply.

6.1.2 End-of-pipe controls

End-of-pipe controls have been examined in previous work. For example, granulated activated carbon (GAC) and sand filters are used as indicative technology to estimate tertiary treatment costs in the UKWIR WW17 report; however, it is recognised that sand filtration may not be capable of ensuring compliance for substances such as PeBDE, DEHP and some of the heavy metals.

End-of-pipe controls can be applied to both direct industrial discharges and to WwTWs. In the pCEA work, the costs of applying sand filtration at WwTWs at risk of EQS failure have been estimated based on unit costs according to the size of the treatment works. Average costs per works are about £2m - £3m for whole life costs over a 20 year period. In total annual costs, the equivalent values range from £0.15m to £0.2m.

6.2 Cost of Scenarios

The main difficulty encountered when reconciling costs of previously presented measures has been the fact that there is uncertainty as to the actual extent of gaps. Whilst the type of measures to be applied can be established, it is not possible to determine the number of point sources where end-of-pipe controls are required to achieve compliance. The large number of point sources means that the effect of various assumptions about the distribution of point sources where end-of-pipe controls are required could be significant.

A summary of the cost estimates is presented in table 6.1. This summarises total annual costs (annualised Capex and Opex) for each scenario and for each main source (see Table 5.1 for the assumed types of measures). The assumptions behind the low and high estimates under the two scenarios are discussed further below.

Table 6.1 Summary of costs for Scenarios 1 and 2 (Total annual costs in £ million)

Sector	Scenario 1		Scenario 2	
	Low	**High**	**Low**	**High**
Direct industrial discharges	2	4	1	2
Industrial discharges to WwTW	No cost estimates provided in any previous work. Additional pre-treatment should be introduced when cost-effective. Will not significantly reduce the total costs.			
Water industry	167	335	84	167
NADiP	Too much uncertainty to introduce measures		Only cost-effective measures should be included and no impact on total costs.	
Agricultural diffuse pollution			0	0
Ports, canals and dredging	35	185	18	93
Investigations and monitoring*	0.1	0.2	0.1	0.2
Total	**210**	**530**	**100**	**260**

* Assumes that 10 substances will require further studies and monitoring at a cost of £100k-£200k per substance. Values in table represent annualised costs over 20 years using a discount rate of 3.5%.

There are a number of key assumptions and uncertainties about the cost estimates that should be emphasised. The main cost driver is the possible requirement for additional end-of-pipe controls for the water industry. As further elaborated below regarding scenario 2, the above cost estimates are subject to a phasing of the investment in end-of-pipe treatment; this also assumes that less investment will be required at the later phases. The possibility of a higher weighting on source control could potentially reduce the costs of scenario 2. If the combination of already implemented restrictions/bans on use and additional source controls would remove the need for end-of-pipe treatment, annual costs could be in the order of £50m.

The key issues to consider include:

- The number of WwTWs at risk which ranges from very low percentages up to 50%. The cessation requirement could under a worst case scenario mean even more WwTWs would need additional treatment.

- Co-removal of substances: it is assumed that 10% of works needs treatment in scenario 1. This implicitly assumes a degree of co-removal and therefore that costs are not additive. If costs prove to be additive, the total costs will be higher.
- The possibility of source control being more cost-effective and reducing the need for expensive end-of-pipe control in scenario 2.
- Additional environmental costs (e.g. additional carbon emissions, removal of PHS from sludge etc) are not included.

The key assumption is the number of WwTWs where end-of-pipe control is to be applied. This assumption determines the order of magnitude of the costs. As described in section 5, the assumption is that 10% of works need additional tertiary treatment and that amounts to £2bn in whole life costs. For the assessment above, it is further assumed that the low costs estimate is equal to the base estimate of £2bn, while the high cost estimate is 2 times the base assumption of £2bn[3].

Considering the illustrative calculation for further source control measures, it should be noted that such measures could reduce the costs of scenario 2. The illustrative calculations (see section 6.1.1) suggest that costs could be at a level of less then £40m per year. If source control succeeded in significantly reducing the need for any further end-of-pipe control, the total costs of scenario 2 could be lower than £50m per year.

Additional environmental costs have not been included in the above cost assessment. The Atkins (2007) report includes estimates of the total carbon emission associated with additional end-of-pipe treatment. Applying the current recommended cost of carbon - around £75 per ton CO_2 - results in carbon costs that are in the order of 5% of the total costs; these will therefore not change the overall conclusion.

6.3 Differences in Previous Cost Estimates

The key sources of information on measures and costs of measures comprise:

- The partial RIA with updated numbers for parliamentary debate
- UKWIR WW17 project

The main differences in the approach and the results are explained below.

6.3.1 Direct industrial discharges

There is no major difference in the cost estimates for direct industrial discharges. The RIA has estimated costs to be £2m-£4m in annual costs, whilst the pCEA work arrives at £5m. The pCEA value is however based on the assumed dilution of 1 in 10, which can be considered low for industrial discharges. A sensitivity analysis shows that with a dilution factor of 100, which often available to industrial discharges, the number of installations requiring additional treatment would be reduced by 50%. That brings the costs within the same order of magnitude.

[3] Atkins (2007) states the total costs range between £2bn and £12bn, while the RIA assumed £2bn. The range applied in Table 6.1 assumes the range of £2bn to £4bn.

Both estimates are based on several assumptions and therefore subject to uncertainty. In terms of their order of magnitude, both cost estimates are fairly moderate compared to the costs in some other sectors.

The costs for (drinking) water treatment works have been included under water industry. The pCEA work has estimated the costs at about £380m (in whole life costs over 20 years).

6.3.2 Water industry discharges

The main difference lies in the assumptions and judgement on the number of WwTWs at risk. The RIA is based on previous work done by Atkins for the water industry; the most updated work seems to suggest a higher share of works could be at risk.

The different factors that affect the assessment of the number of works at risk include:

- The expected effect of existing source controls and their impact on the projected 2015 number of works at risk. A key example is PeBDE, where the RIA assumes that there will be no additional need for end-of-pipe controls given the existing ban on the substance. The pCEA assumes that it will necessary to install end-of-pipe controls to achieve compliance. In previous Atkins work[4] it was assumed that the number of works at risk would decrease by 2015 compared to the number currently at risk. For PeBDE, the projected number at risk by 2015 was stated as one-third of all works (compared to currently 50% of works at risk).

- The approach to determining the required consents. One reason for the increased number of works at risk appears to be the assumption on how the discharge consent is determined. It is assumed that the consent is based on 10% of the EQS and the dilution available. It has not been possible to explore this assumption further. It has been stated in studies that even small changes to the applicable EQS will have a significant impact on the number of works at risk and thereby on the total costs. Therefore a judgement on whether the consent is based on 10%, 50% or 100% of the EQS will make a significant difference to the number of WwTWs being at risk of non-compliance.

- For metals whether the compliance is based on dissolved metals or total metals. An assessment based on total metals concentrations will result in a higher number of works at risk; the pCEA estimates have been based on total metals.

Regarding the unit costs applied to the number of works at risk, both studies draw on the same sources. The RIA is based on the 2006 report and earlier outputs from the WW17 project.

There is generally limited discussion on the unit costs of the treatment options. Most of the cost estimates have been based on sand filtration as the end-of-pipe treatment technology. This technology will not always give sufficient reduction and more expensive options might be required. The possible uncertainty about unit costs has not been quantified or reported. Given the high degree of uncertainty about the number of works at risk and that uncertainty about unit costs is relatively independent of the uncertainty about the numbers at risk, the overall

[4] Atkins Ltd, RPA Ltd and ICF International (2006). Dangerous Substances and Priority Hazardous Substance/Priority Substances under the Water Framework Directive. WW17d Extension Report. Final Report for UKWIR.

uncertainty is not increased. The range of costs provided by different assumptions on the number of works can therefore be used to represent the overall uncertainty.

An aspect that has not been explored in either of the previous studies relates to the total load of the PS and PHS being released into the water environment. The high total costs are related to a high number of works being at risk and therefore potentially needing additional treatment. High unit costs for the smallest works mean that they may easily comprise a large share of the total costs while their share of the total loads might be very low.

Although any EQS exceedance is a compliance failure, if high costs were to lead to an issue of disproportionate costs, the environmental benefits would have to be assessed. It is likely that the environmental benefits would mostly relate to the total loads of released chemicals rather than individual EQS failures. There are no data in the RIA or pCEA work to substantially address that issue. An illustrative analysis can be based on the number of works at different size bands. In the below table, such illustrative calculations are presented. If it is assumed that the load is proportional to the size of the WwTW measured in p.e., the share of the total load from each size band can be estimated.

Table 6.2 Potential Actions under Scenarios 1 and 2

WwTW size band (p.e.)	No of works by size band		Estimated illustrative distribution of load based on p.e.
	No	% distribution	%
> 250	3126	45%	1%
251 to 500	776	11%	0%
501 to 2000	1321	19%	2%
2001 to 10000	992	14%	6%
10001 to 25000	352	5%	6%
25001-50000	198	3%	8%
50000-200000	166	2%	22%
200000-1m	89	1%	55%
>1m	0	0%	0%
Total	7020	100%	100%

The above calculation shows that although the smallest works – less than 250 p.e. – comprise 45% of the total number of works they contribute maybe only 1% of total pollutant load. The

3% largest works could potentially contribute up to 75% of the load. While the discharged amounts of the PS or PHS are not necessarily proportional to the size of WwTW, it likely that a significant total reduction can be achieved by a targeted approach of installing additional tertiary treatment to selected installations.

6.4 Cost Effectiveness Analysis

The previous reports have not explored the costs-effectiveness of alternative measures to a degree that allows firm conclusions to be drawn. The key question is whether source controls are more or less cost-effective than end-of-pipe treatment. Some reports indicate that source controls are not cost-effective while other evidence, such as previous experience, indicates that source controls may be cost-effective.

Further analysis is therefore required for conclusions to be drawn and this further analysis should be one of the measures to be taken forward. The large uncertainty about the compliance gap to close and the potentially very high costs of end-of-pipe treatment suggest that more knowledge is needed before committing to any investments.

The other aspect of cost-effectiveness is addressing the major point sources and ascertaining whether some degree of co-removal can be achieved. Focusing on point sources which contribute several PS and PHS is a possible way forward. On the other hand, the issue of source control where national or international measures are required may be focused on controlling major point source discharges through the RBD management planning.

6.5 Assumptions and Limitations

There are a number of assumptions and limitations that should be noted in this review of measures.

Most of the substances are subject to a large number of existing controls and there is a great deal of uncertainty about the efficiency of these controls and the closure of the gap that can be assumed prior to 2015. Many studies explicitly indicate a lack of confidence that measures will achieve WFD targets.

Most of the Working Group output reports contain very limited or no measures that specifically relate to the 42 substances considered in this synthesis report. This is due to the fact that these substances may have little impact on some market sectors (e.g. flood management). The agricultural working group states that the only pressures of concern were pesticides and that from sheep farming (e.g. cypermethrin). The NADiP working group report proposes generic measures that could potentially apply to some of the 42 substances (see end of Table A for more details).

The phasing of actions can often be seen as a cost saving exercise, as certain measures can benefit from having to close a smaller gap if time is allowed for other measures to take effect. However, the main interest is on Scenario 1 measures that can be applied as soon as possible and do not heavily rely on gap closure by other measures.

No additional measures or control methods have been costed due to time constraints. It is likely that there are some already funded or agreed measures that will provide benefits such as co-removal of substances and cost savings. For example, the requirement to further reduce phosphorus and ammonia effluent levels (to be addressed during the AMP5 period) by the Water Industry; the upgrading of treatment works and tertiary processes is expected to result in co-removal of cadmium, lead, nickel and some of the organic priority substances. However such synergistic effects cannot be presently quantified or assumed to guarantee EQS compliance for priority substances.

7. Further Considerations

7.1 Measures to Reduce Uncertainty

The term uncertainty mainly relates to the extent of the compliance gap and the effectiveness of proposed measures. Moreover, there is uncertainty about the actual costs of measures as these tend to be indicative or approximate. Uncertainties referring to the extent of the gap may be the result of limited understanding of the sources, pathways and fate of chemicals (e.g. chloroform, TBT, DEHP) or due to limitations of the existing monitoring system (e.g. insufficient data points, sparse spatial coverage for certain chemicals) and EQS standards (e.g. metal speciation/toxicity not adequately reflected in current EQS). There is also a level of uncertainty in extrapolating from past failures of EQSs to future failures. Furthermore, there are uncertainties in the implementation of interim or on-going actions, such as risk reduction strategies, voluntary initiatives (that may have low uptake rates), and REACH (which may not succeed in regulating all sources of chemicals). The effectiveness of end of pipe measures, such as tertiary treatment removal efficiency, is the subject of on-going research, field trials, scaling up and transfer of technology (e.g. membranes) to industry and WwTWs.

The above uncertainties can often be reduced by observation of pollution trends and application of technological advances; however, this is subject to pressure from resource constraints. Nevertheless, it is vital to monitor pollutant trends pre- and post- implementation of measures already agreed or funded. For example, nutrient removal by tertiary treatment in the Water Industry may lead to lower effluent levels of cadmium, lead and nickel and some of the organic substances. Close monitoring of pesticide trends is important as there are fast changing pressures relating to the emerging pesticides (that are replacing those banned). Investment in further research and development studies, such as studies of pollutants pathways, co-removal of substances by end of pipe methods, analytical laboratory methods with lower detection limits, and field or pilot scale trials of treatment methods, will help to reduce uncertainty. A more extensive monitoring network and more representative and frequent sampling regimes (e.g. targeting seasonal or diffuse pollution) will help obtain more data to improve knowledge of gap. Interpretation of the collected data is often difficult due to fast changing patterns (or very slow changing patterns, e.g. in groundwater). Monitoring costs are therefore likely to be significant under the WFD (EA currently estimate these to be in the order of £50,000/year per chemical, but this is very much substance dependant).

7.2 Alternative Cost Sharing

It is widely accepted that there are groups of measures that can be applied within one particular sector and provide benefits to all other sectors. End of pipe control, either within the Industry or the Water Industry sector, is generally capable of tackling more than one substance at a time, thereby relieving the pressure on other sectors. For example, it should be technically feasible to set up tertiary treatment processes within WwTWs that remove several heavy metals and/or organic substances in one stage. Taking advantage of the synergies between various measures in one sector can define the potential for alternative cost sharing between sectors. It is evident that the Water Industry has the greatest capacity to employ such combined measures, as it is the recipient of a variety of domestic, trade effluent and diffuse sources of pollutants, and can thereby provide the main target of alternative cost sharing. Equally, source control within one sector can provide cost savings for other sectors; for example, restrictions in the outdoor uses of DEHP would reduce the incoming loads (from run-off intercepted by combined sewers) in WwTWs and therefore the cost of DEHP removal within WwTWs. Source control would also have the added benefit of reducing loads of substances getting directly into freshwater via diffuse sources. However, the costs of end of pipe control may be complementary (in that more than one substance may be removed simultaneously), whereas the costs of source control are for individual substances and tend to be additive.

7.3 Other Considerations

It has been stated in a previous study (Atkins Ltd, WRc Ltd and STL Ltd, 2007) that for certain PHS (cadmium, PeBDE and mercury) between 10 and 100% of works may require upgrading in order to meet the complete cessation of discharges. If end of pipe control was adopted for WFD substances, at least 50% of WwTWs in England, Wales and Scotland would require additional treatment facilities based on the proposed EQS (at a cost exceeding £11 billion). At the same time there is a lack of data on removal rates for specific (advanced) wastewater treatment methods. Removal rates can be highly variable, as indicated by data on copper, zinc, DEHP, nickel, mercury removal rates. Therefore, there will be some uncertainty as to the effectiveness of end of pipe measures.

A further point made in the same study (Atkins Ltd, WRc Ltd and STL Ltd, 2007) is that extra wastewater treatment would produce additional waste and potentially hazardous sludge, and also result in increased energy use and hence greenhouse gas emissions; the negative environmental impact of these should not be overlooked. Calculations, based on additional treatment at more than 50% of WwWTs, indicate that sludge production would be at least 4000 Ml/year, while CO_2 emissions from additional treatment may exceed one million tonnes per year (a 24% increase compared to current Water Industry greenhouse gas emissions).

Another consideration is the potential effects of reduced influent concentrations (due to source control, existing bans/restrictions) on treatment removal efficiency. There may be examples of treatment methods that achieve high removal rates only if the incoming concentrations are above a certain threshold. The possibilities of adverse impacts of removing one substance on another substance –although remote– should be considered; e.g. there may be treatment processes that result in heavy metals changing forms and speciation which may be more toxic and persistent when released into freshwaters.

It is possible that the Commission may extend the priority substances list before 2015. The next review of the priority list is scheduled for 2008. It is also possible that the UK may identify additional specific pollutants. These uncertainties have not been considered in this cost evaluation.

8. Conclusions

This synthesis report has collated and assessed proposed measures and actions to achieve WFD compliance from previous and on-going pCEAs and other studies and consultations.

The following 11 substances have been highlighted as having a medium or high potential of failing WFD EQS in 2015 (see Table 3.1): anthracene, cadmium, chromium, cypermethrin, DEHP, lead, mercury, nickel, TBT, trichloromethane and PeBDE. Copper and zinc, although not in the WFD priority list, are recognised as currently causing frequent EQS failures due to many everyday uses and number of sources.

The main sources of chemicals within each market sector have been identified (see Table 4.1).

Measures have been ranked and grouped (see Table 5.1 and Table A) according to two scenarios:

Scenario 1: Limited phasing (do everything by the soonest date possible)

Scenario 2: High phased action (delay action where not proportionate)

Substance specific measures have also been proposed for each sector under the two scenarios (see Table 5.2); however the cost analysis of alternative measures and scenarios was limited by the availability of data.

The two main approaches to cost assessment of measures (RIA and Atkins pCEA) were considered; this highlighted the difficulties in reconciling the two approaches due to the underlying assumptions and significant associated uncertainties. The key assumption is the number of WwTWs at risk of non-compliance, as this determines the order of magnitude of the costs. This is in turn derived using assumptions on the percentage of EQS that may apply to WwTW discharges to achieve compliance (e.g. 10% EQS to 100% EQS) and the dilution available.

Estimated total annual costs for Scenario 1 are: £210-530m p.a. (comprising: £167-335m p.a. for the water industry, £35-185m for ports, £2-4m for direct industrial discharges), while total annual costs for Scenario 2 are: £100-260m (comprising: £84-167m p.a. for the water industry, £18-93m for ports, £1-2m for direct industrial discharges); see Table 6.1. No estimates could be made for the contribution of non-agricultural diffuse pollution and industrial discharges to sewers, while zero costs were assumed for the agricultural sector (which stated that source control of pesticides is expected to close the gap). The data clearly suggest that the larger share of the costs will fall on the water industry.

The above estimates use the assumption that 10% of works will need additional tertiary treatment (which amounts to £2bn in whole life costs); this allows a 'low cost estimate' to be taken as the base estimate of £2bn while a 'high cost estimate' can be taken as twice the base investment.

The costs and effects of source controls have not been systematically investigated. If source control measures prove more cost-effective than previously thought (in RIA and pCEA), this will reduce the requirement for expensive end-of-pipe control. Source control costs could be as low as £40m per year, which would significantly reduce the total costs of scenario 2 to the order of £50m per year.

Further analysis is required for firm conclusions to be drawn; this further work should be one of the short term measures taken forward. The large uncertainty about the compliance gap to be closed and the potentially very high costs of end-of-pipe treatment suggest that more knowledge (about the gap and the costs of source control) is required before committing to any investments. This is likely to require further monitoring and additional studies of pollutants, treatment methods and co-removal potential. Focusing investment on mitigating the main point sources which contribute the most PS and PHS is a possible way forward.

Phasing of the investments would reduce the risk of undertaking unnecessary investment and increase the benefits from technological advances. Currently, the treatment options that have been considered in the various studies have not been specifically developed for the removal of PHS, PS and SP substances.

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Appendix A
Table A – Proposed Measures and Scenarios

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
Anthracene						
	Scenario 1					
Other Controls and Cessation (More Stringent)[3]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Undetermined costs may apply: due to emission profile (i.e. chemical intermediate and wood combustion).	Undetermined costs may apply: due to emission profile (i.e. chemical intermediate and wood combustion). Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	It is assumed that EQS can be met by 2015 (though cessation may refer to 2025)	No cost comparisons can be made for anthracene, as measures are limited and do not include costings.
End of Pipe Controls[1]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Minimal costs: use profile does not result in significant direct releases to water.	Does not meet the strict requirement for a cessation of emissions and losses of PHS Cost assumes use profile does not result in significant direct releases to water. Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	End of pipe control does not guarantee WFD EQS compliance	
Other Controls and Cessation (Less Stringent)[2]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Zero or minimal costs: ESR RA currently on-going.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Uncertainty that EQS will be met in 2015	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
	Scenario 2 - NONE					
Cadmium (and its compounds)						
	Scenario 1					
End of Pipe Controls[1]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Costs of up to £200,000 may apply (depending on the hardness band).	Does not meet the strict requirement for a cessation of emissions and losses of PHS. Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD	End of pipe control does not guarantee WFD EQS compliance	Great uncertainties as to whether cadmium can be controlled/removed to sufficiently low levels to achieve EQS compliance. Its continuing use in detergents and fertilisers and presence in diffuse sources means that only Scenario 2 measures may be cost-effective.
Other Controls and Cessation (Less Stringent)[2]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Costs of up to £200,000 may apply (depending on the hardness band). Restrictions already in place and EC intends to bring forward proposal to address Cd in fertilisers	Cost assumes restrictions are already in place and that EC intends to bring forward proposal to address Cd in fertilisers. Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Uncertainty that EQS will be met in 2015 (does not resolve diffuse pollution and legacy issues)	
Other Controls and Cessation (More Stringent)[3]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Costs of up to £200,000 may apply (depending on the hardness band). Significant and disproportionate	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Uncertainty that EQS will be met in 2015 (does not resolve diffuse pollution and legacy issues)	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
			costs may apply where decadmiation is the only route to achieve cessation requirement.			
End of Pipe Controls – assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (Other Industry)	£7m to install sand filters at 23 sites (assumes 20% sites still failing)	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
End of Pipe Controls – assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (Power and Nuclear)	£2.7m to install sand filters at 9 sites (assumes 30% sites still failing)	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
Source control through marketing and use restrictions within the last decade	UKWIR WW17d, page 44	Water Industry	No costs incurred	Cannot guarantee EQS compliance in the short term, may be a longer term option	Restrictions put on use in last decade may not fully ensure compliance with EQS	
End of pipe treatment – based on GAC and sand filtration	UKWIR WW17d, page 51	Water industry	£1.2 bn. Costs based on sand filters and GAC installation at works currently at risk with no further source control.	Cost is not additive as co-removal will occur depending on treatment technique used. Uncertainty over removal efficiency and number of works at risk	Technology available (sand filters) but no guarantee that EQS will be achieved.	
End of Pipe Controls – assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (Metals Industry)	£14m to install sand filters at 45 sites (assumes 30% sites still failing)	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
	Scenario 2					
EU-wide charge on cadmium in fertilisers – ‘Uniform’ approach with ‘moderate’ version (lower charges, phasing)	Cadmium in phosphate fertilisers	Fertiliser industry; agriculture	Unspecified		There are sources of cadmium other than fertiliser, therefore the impact of the charge is uncertain	
EU-wide charge on cadmium in fertilisers – ‘Minimum rate’ approach with ‘moderate’ version	Cadmium in phosphate fertilisers	Fertiliser industry; agriculture	Unspecified		There are sources of cadmium other than fertiliser, therefore the impact of the charge is uncertain Some phasing allowed with moderate approach	
EU-wide charge on cadmium in fertilisers – ‘Divergent’ approach with ‘moderate’ version	Cadmium in phosphate fertilisers	Fertiliser industry; agriculture	Unspecified		There are sources of cadmium other than fertiliser, therefore the impact of the charge is uncertain Some phasing allowed with moderate approach	
EU-wide charge on cadmium in fertilisers – ‘Uniform’ approach with ‘stringent’ version (higher charges, no phasing)	Cadmium in phosphate fertilisers	Fertiliser industry; agriculture	Unspecified		There are sources of cadmium other than fertiliser, therefore the impact is uncertain	
EU-wide charge on cadmium in fertilisers – ‘Minimum rate’ approach with ‘stringent’ version	Cadmium in phosphate fertilisers	Fertiliser industry; agriculture	Unspecified		There are sources of cadmium other than fertiliser, therefore the impact of the charge is uncertain	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
EU-wide charge on cadmium in fertilisers – ‘Divergent’ approach with ‘stringent’ version	Cadmium in phosphate fertilisers	Fertiliser industry; agriculture	Unspecified		There are sources of cadmium other than fertiliser, therefore the impact of the charge is uncertain	
Chromium (and its compounds)						
	Scenario 1					
End of Pipe Controls– assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.4	Water industry	No individual costing	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	Lack of measures noted
	Scenario 2 - NONE					
Diethyl-hexyl-phthalate (DEHP)						
	Scenario 1					
Other Controls and Cessation (More Stringent)[3]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Cessation not required; however, source control may result in significant costs.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	It is assumed that EQS can be met by 2015 (though cessation may refer to 2025)	Potentially disproportionate cost of achieving WFD compliance under stringent controls and cessation. It is thought that restriction in outdoor uses and replacement in plastic pipes will help close the gap and should be implemented in the

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
						short term; however, the benefits of this cannot be fully assessed as there are ubiquitous uses of DEHP that require control.
End of Pipe Controls[1]	WFD Article 16 Partial RIA Table 5.9	Unspecified – total implementation costs	Minimal costs to industrial dischargers	Does not meet the strict requirement for a cessation of emissions and losses of PHS. Use profile does not result in significant direct releases to water. Further costs to the water industry may be realised. Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	End of pipe control does not guarantee WFD EQS compliance	
Other Controls and Cessation (Less Stringent)[2]	WFD Article 16 Partial RIA Table 5.9	Unspecified – total implementation costs	Final RAR (and RRS) expected soon	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Uncertainty that EQS will be met in 2015	
Tertiary treatment at all WwTW at risk	UKWIR WW17d	Water Industry	£0.4bn (based on 2005 prices)	Assumes no secondary market for plastics containing DEHP. Thus, the cost of replacing the pipes contain DEHP would not be reduced by revenues generated from selling the used material. Does not account for transporting plastic pipes from homes to a disposal place or for the cost of disposing the DEHP materials into landfill or incinerator, and thus may be underestimated.	Technology for this presumably exists but unclear as to effectiveness and no guarantee that EQS will be achieved	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
End of pipe treatment – based on GAC and sand filtration	UKWIR WW17d, page 51	Water industry	£0.6 bn Costs based on sand filters and GAC installation at works currently at risk with no further source control.	Cost is not additive as co-removal will occur depending on treatment technique used. Uncertainty over removal efficiency and number of works at risk	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
End of Pipe Controls– assumes sand filters are the most appropriate technology	Atkins Pcea for the Water industry, Table 3.4	Water industry	£3.9 bn to upgrade 127 wwtw nationwide. Cost is NPC discounted over 20yrs using 6% discount rate.	Assessment based on sand filters and GAC. May not remove to EQS levels. Costs could be up to 10x higher depending on way EA implements WFD. Unit costs of treatment are sized approximately for each size band of works. See Footnote[i]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
	Scenario 2					
Replacement of pipework in homes <5 years old	UKWIR WW17d, p58	Plumbing/domestic	£4.5bn (excludes costs of disposing of pipework, therefore could underestimate) (based on 2005 prices)	Assumes homes <5 yrs old equate to 10% of housing stock, or 2.4m homes. Assumed that replacement would start immediately and continue for 5 years. Assumes £2000/house labour and material	Replacement would be complete within 5 years (limited phasing). The remaining pipework in older houses might still be a source of emissions.	
Replacement of pipework in homes <5 years old	UKWIR WW17d, p58	Plumbing/domestic	£9bn (excludes costs of disposing of pipework, therefore could underestimate); includes increased labour costs, i.e. worst case scenario (based on 2005 prices)	Assumes homes <5 yrs old equate to 10% of housing stock, or 2.4m homes. Assumed that replacement would start immediately and continue for 5 years. Assumes £4000/house labour and material	Replacement would be complete within 5 years (limited phasing). The remaining pipework in older houses might still be a source of emissions.	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
Lead (and its compounds)						
	Scenario 1					
End of Pipe Controls[1]	WFD Article 16 Partial RIA Table 5.9	Unspecified – total implementation costs	Costs of around £2.6 million to industrial costs may apply; further significant costs to the water industry.	Does not meet the strict requirement for a cessation of emissions and losses of PHS. Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	End of pipe control does not guarantee WFD EQS compliance	There is high uncertainty as to whether all sources of lead can be controlled and whether presently available treatment methods can achieve removal to EQS levels consistently and economically. Lead will always be present in diffuse sources.
Other Controls and Cessation (Less Stringent)[2]	WFD Article 16 Partial RIA Table 5.9	Unspecified – total implementation costs	Costs of around £2.6 million to industrial costs may apply; further significant costs to the water industry.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Does not tackle diffuse sources, legacy issues and natural occurrence	
Other Controls and Cessation (More Stringent)[3]	WFD Article 16 Partial RIA Table 5.9	Unspecified – total implementation costs	Cessation not required, however, costs may apply.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Does not tackle diffuse sources, legacy issues and natural occurrence	
End of pipe treatment – based on GAC and sand filtration	UKWIR WW17d, page 51	Water industry	£0.9 bn. Costs based on sand filters and GAC installation at works currently at risk with no further source control.	Cost is not additive as co-removal will occur depending on treatment technique used. Uncertainty over removal efficiency and number of works at risk	Removal efficiency is uncertain (costs based on sand filters and GAC)	
pH control of water	UKWIR WW17d,	Water Industry	No costs presented	Risk of orthophosphate dosing	Not guaranteed to achieve	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
with propensity to dissolve lead pipes using orthophosphate	page 48			not achieving EQS standards at end of pipe due to other sources of Pb	EQS standards due to other Pb sources	
	Scenario 2					
Source control through allowing marketing and use restrictions within the last decade.	UKWIR WW17d, page 44	Water Industry	No costs incurred	Cannot guarantee EQS compliance in the short term, may be a longer term option	Phasing over 10 years. Cannot guarantee EQS compliance.	
Mercury (and its compounds)						
	Scenario 1					
Other Controls and Cessation (More Stringent)[3]	WFD Article 16 Partial RIA Table 5.9	Unspecified – total implementation costs	Undetermined costs may apply.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	It is assumed that proposed controls are successful in achieving EQS.	High uncertainty that measures will be fully effective and achieve EQS compliance. Mainly due to multiple uses of mercury, some natural sources and historic legacy issues. Amalgam traps and use of mercury-free technology should be implemented immediately where possible. However, heavy reliance on technological advances to achieve full conversion to mercury-free products.
Flue gas desulphurisation (FGD) required under LCPD (BAU)	Entec Mercury SP P.24 Table 4.1/ Mercury PRP Table 3.1	Power Stations – cost is attributable to other pollutants	0.00 (Total Annualised Cost £M/yr); 0.00 (Unit Abatement cost £M/t)	Uncertainties in mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data	Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
Selective catalytic reduction (SCR) required under LCPD (BAU)	Entec Mercury SP P.24 Table 4.1/ Mercury PRP Table 3.1	Power Stations – cost is attributable to other pollutants	0.00 (Total Annualised Cost £M/yr); 0.00 (Unit Abatement cost £M/t)	Uncertainties surrounding mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data	Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
Installation of amalgam separators at dental surgeries (BAU)	Entec Mercury SP P.24 Table 4.1/ Mercury PRP Table 3.1/ UKWIR WW17d, Table 4.3	Dental Surgeries	2.50 (Total Annualised Cost £M/yr); 1.20 (Unit Abatement cost £M/t)/ 2.3 (Total Annualised Cost £M/yr); 0.77 (Unit Abatement cost £M/t)	Uncertainties surrounding mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data	Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
Conversion of Runcorn mercury cells to membrane cells (BAU)	Entec Mercury SP P.24 Table 4.1/ Mercury PRP Table 3.1	Chlor-Alkali Sector	12.1 (Total Annualised Cost £M/yr); 9.05 (Unit Abatement cost £M/t)/ 11.2 (Total Annualised Cost £M/yr); 9.74 (Unit Abatement cost £M/t) Expected to be complete by 2010.	Uncertainties surrounding mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data There is concern about the final fate of the mercury recovered at the end of the plant's life	Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
Flue gas cleaning equipment (BAU)	Entec Mercury SP P.24 Table 4.1/ Mercury PRP Table 3.1	Crematoria	7.9 (Total Annualised Cost £M/yr); 48.28 (Unit Abatement cost £M/t)/ 7.3 (Total Annualised Cost £M/yr); 18.17 (Unit Abatement cost £M/t)	Uncertainties surrounding mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data	Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
Additional ESP field (Beyond BAU)	Entec Mercury SP P.27 Table 4.4/ Mercury PRP Table 3.1	Power Stations	9.3 (Total Annualised Cost £M/yr); 39.16 (Unit Abatement cost £M/t)/ 8.6 (Total Annualised Cost	Uncertainties in mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data.	Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved.	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
			£M/yr); 73.15 (Unit Abatement cost £M/t)			
Carbon injection upstream of FGD (Beyond BAU)	Entec Mercury SP P.27 Table 4.4/ Mercury PRP Table 3.1	Power Stations	3.9 (Total Annualised Cost £M/yr); 102.39 (Unit Abatement cost £M/t)/ 3.6 (Total Annualised Cost £M/yr); 191.25 (Unit Abatement cost £M/t)	Uncertainties surrounding mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data	Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
Near complete cessation of discharges, emissions and losses	Entec Mercury SP/Entec Mercury App B Partial RIA	Numerous – industry, other businesses, Government, and more	Considered to be technically unfeasible or disproportionately expensive	Uncertainties surrounding mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data	Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
End of Pipe Controls[1]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Costs of around £316,000 to industrial dischargers may apply.	Does not meet the strict requirement for a cessation of emissions and losses of PHS. Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	End of pipe control does not guarantee WFD EQS compliance	
End of Pipe Treatment – based on GAC and sand filtration	UKWIR WW17d, page 51	Unspecified - total implementation costs	£1.0 bn. Costs based on sand filters and GAC installation at works currently at risk with no further source control.	Cost is not additive as co-removal will occur depending on treatment technique used. Uncertainty over removal efficiency and number of works at risk	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Costs of around £316,000 may apply to industrial dischargers. Restrictions and emissions control	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD		Other Mercury sources might mean EQS is not achieved and proposed controls are not stringent	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
		(see Mercury Strategy) already in place.	(based on 1997 dataset)			
Reduction of mercury emission from water treatment plant effluent (ion exchange)	Industry WG pCEA Annex I	Power sector	£1,535,802 (Total Annualised Cost); 24,378 (Cost-effectiveness £/unit)	Pollution Inventory data used to extract data has not been quality checked. Assumptions have been made regarding concentration of metals in raw effluent	Other sources of mercury might mean EQS is not achieved	
Closure of remaining mercury cells (BAU)	Mercury PRP Table 3.1	Chlor-Alkali Sector	0.1 (Total Annualised Cost £M/yr); 0.6 (Unit Abatement cost £M/t)		Other sources of mercury might mean EQS is not achieved	
Source control through allowing marketing and use restrictions within the last decade (10-year timescale)	UKWIR WW17d, page 44	Water Industry	No costs incurred	Cannot guarantee EQS compliance in the short term, may be a longer term option	Restrictions put on use in last decade may not ensure compliance with EQS	
	Scenario 2					
Enhanced mercury emission reduction – FGD Waste Water Treatment Plant (ion exchange)	Industry WG pCEA Annex I	Power sector	£348,449 (Total Annualised Cost); 645 (Cost-effectiveness £/unit)	Technical performance of ion exchange is significantly uncertain in this application. Pollution Inventory data used to extract data has not been quality checked. Assumptions have been made regarding concentration of metals in raw effluent	Technical performance of ion exchange is uncertain, other sources of mercury might mean EQS is not achieved	
Reduction of mercury emission from coal	Industry WG pCEA	Power sector	£307,245 (Total Annualised Cost);	Technical performance of ion exchange is significantly	Technical performance of ion exchange is uncertain, other	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
stock or ash stock runoff (ion exchange)	Annex I		68,277 (Cost-effectiveness £/unit)	uncertain in this application. Pollution Inventory data used to extract data has not been quality checked. Assumptions have been made regarding concentration of metals in raw effluent.	sources of mercury might mean EQS is not achieved	
Reduction of mercury emission from ash lagoon effluent (precipitation-clarification process)	Industry WG pCEA Annex I	Power sector	£5,749,865 (Total Annualised Cost); 100,875 (Cost-effectiveness £/unit)	Little practical experience of field performance for precipitation-clarification process; naturally high alkalinity of ash lagoon water may have precipitated much of metals prior to discharge rendering method less effective than indicated. Pollution Inventory data used to extract data has not been quality checked. Assumptions have been made regarding concentration of metals in raw effluent	Uncertainties surrounding performance of method, other sources of mercury might mean EQS is not achieved	
Replacement of mercury sphygmomanometers with alternatives (Beyond BAU)	Entec Mercury SP P.27 Table 4.4/ Mercury PRP Table 3.1	NHS/healthcare	5.9 (Total Annualised Cost £M/yr); 2.68 (Unit Abatement cost £M/t)/ 5.5 (Total Annualised Cost £M/yr); 2.48 (Unit Abatement cost £M/t)	Uncertainties surrounding mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data. Alternatives to mercury are uncertain	Alternatives to mercury are uncertain. Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved.	
Replacement of mercury thermometers with alternatives (Beyond BAU)	Entec Mercury SP P.27 Table 4.4/ Mercury PRP Table 3.1	NHS/healthcare	0.6 (Total Annualised Cost £M/yr); 11.04 (Unit Abatement cost £M/t)/ 0.5 (Total Annualised Cost £M/yr); 10.26 (Unit Abatement cost £M/t)	Uncertainties surrounding mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data	Alternatives to mercury are uncertain. Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
Campaign to replace	Entec Mercury SP	Domestic	1.3 (Total Annualised	Uncertainties surrounding mass	Alternatives to mercury are	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
mercury thermometers with alternatives (Beyond BAU)	P.27 Table 4.4/ Mercury PRP Table 3.1		Cost £M/yr); 11.76 (Unit Abatement cost £M/t)/ 1.2 (Total Annualised Cost £M/yr); 10.92 (Unit Abatement cost £M/t)	balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data	uncertain. Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
Substitution of amalgam with alternative materials (non-biting surfaces) (Beyond BAU)	Entec Mercury SP P.27 Table 4.4/ Mercury PRP Table 3.1	Dental Surgeries	27.6 (Total Annualised Cost £M/yr); 36.14 (Unit Abatement cost £M/t)/ 25.6 (Total Annualised Cost £M/yr); 23.31 (Unit Abatement cost £M/t)	Uncertainties surrounding mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data. Considerable divergence in views from the dental profession with regard to the costs and efficacy of non-mercury based amalgam substitutes	Alternatives to mercury are uncertain. Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
Substitution of amalgam with alternative materials (biting surfaces) (Beyond BAU)	Entec Mercury SP P.27 Table 4.4/ Mercury PRP Table 3.1	Dental Surgeries	430.3 (Total Annualised Cost £M/yr); 281.96 (Unit Abatement cost £M/t)/ 399.5 (Total Annualised Cost £M/yr); 181.86 (Unit Abatement cost £M/t)	Uncertainties in mass balance, estimates of releases/emissions and reductions to be achieved, and abatement cost data. Considerable divergence in views from the dental profession with regard to the costs and efficacy of non-mercury based amalgam substitutes	Alternatives to mercury are uncertain. Uncertainties surrounding emissions, other Mercury sources might mean EQS is not achieved	
Nickel (and its compounds)						
	Scenario 1					
Other Controls and Cessation (More Stringent)[3]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Cessation not required	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD	It is assumed that EQS can be met by 2015 (despite legacy issues/diffuse sources)	It should be theoretically possible to control all major nickel sources and provide adequate treatment. However

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
				(based on 1997 dataset)		the costs are unspecified and most likely disproportionate. More specific restrictions (or /and replacement in products) will help close the gap further and should be implemented where possible; however, compliance cannot be fully assessed as there are ubiquitous uses, diffuse sources and legacy issues.
End of Pipe Controls[1]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Costs of up to £120,000 to industrial dischargers may apply; further significant costs to the water industry.	Does not meet the strict requirement for a cessation of emissions and losses of PHS. Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	End of pipe control does not guarantee WFD EQS compliance	
Other Controls and Cessation (Less Stringent)[2]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Costs of up to £120,000 may apply to industrial dischargers. Significant additional costs may be incurred.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Uncertainty that EQS will be met in 2015 (due to legacy issues, diffuse sources etc)	
End of Pipe Controls – assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.4	Water industry	£0.9 bn to upgrade 380 wwtw nationwide	Assessment based on sand filters and GAC. May not remove to EQS levels. Costs could be up to 10x higher depending on way EA implements WFD. Unit costs of treatment are sized approximately for each size band of works.	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
End of Pipe Controls – assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (Animals, vegetables and food)	£1.8m to install sand filters at 6 sites (assumes 60% sites still failing)	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
End of pipe treatment – based on GAC and sand filtration	UKWIR WW17d, page 51	Water industry	£1.9 bn. Costs based on sand filters and GAC installation at works currently at risk with no further source control.	Cost is not additive as co-removal will occur depending on treatment technique used. Uncertainty over removal efficiency and number of works at risk	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
	Scenario 2					
Replacement of Ni in heating elements of domestic properties plus installation of tertiary treatment	UKWIR WW17d, p57	Domestic/water industry	£0.2bn (cost of installation of treatment at all failing works less cost of treatment at failing works from 2015)	Replacement of Ni in hot water systems and appliances by 2015 (bring 148 works into compliance with EQS. From 2015, tertiary treatment at 905 works. Assumes that treatment technology would be available in 5 years time	Assumes new treatment technology will become available in the future. Replacement will be phased over approx 8 years	
Penta-brominated Diphenylethers (PeBDE)						
	Scenario 1					
Other Controls and Cessation (More Stringent)[3]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Undetermined costs may apply: due to EQS below limit of detection.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	It is assumed that EQS can be met by 2015 under stringent controls	It should be theoretically possible to control all major PeBDE sources and provide adequate treatment. However the costs are unspecified and likely to be disproportionate. Further specific restrictions

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
						and initiatives such as old furniture replacement (preferably with cashback incentives) will help close the gap; however, some uncertainty regarding compliance may remain (as the effectiveness of measures cannot be fully assessed).
End of Pipe Controls[1]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Minimal costs: pentaBDE banned.	Does not meet the strict requirement for a cessation of emissions and losses of PHS. Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	End of pipe control does not guarantee WFD EQS compliance	
Other Controls and Cessation (Less Stringent)2	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Minimal costs: pentaBDE banned.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Uncertainty that EQS will be met in 2015 (due to old furniture, diffuse sources etc)	
Source control through allowing marketing and use restrictions within the last decade	UKWIR WW17d, page 44	Water Industry	No costs incurred	Cannot guarantee EQS compliance in the short term, may be a longer term option	Restrictions put on use in last decade may not ensure compliance	
End of pipe treatment – based on GAC and sand filtration	UKWIR WW17d, page 51	Water industry	£6.3 bn. Costs based on sand filters and GAC installation at works currently at risk with no further source control.	Cost is not additive as co-removal will occur depending on treatment technique used. Uncertainty over removal efficiency and number of works at risk	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
End of Pipe Controls–	Atkins pCEA for the	Water industry	£10.3 bn to upgrade	Assessment based on sand	Technology assumed is	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
assumes sand filters are the most appropriate technology	Water industry, Table 3.4		380 wwtw nationwide. Cost is NPC discounted over 20yrs using 6% discount rate.	filters and GAC. May not remove to EQS levels. Costs could be up to 10x higher depending on way EA implements WFD. Unit costs of treatment are sized approximately for each size band of works. See Footnote[5]	available (sand filters) but no guarantee that EQS will be achieved.	
	Scenario 2					
Furniture replacement and tertiary treatment at works expected to be at risk in 2010. If it was elevated to a POP then stockpiles would have to be destroyed	UKWIR WW17d, p54	Water industry	£3.5 to £7.1bn (based on 2005 prices)	Cost is dependent on assumptions made about lifespan of furniture. More expensive option includes replacement of 50% of furniture stock at once in 2006. Lower ranges assume furniture changes at “natural” rate.	Detection methods are currently uncertain, but expected to be improved through new technology.	
No additional source control beyond current measures, EoP treatment based on works at risk in 2015	UKWIR WW17d, p54	Water industry	£2.9 to £5.4bn (based on 2005 prices)	Risk of non compliance uncertain due to limitations in detection	Detection methods are uncertain. May require new technology.	
Act on works at risk in 2010 and no furniture replacement	UKWIR WW17d, p64	Water industry	£4.8 to £9.0bn (based on 2005 prices)	Risk of non compliance uncertain due to limitations in detection	Detection methods are uncertain. May require new technology.	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
Tributyltin compounds (TBT)						
	Scenario 1					
End of Pipe Controls[1]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Minimal costs may apply	Does not meet the strict requirement for a cessation of emissions and losses of PHS	End of pipe control does not guarantee WFD EQS compliance	High uncertainty that measures will be fully effective and achieve EQS compliance. Mainly due to TBT presence as contaminant in many products, accumulated stocks in the environment and historic legacy issues. It is thought that it will be less of a problem with time as legacy issues will decline; therefore, there may be added value in Scenario 2 measures (when the compliance gap is better understood).
End of Pipe Controls– assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (Chemical)	£22m to install sand filters at 73 sites (assumes 70% sites still failing)	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
Other Controls and Cessation (Less Stringent)[2]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Minimal costs: product controls already in place.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Uncertainty that EQS will be met due to diffuse sources and significant historic legacy	
Other Controls and Cessation (More	WFD Article 16 Partial RIA Table	Unspecified - total implementation costs	Costs may vary from £2 million to £2.3	Cost estimates based on discrepancy between current	Uncertainty that EQS will be met due to diffuse sources	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
Stringent)[3]	5.9		billion	and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	and significant historic legacy	
Use Agency regulatory powers under IPC/IPPC legislation to ensure good practice and control of TBT emissions from use in organotin formulation	CEA of draft PRP for TBT/ TBT PRP Table 3	Industry	Review of IPC/ IPPC permits for ship yards, timber treatment plants, paper and pulp industry, textile plants and polymer manufacturing plants. Should cease by 1 September 2006 for products used in the EU. Low benefits. Existing Agency data indicates TBT emissions from IPC/IPPC regulated sites are probably low although more info is required	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions.	No guarantee of meeting EQS	
Use Agency regulatory powers under the Water Resources Act to ensure good practice and the control of TBT emissions during organotin formulation	CEA of draft PRP for TBT/ TBT PRP Table 3	Industry	Review of Sewage Treatment Works and Trade Effluent Consents to Discharge in line with the Agency's Policy Dangerous Substances Consenting Policy. High benefits. Existing Agency data indicates STWs are a source of TBT emissions into the environment. Whilst approximately 120	Should cease by 1 September 2006 for products used in the EU. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	No guarantee of meeting EQS	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
			effluents are monitored for TBT only around 20 of these are consented for TBT. There is therefore significant scope for better control.			
Use Agency regulatory powers under the Waste Management Regulations to ensure control of TBT emissions related to releases from landfill	CEA of draft PRP for TBT/ TBT PRP Table 3	Landfill operators	Agency: £410 per permit Industry: £ N/A Medium benefits. Existing Agency data indicates there are a small number of landfill sites where emissions of TBT may need to be better controlled.	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Other sources of TBT mean no guarantee of achieving EQS	
Use Agency regulatory powers under IPC/IPCC legislation to ensure good practice and control TBT emissions from pulp and paper plants. If necessary, extend controls to those sites identified to be jeopardising the EQS	CEA of draft PRP for TBT	Industry (paper and pulp)	Agency: £420 Industry: £400 – 12,300	Medium The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Other sources of TBT mean no guarantee of achieving EQS	
Use Agency regulatory powers under the Water Resources Act to	CEA of draft PRP for TBT	Water industry	Agency: £5,460 Industry: £40,900 – 840,000 water treatment plus 840 –	Medium The gap between actual TBT emissions and the EQS is unknown and there is	Other sources of TBT mean no guarantee of achieving EQS	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
ensure good practice and the control of TBT emissions from WwTWs.			232,680 permits for P&P and textile industries	uncertainty related to unit costs of implementation and sources and extent of emissions		
Use Agency regulatory powers under IPC/IPCC legislation to ensure good practice and control TBT emissions from textile plants. If necessary, extend controls to those sites identified to be jeopardising the EQS	CEA of draft PRP for TBT	Industry (textiles)	Agency: £0 Industry: £5,700 – 241,900	Medium. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Other sources of TBT mean no guarantee of achieving EQS	
Combination 1 (effluent treatment and other industry actions)	CEA of draft PRP for TBT	Textiles; pulp and paper; sewage treatment works	£2.3 million	May not deliver 100% of gap. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	May not deliver 100% of gap	
Combination 2 (dredging, effluent treatment and other industry actions)	CEA of draft PRP for TBT	Textiles; pulp and paper; sewage treatment works; dredging	£1,178 million	May not deliver 100% of gap. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	May not deliver 100% of gap	
Combination 3 (investigate uncertainty, mass balance model,	CEA of draft PRP for TBT	Textiles; pulp and paper; sewage treatment works; dredging	£1,008 million	May not deliver 100% of gap. The gap between actual TBT emissions and the EQS is unknown and there is	May not deliver 100% of gap	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
dredging, effluent treatment and other industry actions)				uncertainty related to unit costs of implementation and sources and extent of emissions		
Combination 4 (mass balance model, dredging, effluent treatment and other industry actions)	CEA of draft PRP for TBT	Textiles; pulp and paper; sewage treatment works; dredging	£1,008 million	May not deliver 100% of gap. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	May not deliver 100% of gap	
Combination 5 (investigate uncertainty, dredging, effluent treatment and other industry actions)	CEA of draft PRP for TBT	Textiles; pulp and paper; sewage treatment works; dredging	£1,178 million	May not deliver 100% of gap. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	May not deliver 100% of gap	
Combination 6 (investigate uncertainty, mass balance model, effluent treatment and other industry actions)	CEA of draft PRP for TBT	Textiles; pulp and paper; sewage treatment works; dredging	£1.9 million	May not deliver 100% of gap. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	May not deliver 100% of gap	
Combination 7 (investigate uncertainty, effluent treatment and other industry actions)	CEA of draft PRP for TBT	Textiles; pulp and paper; sewage treatment works; dredging	£1.9 million	May not deliver 100% of gap. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	May not deliver 100% of gap	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
Combination 8 (mass balance model, effluent treatment and other industry actions)	CEA of draft PRP for TBT	Textiles; pulp and paper; sewage treatment works; dredging	£2.4 million	May not deliver 100% of gap. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	May not deliver 100% of gap	
	Scenario 2					
Determine levels of TBT biocides in wood preservatives applied to recycled wood products	CEA of draft PRP for TBT	Industry (wood preservatives)	Agency: £2,700 Industry: £N/A	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Investigative measure – will not in itself contribute to EQS achievement	
Use Agency regulatory powers under IPC/IPCC legislation to ensure good practice and control TBT emissions. If necessary, extend controls to those sites identified to be jeopardising the EQS	CEA of draft PRP for TBT	Industry (chemical)	Agency: £420 per permit Industry: £0	Low. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	No certainty of achieving EQS	
Use existing Agency powers as a consultee to license the disposal of dredged material and to introduce voluntary agreements with the dredging industry to avoid overflow of	CEA of draft PRP for TBT	Dredging industry	Agency: £51,000 per new restriction or agreement Industry: £23 – 100.6 million	Low. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Includes voluntary measures, no certainty of achieving EQS	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
dredged material						
Use existing Agency powers as a consultee and voluntary agreements with the dredging industry to introduce physical treatment of dredged material to remove and dispose of TBT	CEA of draft PRP for TBT	Dredging industry	Costs are likely to be very high (above £1 billion as it affects all industry activity) and there would still be a need for final disposal of dredged material/TBT not completely removed	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Includes voluntary measures, no certainty of achieving EQS	
Use existing Agency powers as a consultee and voluntary agreements with the dredging industry to introduce chemical treatment of dredged material to remove and dispose of TBT	CEA of draft PRP for TBT	Dredging industry	Costs are likely to be very high (above £1 billion as it affects all industry activity) and there would still be a need for final disposal of dredged material/TBT not completely removed	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Includes voluntary measures, no certainty of achieving EQS	
Use existing Agency powers as a consultee and voluntary agreements with the dredging industry to minimise disturbances into the water column	CEA of draft PRP for TBT	Dredging industry	Agency: £51,000 per new restriction or agreement Industry: £12.53 – 86.3 million	Low. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Includes voluntary measures, no certainty of achieving EQS	
Use existing Agency regulatory powers and voluntary agreements with the dredging industry to impose controls on disposal of dredged	CEA of draft PRP for TBT	Dredging industry	Agency: £51,000 per new restriction or agreement Industry: £700 – 1,400 million	Low. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources	Includes voluntary measures, no certainty of achieving EQS	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
material				and extent of emissions.		
Confirm whether there are sites in England and Wales formulating TBT products and, if so, whether TBT emissions are occurring at these sites from organotin formulation	CEA of draft PRP for TBT/ TBT PRP Table 3	Industry	Agency: £3,400 Industry: £1,800 – 3,600 Low benefits as formulation of TBT products and associated emissions of TBT from formulation sites will cease by or before 01 September 2006 as a result of the Biocidal Products Directive. The only exception could be sites that formulate products and then directly export out of Europe.	Medium. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions.	Investigative measure – will not in itself contribute to EQS achievement	
UK signature to the IMO convention banning use of TBT-containing paints on the hulls of boats	CEA of draft PRP for TBT	Industry/navigation	Council Reg already exists requiring EU ships to have removed TBT coatings (2003) and all non-EU ships entering EU waters to have removed coatings by 2008	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Other sources of TBT mean no guarantee of achieving EQS	
Awareness campaign for small boat owners on the impacts of using TBT-containing paints	CEA of draft PRP for TBT	Small industry/domestic	Usage on small boats (<25m) banned in UK so hopefully no usage now exists	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Other sources of TBT mean no guarantee of achieving EQS	
Use Agency regulatory powers	CEA of draft PRP for TBT	Industry/navigation	Agency: £420 per permit	Low	Other sources of TBT mean no guarantee of achieving	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
under IPC/IPCC legislation to ensure good practice and control TBT emissions from stripping of TBT antifouling paints from ships' hulls. If necessary, extend controls to those sites identified to be jeopardising the EQS			Industry: £0	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	EQS	
Characterise the levels of TBT present in landfill leachate/ To characterise the levels of TBT present in landfill leachate, targeting those landfills which have received TBT contaminated waste from ship yards.	CEA of draft PRP for TBT/ TBT PRP Table 3	Landfill operators	Agency: £2,700 Industry: £N/A Monitoring to be conducted by Landfill operator Medium benefits. Landfill sites which have received ship yard waste may be important local sources of TBT into the environment.	Little is known about releases of TBT from leachate but this is likely to increase with time as TBT-containing products become wastes. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Investigative measure – will not in itself contribute to EQS achievement	
Identify the reasons for releases of TBT from the paper and pulp industry	CEA of draft PRP for TBT/ TBT PRP Table 3	Industry (paper and pulp)	Agency: £1,500 Industry: £5,850 – 72,000 Benefits are Low - PI data indicates emissions from the Paper and Pulp industry are low.	Low The source of TBT in these releases is unclear. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Investigative measure – will not in itself contribute to EQS achievement	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
Characterise levels of TBT in sewage sludge and potential for contamination of the aquatic environment via runoff	CEA of draft PRP for TBT/ TBT PRP Table 3	Water industry	Agency: £2,700 Industry: £ N/A Benefits are LOW	Little is currently known about the extent of TBT in STW effluent. The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Investigative measure – will not in itself contribute to EQS achievement	
Confirm use levels of TBT in the textile industry and levels of TBT released from textile plants and in service use of textiles	CEA of draft PRP for TBT/ TBT PRP Table 3	Industry (textiles)	Agency: £3,400 Industry: £4,500 – 427,500 Medium benefits. The application of TBT to textiles will cease within Europe by 01 September 2006.	Although the application of TBT to textiles will cease within Europe by September 2006, TBT treated textiles may still be imported into Europe. Losses of TBT may occur during processing of these textiles, or through 'in service' use. There is little information presently available to quantify the significance of this source. The gap between actual TBT emissions and EQS is unknown. Uncertainty related to unit costs of implementation and sources and extent of emissions	Investigative measure – will not in itself contribute to EQS achievement	
Influence Government policy to introduce marketing and use restrictions on the import of textile products containing TBT	CEA of draft PRP for TBT/ TBT PRP Table 3	Industry (textiles)	Agency: £30,000 per annum Industry: £ N/A Medium benefits. TBT presence in imported textiles will represent one of few remaining inputs of TBT into the environment.	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Requires successful influence on policy; other sources of TBT mean no guarantee of achieving EQS	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
Identify alternatives to PVC products containing TBT. Categorising uses as essential or non-essential	CEA of draft PRP for TBT	Industry (plastics and PVC)	Agency: £1,500 Industry: £ N/A	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Requires successful identification of alternatives	
Better characterise alternatives to mono and di butyl tins as stabilisers in PVC and as catalysts, including costs of alternative stabilisers/catalysts and assessment of lifecycle impacts	CEA of draft PRP for TBT	Industry (plastics and PVC)	Agency: £1,500 Industry: £ N/A	High The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Investigative measure – will not in itself contribute to EQS achievement	
Influence the polymer industry to substitute organotin usage as a stabiliser in PVC, and as a catalyst so as to avoid TBT contamination	CEA of draft PRP for TBT/ TBT PRP Table 3	Industry (plastics and PVC)	Agency: £30,000 per annum Industry: £ N/A Medium benefits. TBT presence as a contaminant in PVC and in products using organotin catalysts will represent one of the few remaining inputs of TBT into the environment.	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Requires successful influence on polymer industry; other sources of TBT mean no guarantee of achieving EQS	
Build a mass balance model providing information on the relative significance of various sources of TBT emissions into the aquatic	CEA of draft PRP for TBT/ TBT PRP Table 3	All sectors/Not sector-specific	Agency: £4,500 (on top of costs of other research) plus £70,000 for consultants Industry: £ N/A	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Investigative measure – will not in itself contribute to EQS achievement	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
environment			Medium/High benefits. A mass model will allow for better prioritisation of resource by identifying key sources and help predict when TBT levels in the aquatic environment may meet EQS limits			
Confirm the presently unknown uses for 5 TBT compounds identified under the Biocidal Products Directive	CEA of draft PRP for TBT/ TBT PRP Table 3	All sectors/Not sector-specific	Investigation time for EA Policy or Science staff (no.of days x grade of staff). Use of TBT as a biocide is prohibited from 1 September 2006 in EU	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Investigative measure – will not in itself contribute to EQS achievement	
Provide input into Defra's UK Strategy for Managing Contaminated Sediments	CEA of draft PRP for TBT/ TBT PRP Table 3	All sectors/Not sector-specific	Agency: £30,000 per annum Industry: £ N/A High benefits. Ensures joined up thinking and development of a Strategy that compliments EA work	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Requires successful influence on strategy, no guarantee of achieving EQS	
Better characterise the extent to which TBT-contaminated sediments contribute to contamination of the water column and EQS failures	CEA of draft PRP for TBT/ TBT PRP Table 3	All sectors/Not sector-specific	Agency: £3,400 plus £30,000 for consultants Industry: £ N/A Benefits are High. Contaminated	The gap between actual TBT emissions and the EQS is unknown and there is uncertainty related to unit costs of implementation and sources and extent of emissions	Investigative measure – will not in itself contribute to EQS achievement	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
			sediments are a major source of TBT. A better understanding of the mechanisms /conditions of desorption of TBT from sediments to the water column will allow better management of contaminated sediments and better predictions on how contamination varies			
Trichloromethane (Chloroform)						
	Scenario 1					
Other Controls and Cessation (More Stringent)[3]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Cessation not required.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	It is assumed that EQS can be met by 2015 under stringent controls	It should be theoretically possible to control most chloroform sources and provide adequate treatment. However the costs are unspecified and likely to be disproportionate. Some uncertainty will remain as it is produced unintentionally in industry and also thought to be created in sewers However diffuse sources should not be a problem if point sources can be controlled.

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
End of Pipe Controls[1]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Minimal costs may apply	Does not meet the strict requirement for a cessation of emissions and losses of PHS. Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	End of pipe control does not guarantee WFD EQS compliance	
Other Controls and Cessation (Less Stringent)[2]	WFD Article 16 Partial RIA Table 5.9	Unspecified - total implementation costs	Minimal costs: Risk Assessment to be completed in 2006.	Cost estimates based on discrepancy between current and proposed EQS and number of samples recorded below LOD (based on 1997 dataset)	Uncertainty that EQS will be met in 2015 (due to unintentional production etc)	
End of Pipe Controls– assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (other industry)	£9.8m to install aeration at 32 sites (assumes 40% sites still failing)	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
End of Pipe Controls– assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (Waste industry)	£3.05m to install aeration at 10 sites (assumes 70% sites still failing)	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
End of Pipe Controls– assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (metals industry)	£6.7m to install aeration at 22 sites (assumes 0% sites still failing)	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	
End of Pipe Controls– assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (chemical industry)	£20m to install aeration at 64 sites (assumes 10% sites still failing)	See Footnote[4]	Technology assumed is available (sand filters) but no guarantee that EQS will be achieved.	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
End of Pipe Controls– assumes sand filters are the most appropriate technology	Atkins pCEA for the Water industry, Table 3.2	Industry (water treatment works)	£360m to install aeration at 1172 sites (assumes 70% sites still failing)	See Footnote[4]	Technology assumed is available (aeration) but no guarantee that EQS will be achieved.	
	Scenario 2 - NONE					
Generic PHS, SP and PS metals (may apply to lead, nickel, cadmium, mercury and chromium)						
	Scenario 1					
End of pipe[1]	WFD Article 16 Partial RIA Table 5.5	Industry – chemicals and pharmaceutical	Lower 533.35 £/kg Upper 1,403.77 £/kg	The costs assume that the additional reductions required to meet the EQS can be achieved by either increasing the efficiency of the secondary treatment plant or by adding tertiary treatment. Costs only reflect the current situation (using PI data) and not future changes in emissions or planned investments. Not all discharges are included in the PI (e.g. small sources)	No certainty of meeting EQS as assumes secondary treatment is already in place and that efficiency can be increased. Not all discharges have been included in the assessment.	
End of pipe[1]	WFD Article 16 Partial RIA Table 5.5	Industry – paper and pulp	Lower 5.83 £/kg Upper 28.62 £/kg	The costs assume that the additional reductions required to meet the EQS can be achieved by either increasing the efficiency of the secondary treatment plant or by adding tertiary treatment. Costs only reflect the current	No certainty of meeting EQS as assumes secondary treatment is already in place and that efficiency can be increased. Not all discharges have been included in the assessment.	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
				situation (using PI data) and not future changes in emissions or planned investments. Not all discharges are included in the PI (e.g. small sources)		
End of pipe[1]	WFD Article 16 Partial RIA Table 5.5	Industry – metal finishing	Lower 0.76 £/kg Upper 5.31 £/kg	The costs assume that the additional reductions required to meet the EQS can be achieved by either increasing the efficiency of the secondary treatment plant or by adding tertiary treatment. Costs only reflect the current situation (using PI data) and not future changes in emissions or planned investments. Not all discharges are included in the PI (e.g. small sources)	No certainty of meeting EQS as assumes secondary treatment is already in place and that efficiency can be increased. Not all discharges have been included in the assessment.	
End of pipe[1]	WFD Article 16 Partial RIA Table 5.5	Industry - textiles	Lower 105.29 £/kg	The costs assume that the additional reductions required to meet the EQS can be achieved by either increasing the efficiency of the secondary treatment plant or by adding tertiary treatment. Costs only reflect the current situation (using PI data) and not future changes in emissions or planned investments. Not all discharges are included in the PI (e.g. small sources)	No certainty of meeting EQS as assumes secondary treatment is already in place and that efficiency can be increased. Not all discharges have been included in the assessment.	
	Scenario 2					

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
Urban drainage: Permeable surface	Royal Haskoning NADWP report	Government/councils	(EAV) Investment: £3,543,839 plus planning/design and construction overhead. Maintenance £/yr): £2967645		Information on certainty of achieving EQS for individual substances is not known	
Urban drainage: Filter strips and swales	Royal Haskoning NADWP report	Government/councils	(EAV) Investment: £15k to 40k Maintenance £/yr): £350 Effectiveness 70-90%		Information on certainty of achieving EQS for individual substances is not known	
Urban drainage: Infiltration devices	Royal Haskoning NADWP report	Government/councils	(EAV) Investment: £1,359,174 plus planning/design and construction overhead Maintenance £/yr): £1,060 plus £3,840 every 10 yrs (sediment removal) Effectiveness 80-90% except Cu		Information on certainty of achieving EQS for individual substances is not known	
Urban drainage: Basins and ponds	Royal Haskoning NADWP report	Government/councils	(EAV) Investment: £6,172,235 plus planning/design and		Information on certainty of achieving EQS for individual substances is not known	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
			construction overhead Maintenance £/yr): £45,150 Effectiveness 60-90% except Cu and Pb			
Generic PHS, PS and SP organics (may apply to DEHP, chloroform, PeBDE and TBT)						
	Scenario 1					
End of pipe[1]	WFD Article 16 Partial RIA Table 5.5	Industry – chemicals and pharmaceutical	Lower 2.36 £/kg Upper 5.01 £/kg	The costs assume that the additional reductions required to meet the EQS can be achieved by either increasing the efficiency of the secondary treatment plant or by adding tertiary treatment. Costs only reflect the current situation (using PI data) and not future changes in emissions or planned investments. Not all discharges are included in the PI (e.g. small sources)	No certainty of meeting EQS as assumes secondary treatment is already in place and that efficiency can be increased. Not all discharges have been included in the assessment.	
End of pipe[1]	WFD Article 16 Partial RIA Table 5.5	Industry – paper and pulp	Lower 0.08 £/kg Upper 1.16 £/kg	The costs assume that the additional reductions required to meet the EQS can be achieved by either increasing the efficiency of the secondary treatment plant or by adding tertiary treatment. Costs only reflect the current situation (using PI data) and not future changes in emissions or planned investments. Not all discharges are included	No certainty of meeting EQS as assumes secondary treatment is already in place and that efficiency can be increased. Not all discharges have been included in the assessment.	

Measure	Document Reference	Sector	Cost/Affordability	Uncertainty	Comments on Effectiveness	Overall Comments
				in the PI (e.g. small sources)		
End of pipe[1]	WFD Article 16 Partial RIA Table 5.5	Industry – metal finishing	Lower 5.82 £/kg Upper 10.64 £/kg	The costs assume that the additional reductions required to meet the EQS can be achieved by either increasing the efficiency of the secondary treatment plant or by adding tertiary treatment. Costs only reflect the current situation (using PI data) and not future changes in emissions or planned investments. Not all discharges are included in the PI (e.g. small sources)	No certainty of meeting EQS as assumes secondary treatment is already in place and that efficiency can be increased. Not all discharges have been included in the assessment.	
End of pipe[1]	WFD Article 16 Partial RIA Table 5.5	Industry - textiles	Lower 1.64 £/kg Upper 6.16 £/kg	The costs assume that the additional reductions required to meet the EQS can be achieved by either increasing the efficiency of the secondary treatment plant or by adding tertiary treatment. Costs only reflect the current situation (using PI data) and not future changes in emissions or planned investments. Not all discharges are included in the PI (e.g. small sources).	No certainty of meeting EQS as assumes secondary treatment is already in place and that efficiency can be increased. Not all discharges have been included in the assessment.	

1. WFD Article 16 Partial RIA: End of Pipe controls - This Option builds on the baseline set by the ‘do nothing’ option and assumes that end-of-pipe controls are placed on point source discharges of the substances to the aquatic environment in order to comply with the proposed EQS and, thus, achieve good chemical status in surface waters. These controls may be introduced at site level through Local Authority licences, IPC licences and/or at waste water treatment plants (WWTP), which will address trade effluent and non-industrial discharges.

Note that there is a risk that not all water bodies will achieve good status under this option, as the EQS may not be met in all water bodies. As this option does not involve a cessation of emissions and losses of PHS, there is a risk that this option would not be in conformance with the requirements of the WFD.

2. WFD Article 16 Partial RIA: Other Controls and Cessation (Less Stringent) - This Option assumes that compliance with the EQS, achieving good chemical status in surface waters and, in particular, the cessation or phase-out requirement for PHS will require not only end-of-pipe controls at point source discharges but also source controls on specific products or processes which are responsible for discharges, emissions and losses. Assumes that no further emissions control measures will be required to meet the cessation requirement for those substances which have already been subject to detailed risk assessment (RA) and/or risk reduction strategies with recommendations for further regulatory action under any other regulatory framework (e.g. Existing Substances Regulation, Biocides Directive, Plant Protection Products Directive, etc). This interpretation of the cessation requirements is also based on recitals to the WFD which indicate that levels of naturally occurring substances should be close to background levels and anthropogenic emissions etc. close to zero; measures adopted should aim at elimination of pollution (not substances) to levels which allow the WFD objectives to be achieved and proportionate and cost-effective controls are required. This Option also reflects the approach which appears to have been adopted in the Commission's Impact Assessment.

3. WFD Article 16 Partial RIA: Other Controls and Cessation (More Stringent) - This Option assumes that compliance with the EQS, achieving good chemical status in surface waters and, in particular, the cessation or phase-out requirement for PHS will require not only end-of-pipe controls at point source discharges but also source controls on specific products or processes which are responsible for discharges, emissions and losses. Assumes that cessation requires a total phase-out of losses, emissions and discharges of the PHS into the environment by 2025.

4. Atkins Report, cross references to Table 3.4 include the following assumptions:

- Data from the 30 WwTW screening study is representative of all WwTW
- The data presents the situation for domestic works. Works with trade effluent inputs may have higher concentrations of the substances in their effluent than domestic works
- It is assumed that all WwTW have primary and secondary treatment already. No account has been made for WwTW with more or less treatment
- The range of dilutions available in the receiving water have been determined from an assessment of WwTW flows and the flow of the nearest watercourse, as determined using GIS. There is therefore a degree of error in this and the dilutions should not be taken as absolute, but as an indication only.

Sand filters and GAC CAPEX and OPEX costs have been used to derive the costs on the assumption that these will be sufficient to meet the required standard. In reality this will not be the case and there may be a need for further or more advanced treatment to be introduced. This is especially true for nickel.