Presentation

Presentation from the 2009 World Water Week in Stockholm

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PS/PHS - Developing control strategies based on a risk based catchment management approach to understanding relative sources of pollution

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Contents

- Mandate and key requirements
- PS/PHS situation in the UK

- Sewer catchment: Treatment & source control
- Integrated catchment management

- Key conclusions from UK examples

Mandate and Key requirements:

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy – i.e. the WFD

- Para 11 - . environmental damage should, as a priority, be **rectified at source** and that the **polluter should pay**.
- Para 43 - … on specific measures to be taken against pollution of water by those substances, taking into account all **significant sources** and identifying the **cost-effective** and **proportionate** level and **combination** of controls.
- Article 10 - The **combined approach for point and diffuse sources**
  - the emission controls based on **best available techniques**, or
  - the **relevant emission limit values**, or
  - in the **case of diffuse impacts** the **controls including**, as **appropriate, best environmental practices**
- Article 16 - In doing so it shall identify the appropriate **cost-effective and proportionate level** and **combination** of **product and process controls** for **both point and diffuse sources** ……..and **controls on the principal sources of such discharges**, based, inter alia, on consideration of all technical reduction options.

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PS/PHS situation in the UK

- RBMP (1st cycle maps) limited owing to lack of data
- Aquatic monitoring largely limited to metals (Pb, Ni, Cd, Hg and other DSD metals)
- Organics data more limited, much is < LOD
- Water Industry has spent ca. £500,000+ since 2000 on measuring sources of priority chemicals to WwTW, their removal during treatment and measuring/predicting effluent concentrations
- Highway runoff data available
- Some catchment studies (Ribble)
- Limited information about other sources

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UK research to quantify sources in the sewer system:

Investigate treatment options & source control

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UK Water Industry Research (UKWIR)

- A review of over 1000 published papers on source and occurrence of substances of interest;
- A screening study of the influent from 30 WwTW to determine the presence of P(H)S;
- A catchment study to determine the presence of substances from different sources,
- A field sampling to understand removal rates;
- Laboratory studies to investigate tertiary treatment options
- Risk assessment to determine the number of WwTW potentially at risk of requiring additional treatment;
- A cost exercise to estimate the range of potential costs in financial and environmental terms of meeting the tighter consents set under the WFD.

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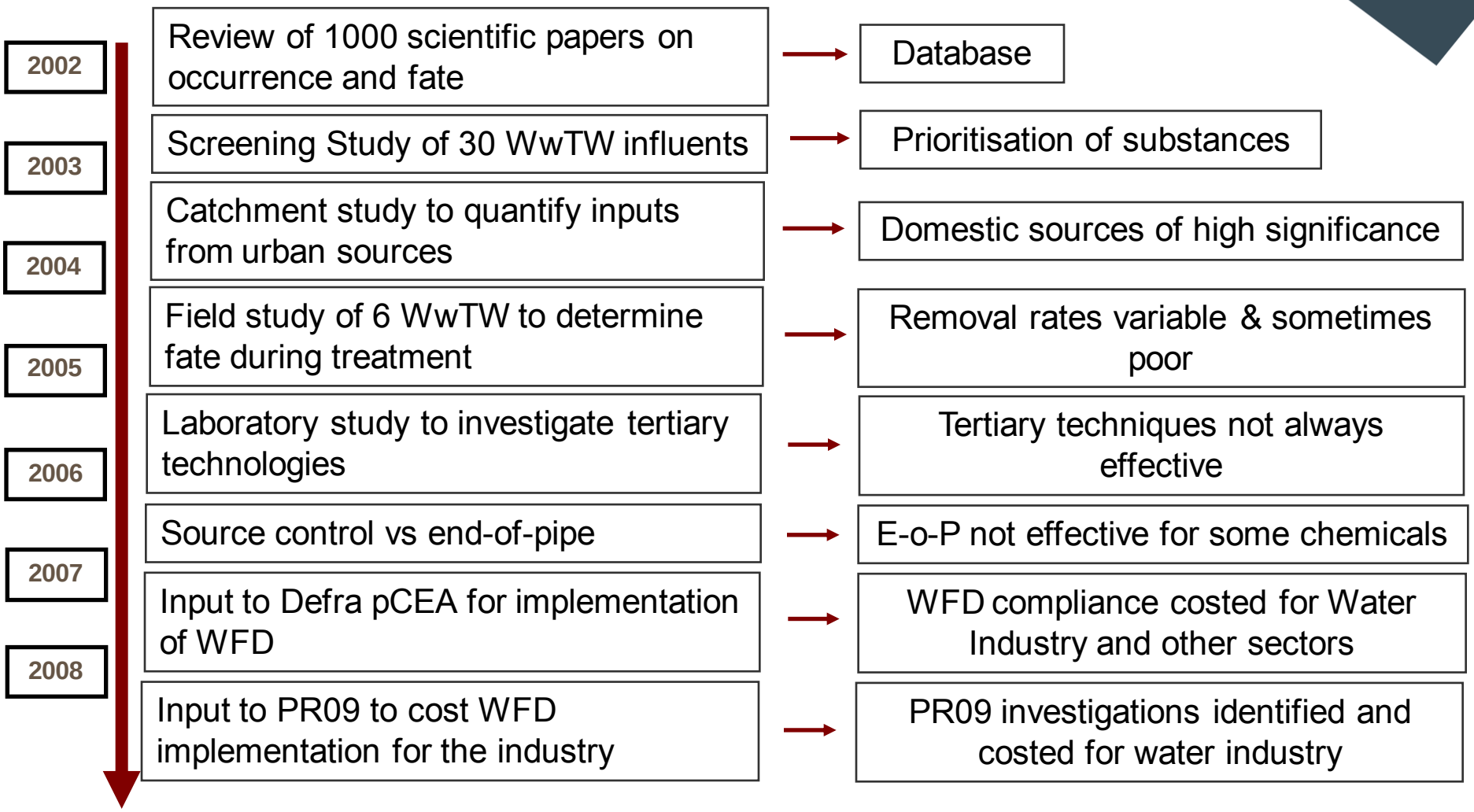
The UK Research Programme



Occurrence of substances in wastewaters

Screening study to determine occurrence:

- 30 influent WwTW sampled (2 occasions)
- Comprehensive set of determinands:
  - Priority substances
  - Priority hazardous substances
  - Specific Pollutants
  - Dangerous substances

Metals	Cu, Ni, Zn, Cr, Pb, Cd, Hg
Pesticides	Diuron, isoproturon, atrazine, simazine, trifluralin, HCH, HCB, PCP
Solvents	DCM, Chloroform, carbon tetrachloride, trichloroethene, tetrachloroethene, benzene
C10-C13 chloroalkanes	
Industrial chemicals	HCBD, chlorinated benzenes
Additives	DEHP, PeBDE, LAS, TBT
PAHs, PCBs	
Drins	

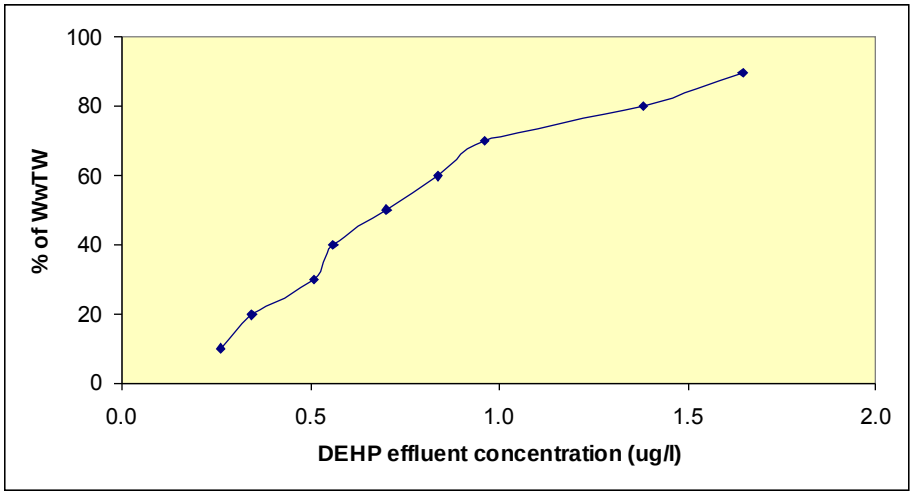
WwTW	Company
Croston	UU
Barrow	UU
Woolton	UU
Crewe	UU
Skelmersdale	UU
Exmouth	SWW
Plympton	SWW
Launceston	SWW
Dawlish	SWW
Longlane	YW
Ripon	YW
Lemonroyd	YW
Wetherby	YW
Rushmoor	ST
Claymills	ST
Brancote	ST
Redditch	ST
Washington	NW
Consett	NW
Wargrave	TW
Bracknell	TW
Fleet	TW
Sherfield	TW
Arborfield	TW
Henley	TW
Letchworth	AW
Milton Keynes	AW
Boston	AW
Bury St Edmunds	AW
Horsham	SW

Estimates of levels in effluents

Screening study influent data for 30 WwTW

Measured/predicted removal rates during treatment

- Substances prioritised based on occurrence
- High priority substances investigated further
- Included:
  - Metals,
  - DEHP,
  - PeBDE,
  - NP/NPE
  - PAHs



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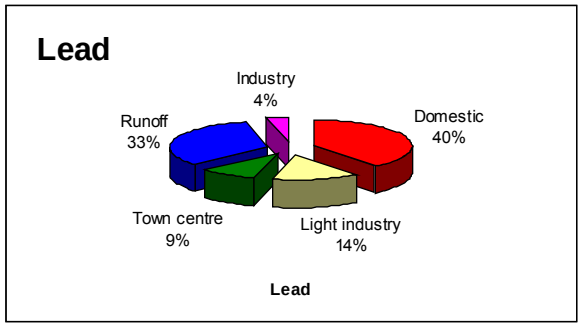
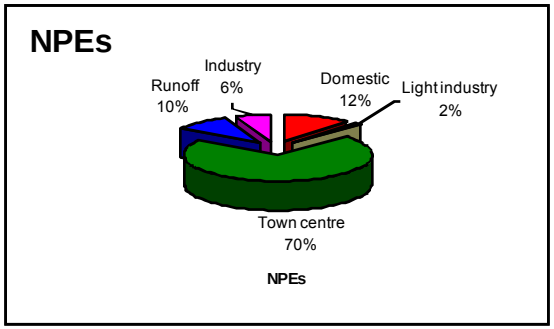
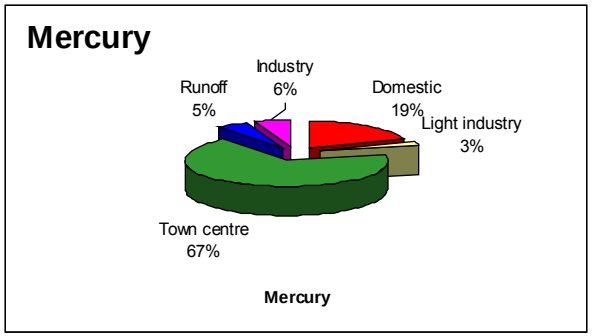
Sources of substances to sewer

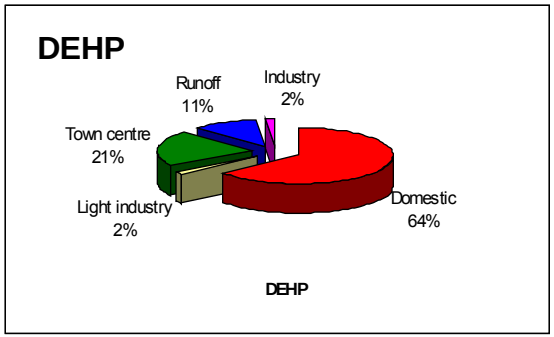
- **Project concentrated on 'diffuse sources'**
  - Domestic inputs (Zn, NP/NPE, DEHP, PeBDE, Pb)
  - Town centre (bars, restaurants, laundrettes, dentists, car washes, dry cleaners)
  - Light industry (engineering works, fabricators, car body/engine repair)
  - Runoff (metals, PAHs)
  - (Traders)
- **Catchment sampling carried out**

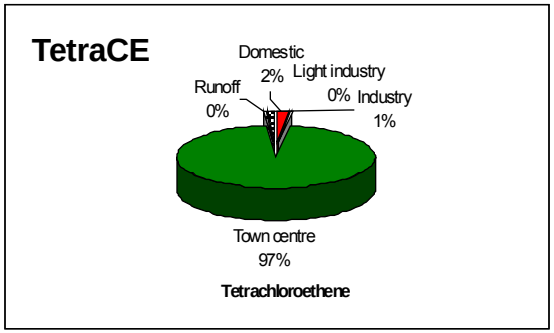
Source apportionment

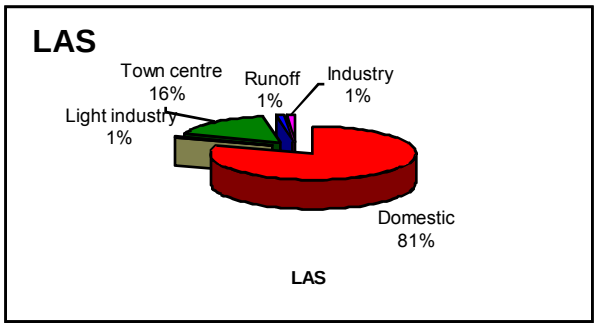


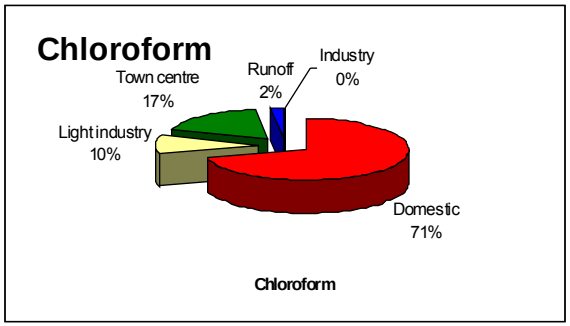


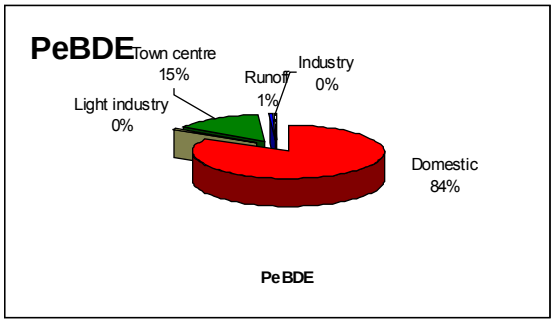






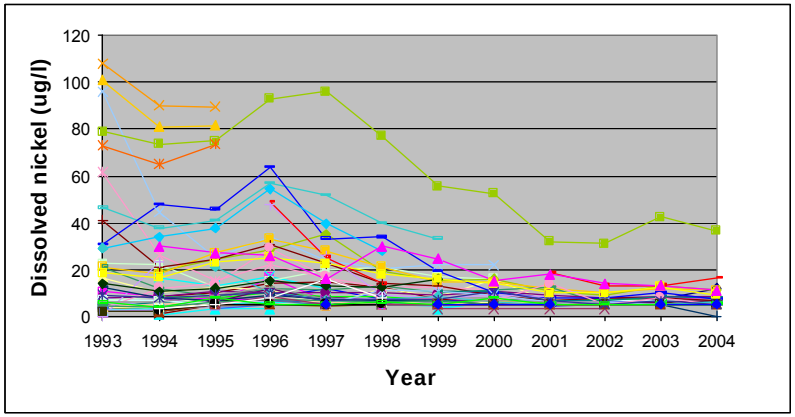


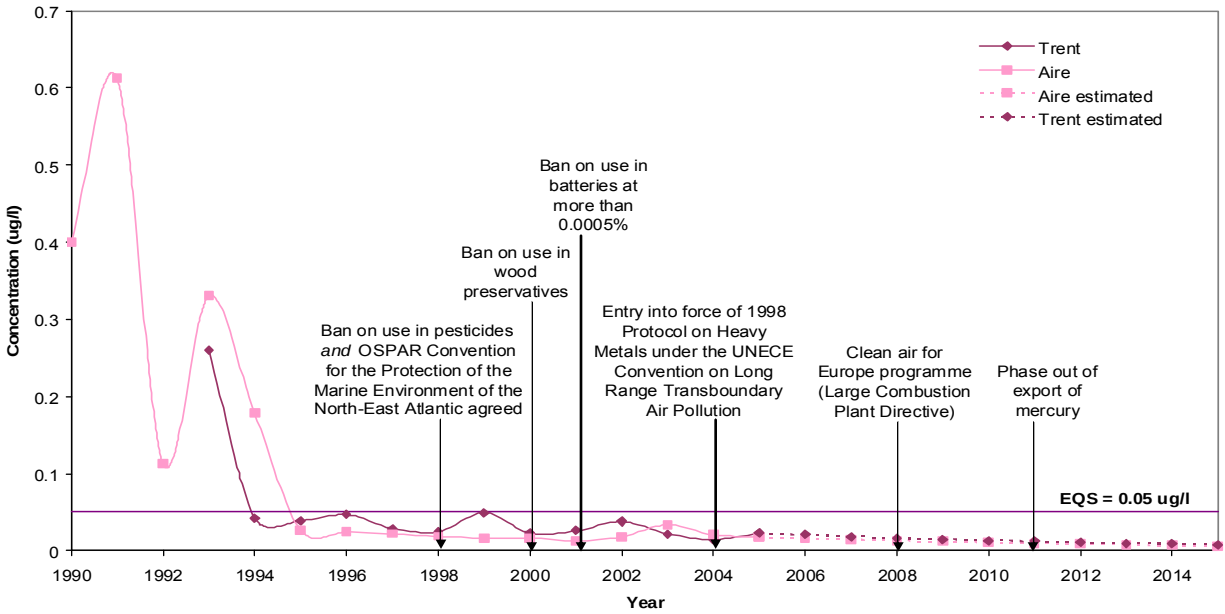




Changing trends

- Concentrations of historically controlled substances (under DSD and other international agreements) are decreasing in the environment.
- Recent control measures are also having an effect:
  - P-dosing of tap waters for Pb (& other metals)
  - M&U restrictions for PeBDE & NP/NPEs
  - Cd/Hg in batteries and products

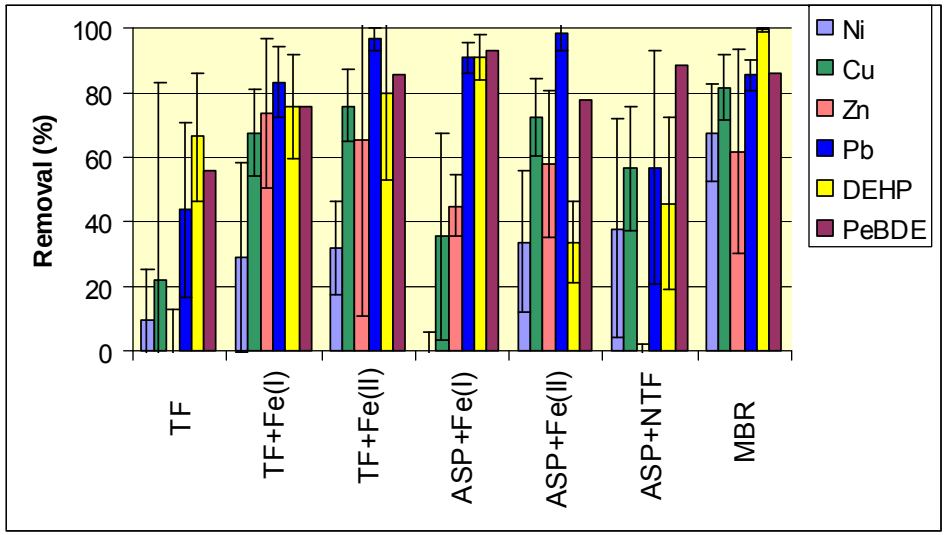




Fate during treatment

How do we treat substances for which source control is not the answer?

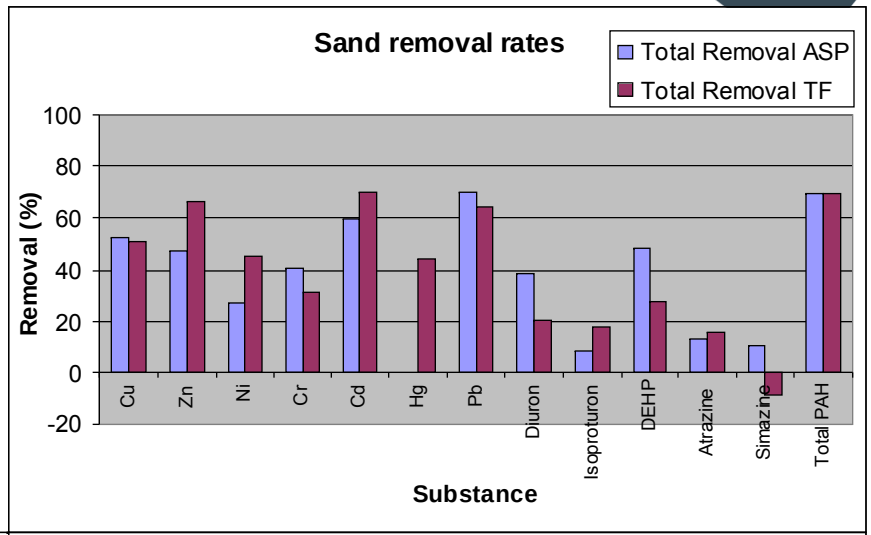
- Conventional treatment not necessarily sufficient.
- Field and laboratory experiments to determine removal efficiencies.
- Field programme:
  - 6 WwTW, composite samples for 2 days on 2 occasions,
  - Influent, primary, secondary & tertiary treatment assessed.
- Removal rates varied significantly. (both by treatment & by time)
- Ni removal poor.
- MBR 'generally' provided best performance.

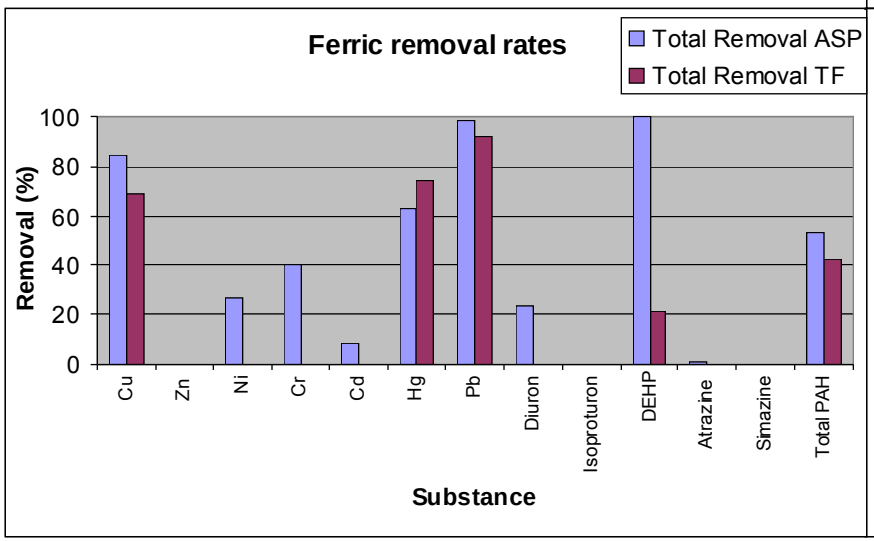


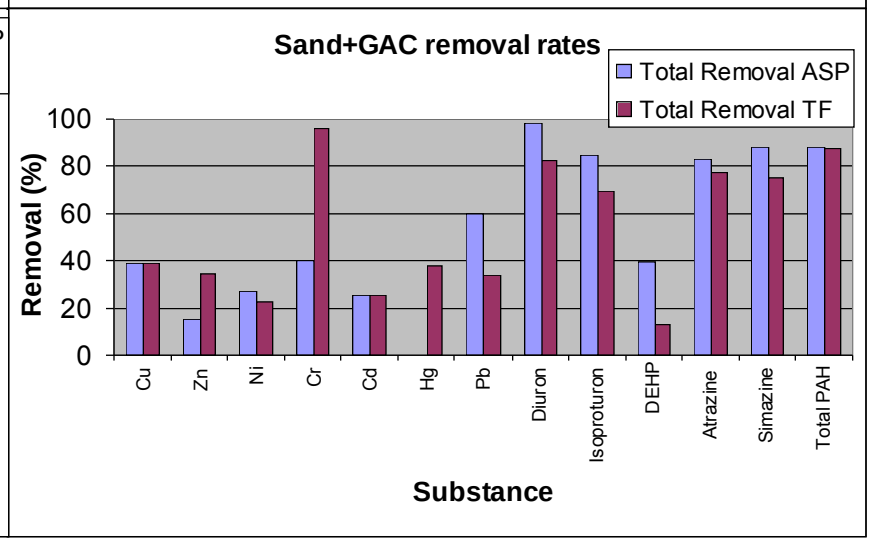
Fate during treatment – Lab studies

Options for more 'novel' technologies?

- Two effluents tested (ASP & TF).
- Removal rates improved at 'high' spiking concentrations.
- Sand removal a certain % of metal.
- Sand & GAC - 'broadband' removal.
- Ferric – variable; Bauxsol good for most metals; PAC poor all round.



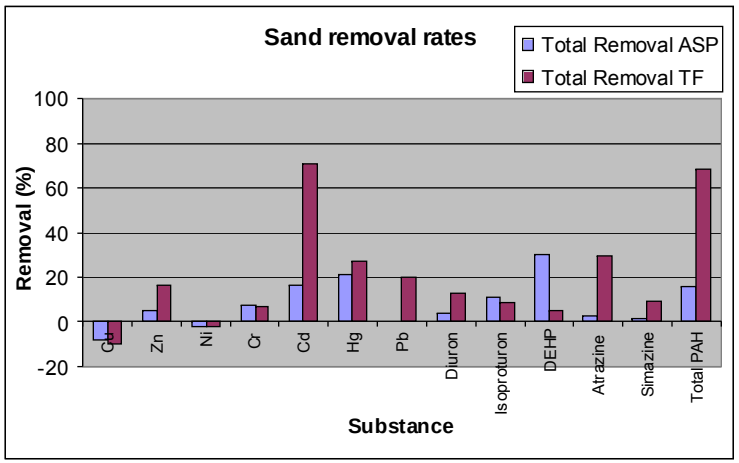


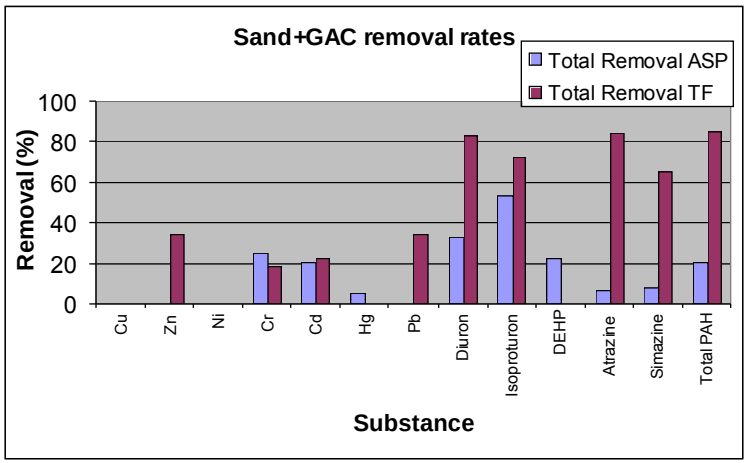


Fate during treatment – Lab studies

- Removal rates poor for 'low' spiking concentrations.
- Removal also more variable between effluents.
- Ferric – variable.
- Bauxsol and PAC poor all round.

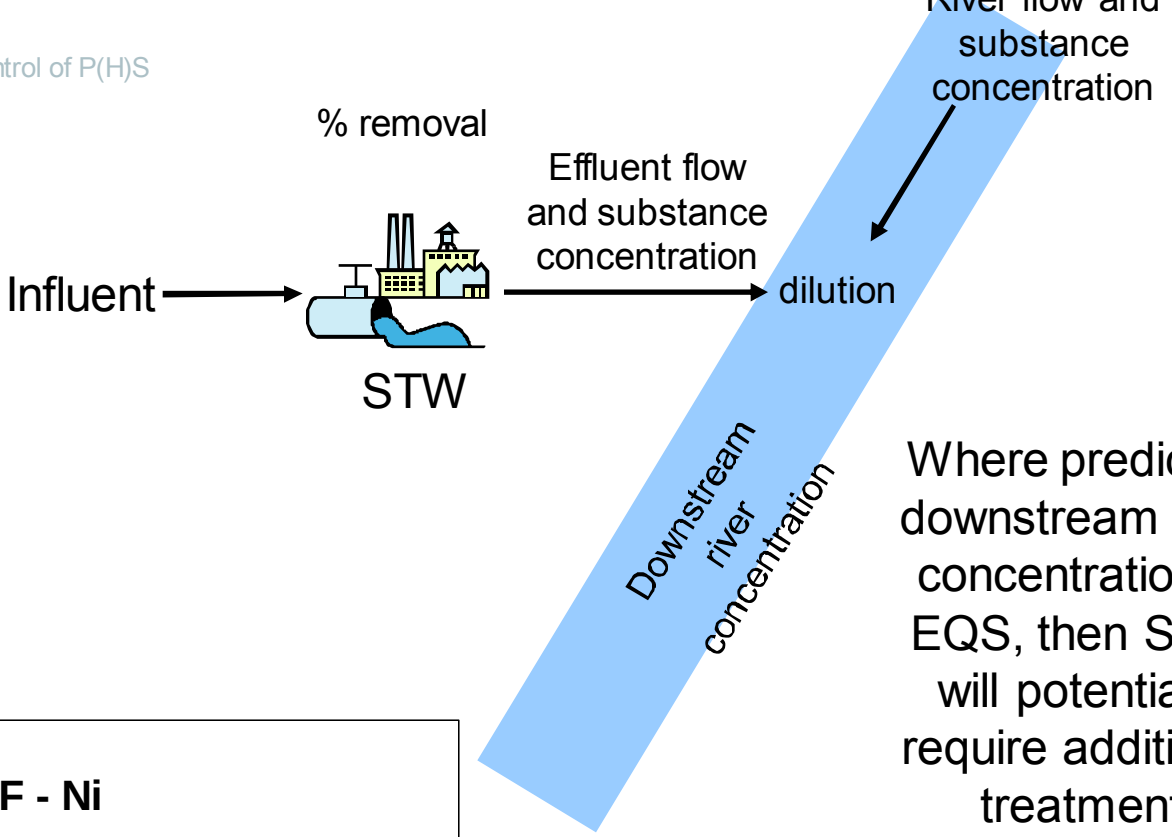
Substance	High spike	Low spike	Mean of WW17c screening study estimated effluent concentration for 30 works
Copper	50	Unspiked	12.4
Cadmium	1	0.5	0.11
Chromium	10	5	2
Lead	20	Unspiked	4.6
Zinc	50	Unspiked	29.5
Nickel	20	Unspiked	9.4
Mercury	1	0.5	0.13
DEHP	10	5	0.93
PAHs	0.5	0.1	0.0084 (total)
Atrazine	1	0.1	<0.005
Simazine	1	0.1	<0.005
Diuron	10	5	<1.0
Isoproturon	10	5	<2.0



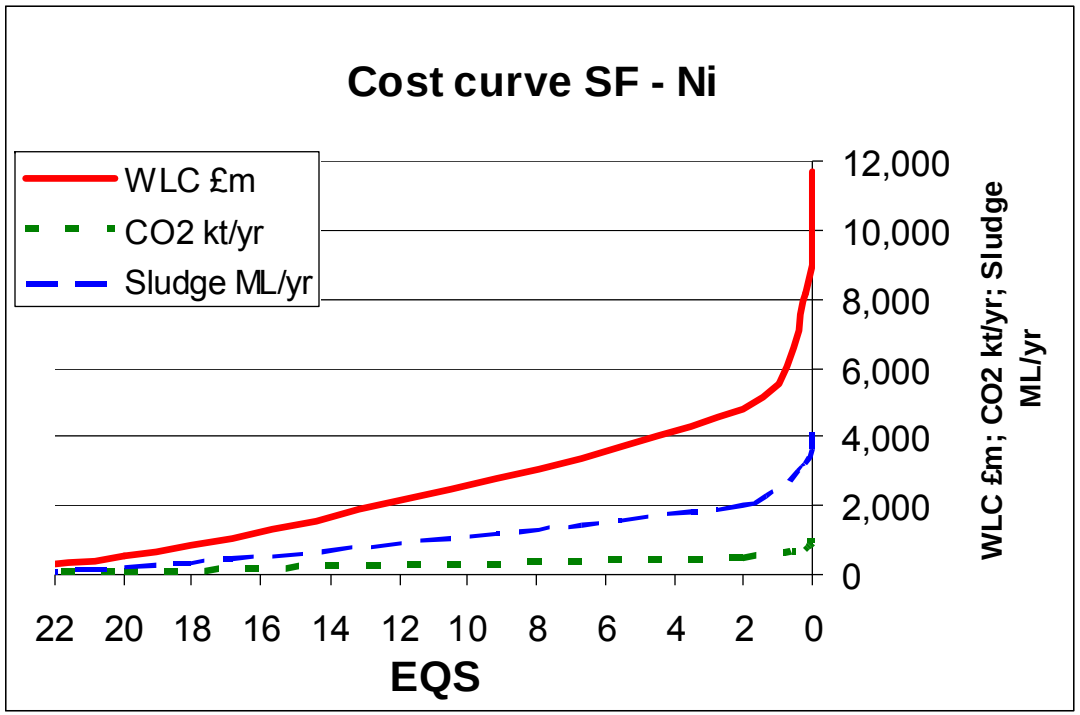


Compliance assessment

Generic risk assessment using average removals and WwTw grouped according to size and predicted dilution in river



Where predicted downstream river concentration > EQS, then STW will potentially require additional treatment



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Implications

- Marketing and Use restrictions now 'biting' for many priority substances.
- Extensive treatment may not therefore be required.
- Residual issues for substances:
  - Poorly removed (e.g. Ni),
  - Those with a low EQS (PeBDE, TBT),
  - Ubiquitous metals with possibly tighter EQS (Cu and Zn).
- Tertiary treatment options will remove most substances to a degree (although not to the required degree in all cases) at a cost (£ and CO_2).

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Remaining uncertainties

- Uncertainty in WwTW removal processes.
- Upscaling of laboratory/pilot scale tertiary treatment options.
- Impacts of P-dosing of tap waters (and to a lesser extent ferric dosing at WwTW) on metal levels at WwTW (subject of a upcoming review).
- DEHP removal variability.
- Ni poor removal (significance lies with EQS value, yet to be confirmed, provisionally 20 µg/l).
- Future substances (additional WFD priority substances such as EDTA, MTBE, glyphosate, musks, PFOS).
- Other sources

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Current investigations: Integrated catchment management

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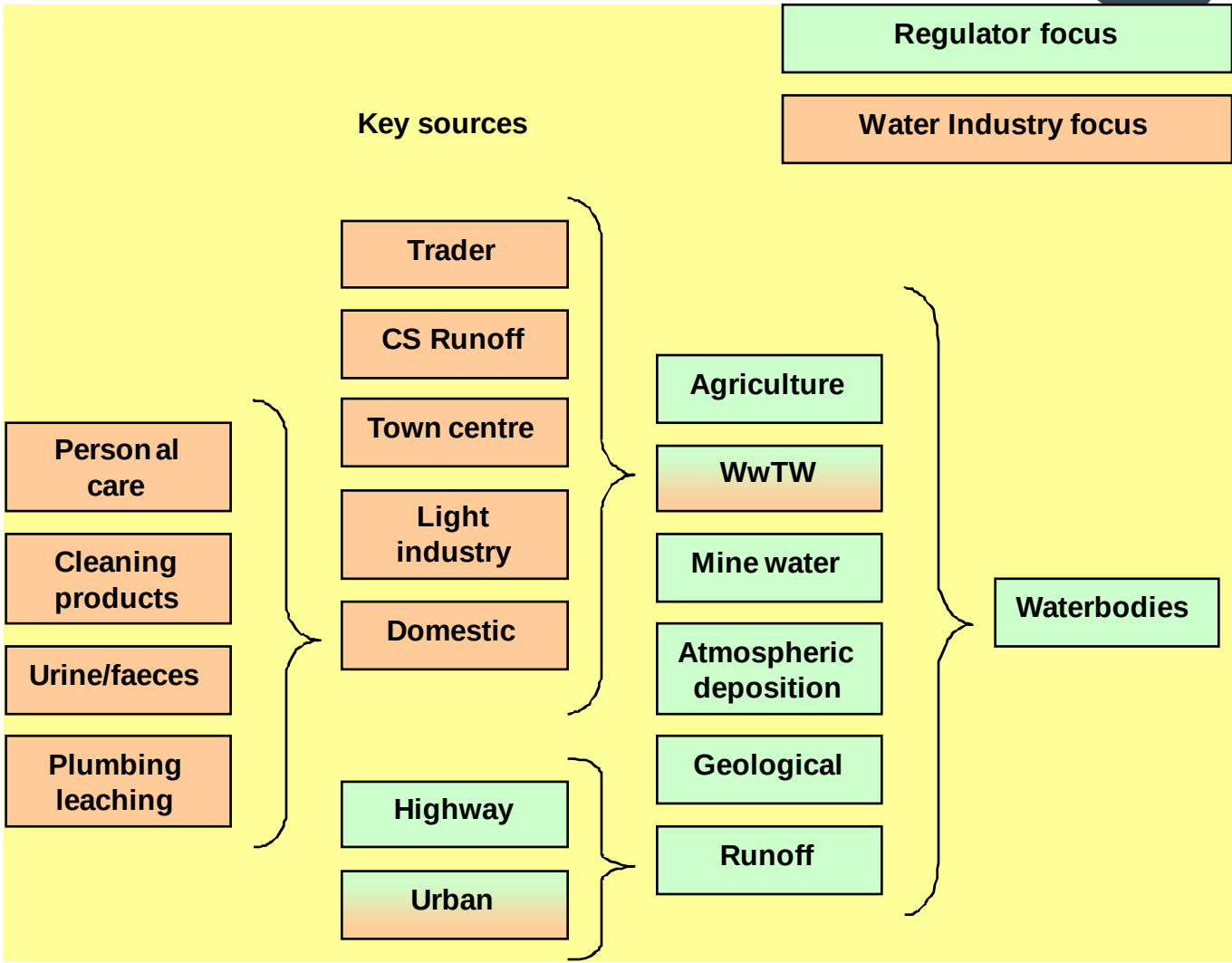
Objectives

- Two collaborative projects between Environment Agency/UKWIR to:
  - Identification of priority chemicals for developing source apportionment tools
  - Identification of data requirements and available databases
  - Options for determining inputs to WwTW
  - Options for best predicting WwTW effluent inputs to surface waters
  - Identification of conceptual methodology for source apportionment
  - Review of available catchment/water quality models (incl. Simcat)
  - Options for pilot catchment testing

Summary of key sources requiring quantification



Source apportionment hierarchy

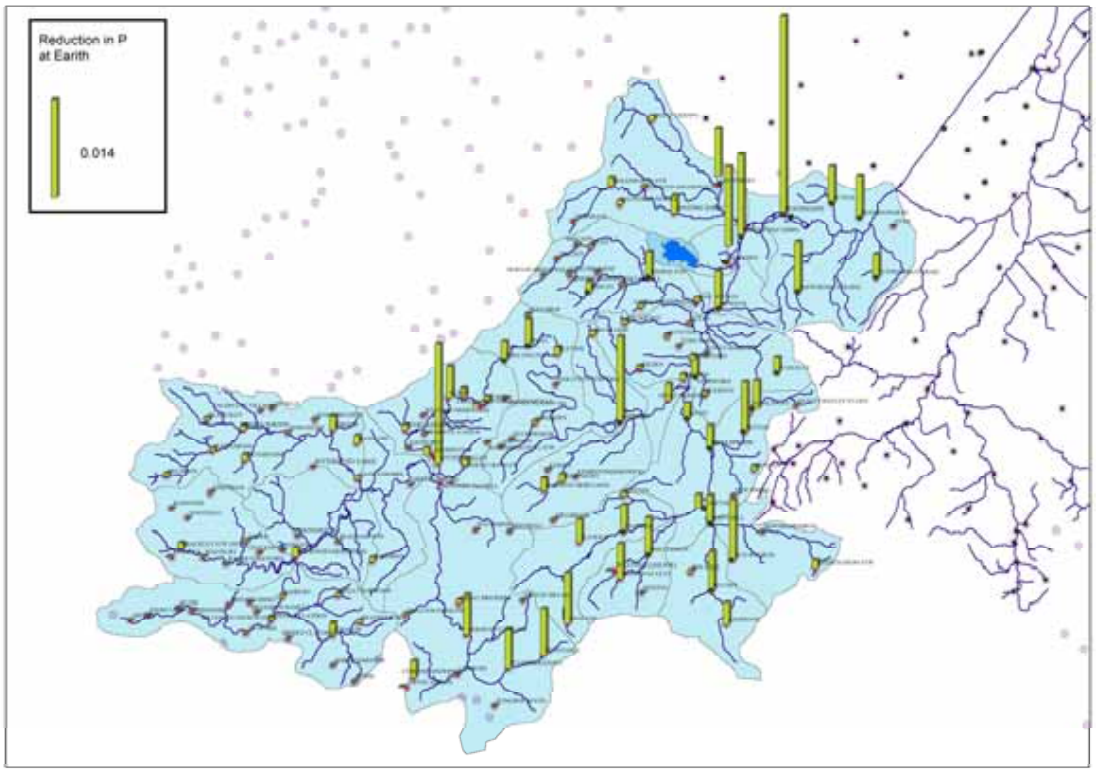
Where substances are from point sources (e.g. WwTW): SIMCAT is suitable to assess source apportionment between individual sources within these sectors.

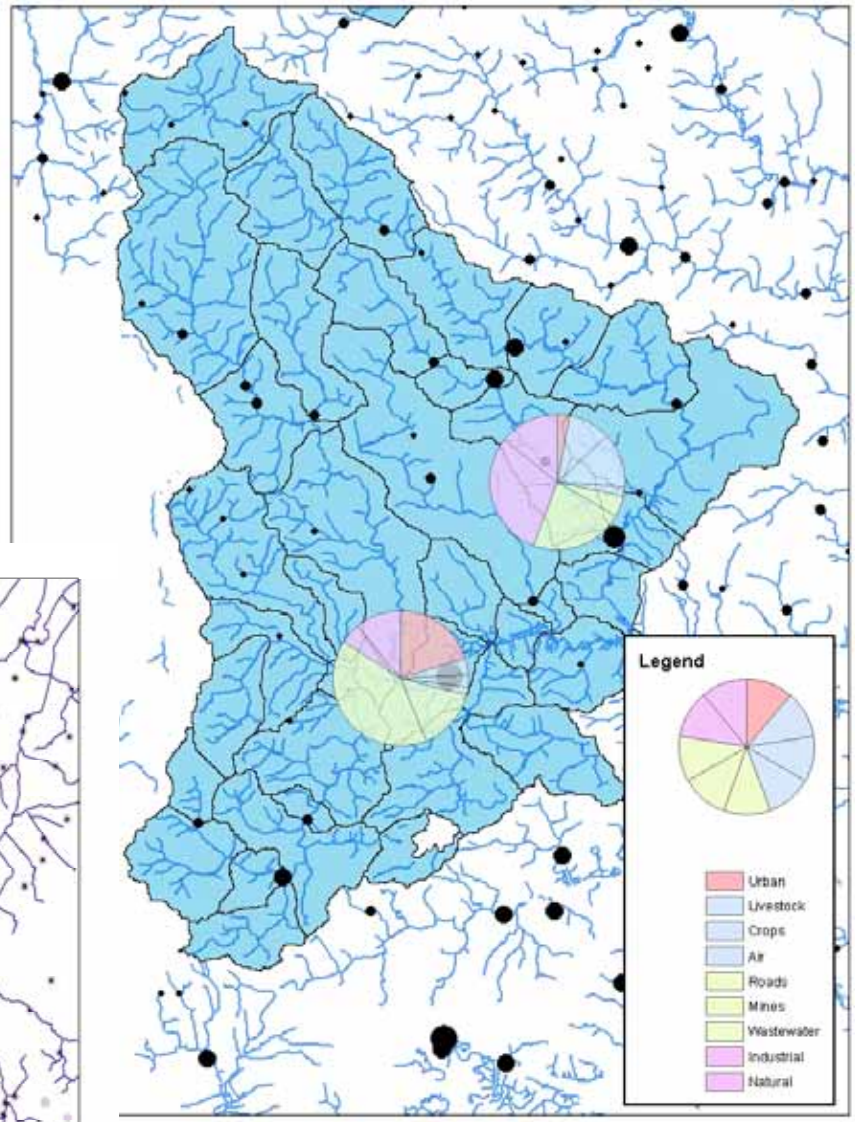
For substances with multiple sources: Develop a methodology for source apportionment work to operate within either the existing or planned IT system. The proposed approach to achieve this is to link a GIS tool, representing the range of diffuse sources, to SIMCAT.

Use of existing models to assess apportionment issues that are too complex to be assessed using above approaches: The complexity of these models means that they are likely to be used by technical specialists.

In some cases data may be insufficient to support a robust source apportionment assessment: identifying requirements for data gathering and review with the aim of feeding into above approaches.

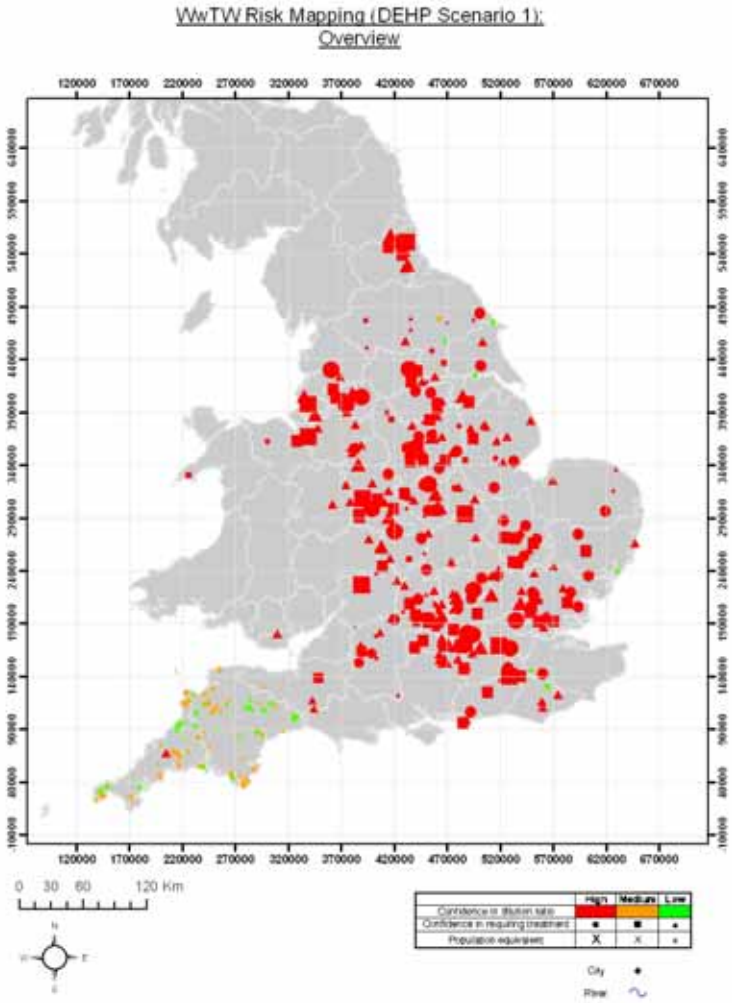
Example of potential outputs from source apportionment



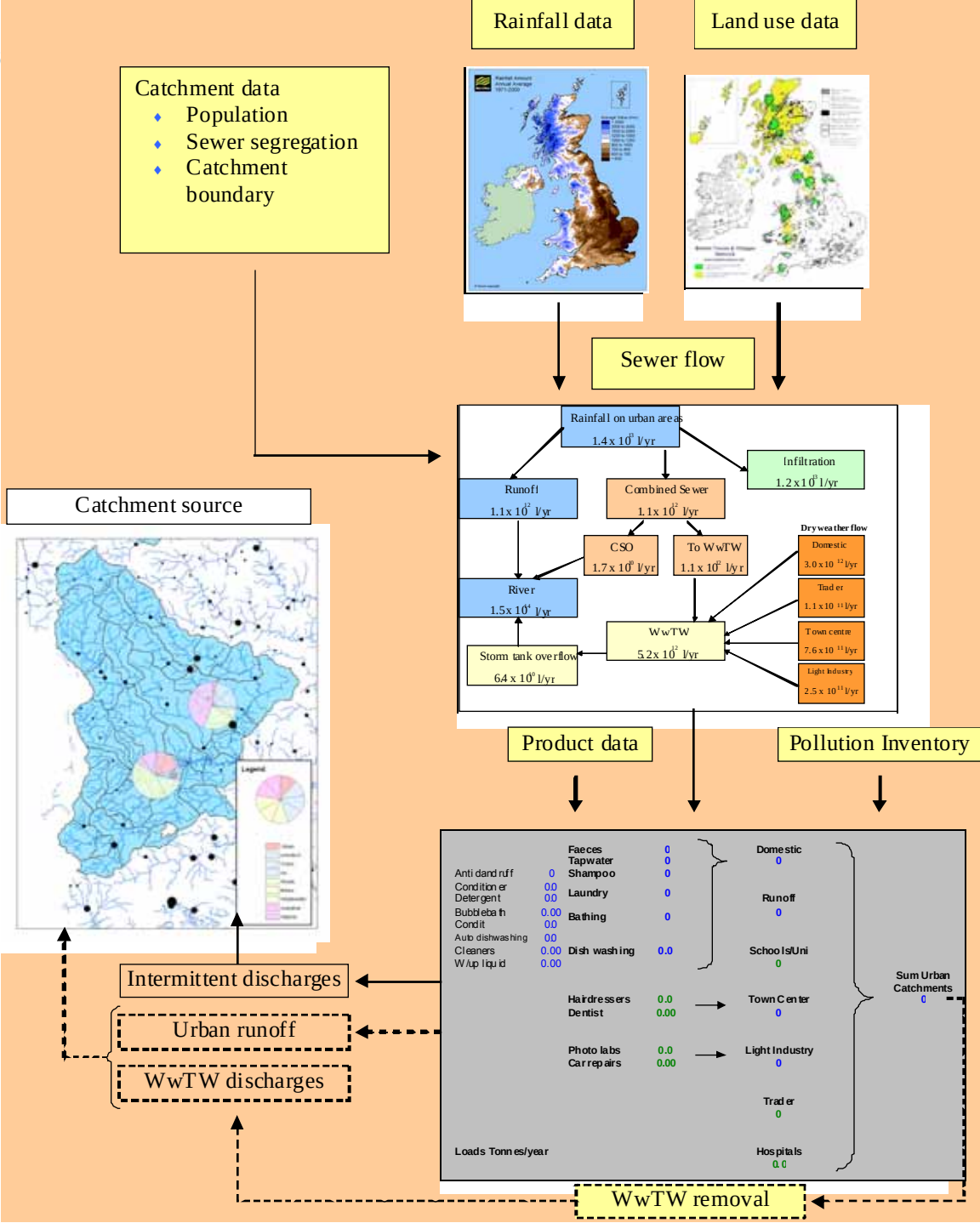


GIS layers already available or under development

- Predicted WwTW concentrations and downstream compliance with EQS
- Non-coal mine discharges contributing to waterbodies at risk or probably at risk.
- Background geology
- Hydrology (Surf/LF2000)
- Other databases also exist:
  - Pollution Inventory
  - National Air Emissions Inventory
- IPR/License issues may need resolving



Schematic of conceptual source apportionment model for sources to WwTW



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Work packages:

1. Develop catchment modelling further:
   - metal partitioning
   - monthly statistics (load and concentration)
   - increased number of determinands
2. GIS approach
   - Develop export coefficients for key substances for the sources identified under Option 2.
   - Generate representative GIS-layers for each input linked to SIMCAT as more appropriate representations of diffuse sources
3. Water Industry/Environment Agency £35 million chemical investigation programme
   - 169 WwTW
   - 66 determinands (incl. tot/diss metals)
   - ~650,000 analyses
   - Spot samples to be taken on up to 30 occasions
   - WwTW influent, primary settled, secondary, tertiary, sludge
   - Trader, runoff, domestic, town centre wastewaters

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Key Conclusions:

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Key Conclusions:

- **Sewer catchment & treatment:**
- Great deal of work done to understand sources and fate within sewage treatment systems.
- Do we have the treatment techniques to treat the substances to meet the EQS at what cost (financial Carbon Dioxide)?
- Investment in WwTW studies will be £35m in next 5 years to investigate the technology requirements options and GHG emissions (whole life costs).

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Key Conclusions:

- **Integrated catchment managment:**
  - Need to better understand all of the sources within the catchment to enable effective POMs development.
  - The strategy of catchment modelling is being developed that will include diffuse, point source and time (seasonality).
  - Significant monitoring required to determine die away when controls are implemented.
  - The links to Good Ecological Status need to be demonstrated; again requiring significant catchment monitoring.

UKWIR - Mission

Develop and deliver, in *collaboration* with other sponsors, regulators and researchers, a research programme that meets the *priority needs* of the UK water service industry

ALL Water Service operators in Scotland, Northern Ireland, England and Wales

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UKWIR aims to

"establish sound science for sound regulation and sound practice "

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Reports Available: www.ukwir.org