Wastewater treatment
Optimisation strategies

Pharmaceuticals and priority chemicals in the Highlands and Islands environment
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Reduce Carbon:
42% by 2020
66% by 2032
80% by 2040
## CIP2 Scotland substances analysed

<table>
<thead>
<tr>
<th>Substance Category</th>
<th>List of Substances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority Substances</td>
<td>BDE 100, BDE 153, BDE 154, BDE 28, BDE 47, BDE 99, Benzo(a)pyrene, Cadmium, Cypermethrin, Di-2-(ethylhexyl) phthalate (DEHP), Dissolved Lead, Dissolved Mercury, Dissolved Nickel, Fluoranthene, Hexabromocyclododecane, Nonylphenol, Octylphenol, Perfluorooctane sulfonic acid, Total BDE, Tributyl Tin</td>
</tr>
<tr>
<td>UKTAG Substances</td>
<td>Dissolved Copper*, Dissolved Zinc*, Dissolved Manganese*, Triclosan</td>
</tr>
<tr>
<td>Watch List Substances</td>
<td>17-alpha ethinyloestradiol (EE2), 17-beta oestradiol (E2), Azithromycin, Clarithromycin, Diclofenac, Erythromycin, Oestrone (E1)</td>
</tr>
<tr>
<td>Additional Pharmaceuticals</td>
<td>1,2,3 Benzotriazole, 10,11-epoxy-Carbamazepine, Atenolol, Atorvastat Carbamazepine, Ciprofloxacin, Fluoxetine, Ibuprofen, Metformin, Norerythromycin, Norsertraline, ortho-Hydroxyatorvastatin, para-Hydroxyatorvastatin, Propanolol, Ranitidine, Sertraline, Tamoxifen, Tolyltriazole, Trixylenyl Phosphate</td>
</tr>
<tr>
<td>Sanitary Determinands</td>
<td>Ammonia, Biochemical oxygen demand, Calcium, Phosphorus, Soluble Reactive Phosphate, Suspended solids, Total Chemical Oxygen Demand, Total organic carbon, Total organic carbon (filtered), Total Oxidised Nitrogen</td>
</tr>
</tbody>
</table>

### Supporting Substances
- Copper, Dissolved Cadmium, Dissolved Organic Carbon (filtered), Hydrogen ion, Lead, Manganese, Mercury, Nickel, Nonylphenol Ethoxylates (NPEO1-3), PAH - total, Perfluorooctanoic acid, Zinc
Key stages in the project

- 24 month **sampling programme** at 20 WWTWs taking upstream, downstream, influent and effluent samples
- 10 month **sludge sampling** at a WTWW
- **Analysing results** and **risk** to identify action
- **Process optimisation** and **catchment management**
- Identifying how substances will be dealt with in the **most sustainable way** and informing the **National Substance Strategy**
Priority of substances and sites

- **Upstream concentration is below EQS/PNEC and downstream and effluent are above EQS/PNEC**
  - Recommend for process optimisation

- **Upstream, downstream and effluent are above EQS/PNEC**
  - Recommend for process optimisation and catchment management

- **Upstream above EQS/PNEC but downstream and effluent are below EQS/PNEC**
  - Refer to SEPA for catchment management

- **Substances found below EQS in effluent**
  - Once enough data confirm that sampling no longer required
**WFD Emerging Issues - Priority Substances**

- **cypermethrin**, insecticide in arable farming and forestry
- **HBCDD** brominated flame retardants now only in wall insulation
- **PFOS** used in fabric protectors banned in 2009, still used in fire fighting foams
- **Benzo (a) pyrene** incomplete burning of fossil fuels, urban diffuse sources inc tarmac
- **Fluoranthene** Coal tar pitch and exhaust emissions, urban diffuse sources inc tarmac
- **Antibiotic currently on the EU Watch list** which is used to treat bacterial infections
- **Metformin**, oral diabetes medicine that helps control blood sugar levels
14 substances recommended for process optimisation

PFOS used in fabric protectors & for fighting foams banned in 2009, still used in photographic coatings

cypermethrin, insecticide used in arable farming and forestry (Tully tubes) also for source control & sewer network management

Tributyl tin antifouling, wood preservatives, antibacterial agent in textiles

HBCDD brominated flame retardants now only in wall insulation

Triclosan found in toothpaste, soaps & cosmetics (voluntary action) - declining

Clarithromycin & erythromycin - antibiotic

Propanolol – high blood pressure medication

Ranitidine – reduces stomach acid

E1 & E2 natural excreted by humans & animals

EE2 birth control pills

Sertraline anti depressant medication

Diclofenac – anti inflammatory gel & pill
What process optimisation may look like - large works

real-time flow measurement

Anoxic zone

Greater removals of biodegradable trace contaminants

in situ SS probes

increased SRT and HRT

improved SS removal

Enhanced particulate bound hazardous chemical removal i.e. metals and nonylphenol
What process optimisation may look like

**Sorption**
- Adsorbable if log Kow > 5
- Poorly adsorbable if log Kow < 3

**Biological sludge**

**Biodegradation + hydrolysis**
- Biodegradable if $T_{1/2} < 10$ d
- Non biodegradable if $T_{1/2} > 500$ d

**Stripping / volatilisation**
- Volatile for $H > 500$ Pa.m³/mol
- Not volatile if $H < 10$ Pa.m³/mol

**CO₂ + H₂O**

**by-products**
Potential source control options

Source control opportunities will be considered once we quantify extent of the problem

- Control levels, trader controls/treatment, cypermethrin, diclofenac
- Source separation
- Product substitution triclosan
- Green chemistry
- Customer education, safe disposal of medicines
- Catchment management, Sustainable Land Management
Source to Sip
The importance of protecting drinking water sources

**Catchment activities**
can greatly impact our source water

**Pesticides & fertilisers**
can make their way into our catchment water sources and alter the water quality

**Our treatment works**
remove these harmful substances but this is cost and energy intensive

This also helps deliver
real environmental improvements

It would also help
enhance and maintain a high quality of drinking water

Protecting our water
sources will provide even greater value for money for our customers
Pesticide issue for Scottish Water

- Two catchments closely monitored for a range of pesticides
  - River Ugie and River Deveron
- Large number of applications for aerial spraying of asulam
- Recent concerns regarding detections of MCPA
Catchment monitoring

- MCPA, MCPP, Propiconizole
- Chlorotoluron, MCPA, MCPP, Metaldehyde, Metazachlor, Propiconizole
- 2, 4-D, Chlorotoluron, MCPA, Metaldehyde, Metazachlor
- Chlorotoluron, MCPA, MCPP, Metaldehyde, Metazachlor
- 2, 4-D, Chlorotoluron, MCPA, MCPP, Metaldehyde, Metazachlor

Monitoring Points
Ugie River System
Number of Pesticides
1
2
3
4
5
6

Sustainable Land Management Incentive Scheme

- Started in April 2012
- Assists with the finance of measures that will improve and protect drinking water quality
  - Finance rate of 75 - 100%
  - Mixture of fixed rates and actual costs
- Cannot be used to meet regulatory compliance
- Offers a range of capital and management items
Thank You