WSP IN EUROPE & THE UK

<table>
<tr>
<td>1.</td>
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</td>
<td>This presentation is on waste stabilization ponds in Europe.</td>
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<td>2.</td>
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<td>Europe is often considered to be too cold for waste stabilization ponds. Many European countries experience cold winters and warm summers so natural systems require much longer retention times to complete the treatment process. However in Quebec, Canada, where the temperatures are far colder than those in Europe, this pond system, designed to allow for temperature extremes, functions particularly well.</td>
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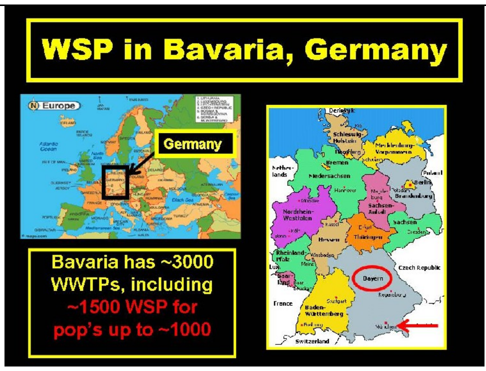
<td>3.</td>
<td>
</td>
<td>Germany experiences a similar climate to that in the UK. In Bavaria in southern Germany there are around 1500 waste stabilization pond systems which make up 50% of Bavaria's wastewater treatment plants.</td>
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<td>4.</td>
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<td>This slide shows a small waste stabilization pond system in Bavaria in the village of Berg near Munich. It serves a population of 250 people and operates satisfactorily all year round, despite mean January temperatures falling to −2°C.</td>
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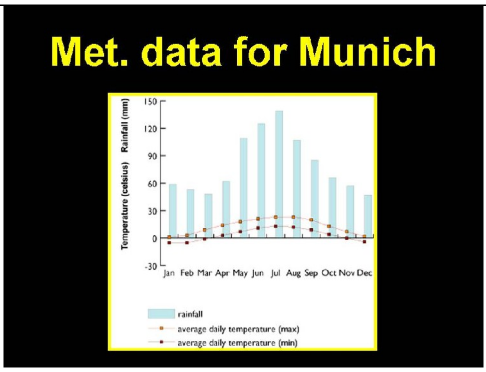
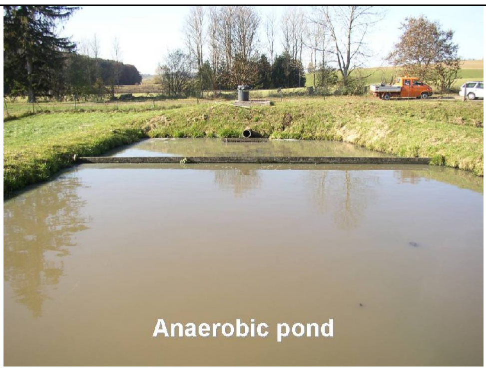
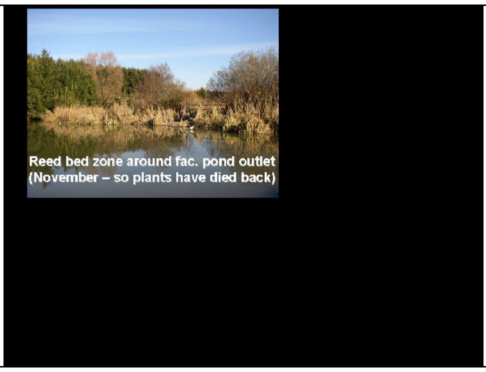
5.		The Berg pond system is designed to meet local water quality requirements whilst taking into account the cold winters, warm summers and high levels of rainfall throughout the year.
6.		This is the first pond in the series. It is an anaerobic pond and is used for primary treatment of raw wastewater. This system has two anaerobic ponds operating in parallel.
7.		This is the secondary facultative pond which follows the anaerobic pond. The majority of BOD and suspended solid removal occur in the anaerobic pond and this pond.
8.		At the far end of the secondary facultative pond is an integrated reedbed. This is planted with *Typha*. This photograph was taken in November, so the *Typha* has died back. It will begin to grow again in March or April.

<table>
<tr>
<td>9.</td>
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<td>The effluent from the reedbed channel flows along a specially designed outlet channel…</td>
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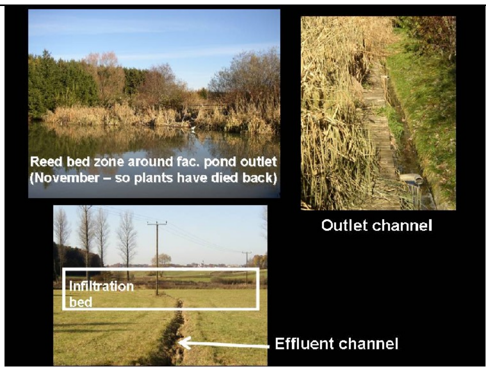
<td>10.</td>
<td>
</td>
<td>…and percolates through an infiltration bed before flowing along an effluent channel to the Lake of Starnberg.</td>
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<tr>
<td>11.</td>
<td>Capital and O&M costs of various wastewater treatment processes for 500 p.e. in Germany in 1996
<table>
<tr><th>Treatment process</th><th>Capital costs (DM p.e.$^{-1}$)</th><th>O&M costs (DM m^{-3})</th></tr>
<tr><td>Activated sludge</td><td>2,000</td><td>2.00</td></tr>
<tr><td>Trickling filter</td><td>1,500</td><td>1.70</td></tr>
<tr><td>Aerated lagoon</td><td>1,200</td><td>1.70</td></tr>
<tr><td>Vertical-flow CW</td><td>1,200</td><td>1.50</td></tr>
<tr><td>Horizontal-flow CW</td><td>1,500</td><td>1.30</td></tr>
<tr><td>**WSP**</td><td>**700**</td><td>**1.20**</td></tr>
</table>
Average 1996 exchange rate: DM1 = €0.53 = £0.43</td>
<td>This slide shows the difference between capital and operation and maintenance costs for various wastewater treatment processes in Germany in 1996. The capital cost of waste stabilization ponds is ½ that of constructed wetlands and ⅓ that of activated sludge. Similarly, waste stabilization ponds offer the cheapest alternative in terms of operation and maintenance costs. These figures are based on small communities of 500 population equivalents.</td>
</tr>
<tr>
<td>12.</td>
<td>**German pond design criteria (ATV-DVWK-A 201, 2003)**
▪ Anaerobic ponds (sedimentation ponds):
0.5 m^3 per person, depth ≥1.5 m
(equivalent to 100 g/m^3 day *)
▪ Secondary facultative ponds (nonaerated lagoons):
8 m^2 per person, depth ~1 m
(≡ 38 kg BOD/ha d *)
* assuming 50 g BOD per person per day
➢ OR: Primary facultative ponds:
10 m^2 per person, depth ~1 m (≡ 50 kg/ha d *)</td>
<td>German pond design criteria published in 2003 states that a German pond system should consist of an anaerobic pond, at least 1.5 m deep, and a secondary facultative pond, 1 m deep. These two ponds require a total land area of 8.5 m^2 per person.
Alternatively, a primary facultative pond can be used instead of these two; it requires 10 m^2 per person and is 1 m deep. Obviously, this is a less favourable option since land can be hard to obtain and can also be expensive!</td>
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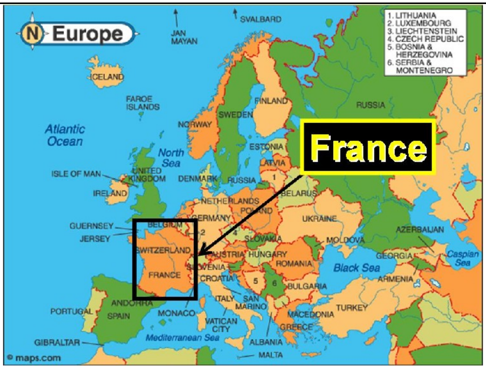
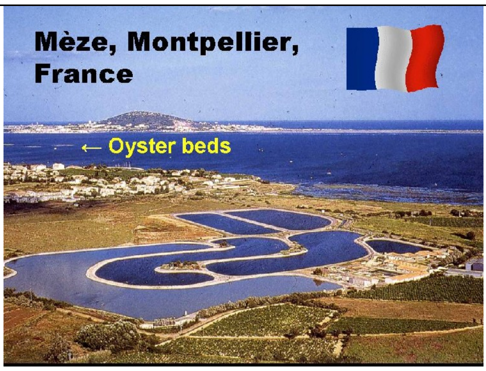
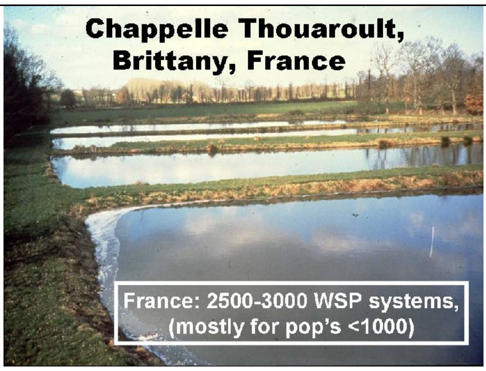
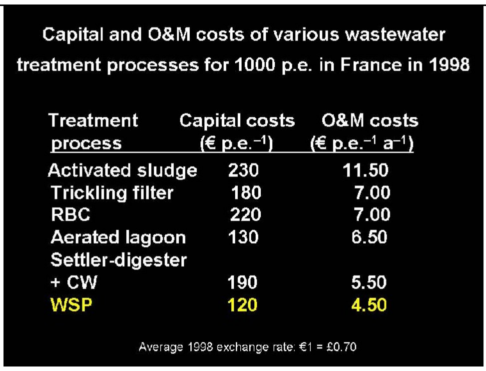
<tr><td>13.</td><td>
</td><td>The next European pond system we will look at is situated in the south of France.</td></tr>
<tr><td>14.</td><td>
</td><td>Mèze is a small tourist town near Montpellier. The waste stabilization pond system treats the wastewater from the town and discharges into the sea. The final effluent has to be high quality due to the close proximity of oyster beds, the oysters from which are used for human consumption.</td></tr>
<tr><td>15.</td><td>
</td><td>This slide shows another waste stabilization pond system in Brittany, in north-west France. It is one of up to 3000 French systems, most of which are for populations below 1000.</td></tr>
<tr><td>16.</td><td>
Capital and O&M costs of various wastewater treatment processes for 1000 p.e. in France in 1998
<table>
<tr><th>Treatment process</th><th>Capital costs (€ p.e.$^{-1}$)</th><th>O&M costs (€ p.e.$^{-1}$ a^{-1})</th></tr>
<tr><td>Activated sludge</td><td>230</td><td>11.50</td></tr>
<tr><td>Trickling filter</td><td>180</td><td>7.00</td></tr>
<tr><td>RBC</td><td>220</td><td>7.00</td></tr>
<tr><td>Aerated lagoon</td><td>130</td><td>6.50</td></tr>
<tr><td>Settler-digester + CW</td><td>190</td><td>5.50</td></tr>
<tr><td>WSP</td><td>120</td><td>4.50</td></tr>
</table>
Average 1998 exchange rate: €1 = £0.70</td><td>This slide shows the difference between capital and operation and maintenance costs in France in 1998, based on communities of 1000 population equivalents. The capital cost of waste stabilization ponds is approximately ½ that of activated sludge and ⅔ that of constructed wetlands. Despite this, it has become more common for French designers to use constructed wetlands rather than ponds in recent years.</td></tr>
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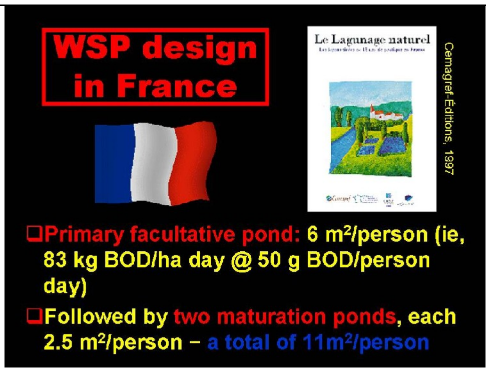
17.



This document, published in 1997, outlines French design criteria for waste stabilization ponds. It states that a waste stabilization pond system should consist of a primary facultative pond at 6 m^2 per person, followed by two maturation ponds at 2.5 m^2 per person each. This amounts to a system requirement of 11 m^2 per person and is slightly larger that the equivalent German system.

18.

Now we will move on to waste stabil-ization ponds in the UK.

19.

There are only around 40 waste stabilization ponds in the UK and all but two are privately owned. The UK water companies do not use waste stabilization ponds for wastewater treatment unless they are specifically requested by the land owner. Our 'inexperience' of appropriate pond design in the UK has resulted in a few strange designs!

20.

This system at Tigh Mor Trossachs in Perthshire, Scotland, serves the house you can see in the top photograph plus some holiday apartments. The final wastewater quality after the waste stabilization ponds has to be of a high standard since it flows into the pristine Loch Achray.

<table>
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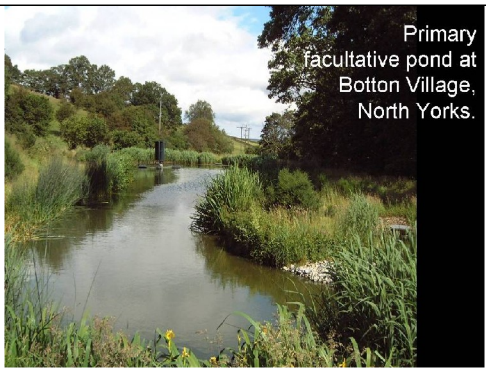
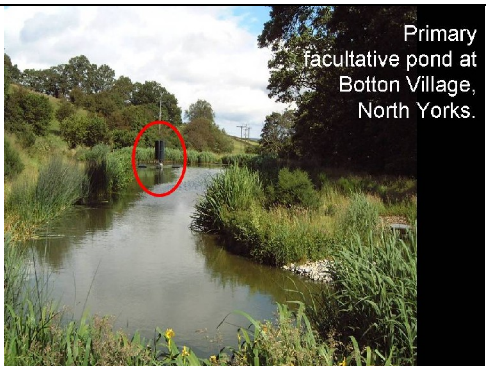
<td>21.</td>
<td>
</td>
<td>This is a photograph of a pond system in Botton village in North Yorkshire. The system was commissioned in 1997 and it was designed for 240 people. It consists of a facultative pond and two maturation ponds.</td>
</tr>
<tr>
<td>22.</td>
<td>
</td>
<td>More recently, a wind-powered aerator has been installed to facilitate mixing in the top 30 cm of the facultative pond. This prevents the pond from going stagnant and maintains the conditions necessary for essential algae to survive.
Consequently, rock filter channels, separating the maturation ponds into smaller ponds have also been installed to remove surplus algal solids before discharge into a stream.</td>
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<td>23.</td>
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<td>This is a Google Earth image of Esholt wastewater treatment works in Bradford, Yorkshire. It is a conventional trickling filter works which treats the wastewater of 620,000people. It is the largest trickling filter WWTW in Europe and it accepts wastewater from both domestic and industrial sources.</td>
</tr>
<tr>
<td>24.</td>
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<td>At Esholt there is a small pilot-scale pond system which is owned and operated by Leeds University. It is a purely experimental system which takes a portion of the raw wastewater from the sewage works, treats it in a waste stabilization pond system and then simply returns the final effluent to the works for conventional treatment.</td>
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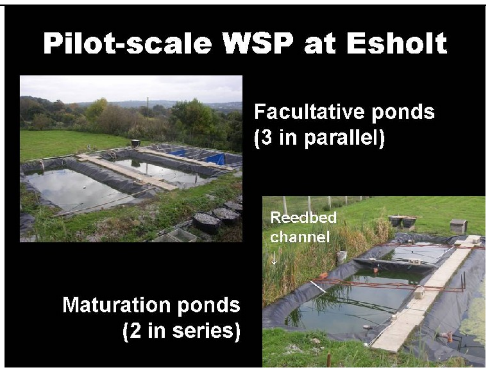
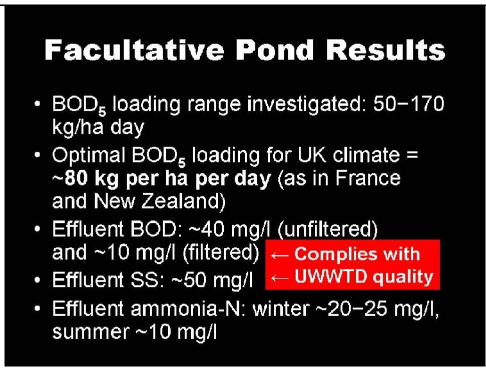
25.



The system comprises three facultative ponds in parallel each receiving raw sewage from the treatment works. Each pond is operated at a different loading rate to establish the optimum loading for ponds in the UK climate. The effluent from the facultative ponds is pumped into a series of two maturation ponds and a reedbed channel. The ponds have now been monitored since 1999.

26.



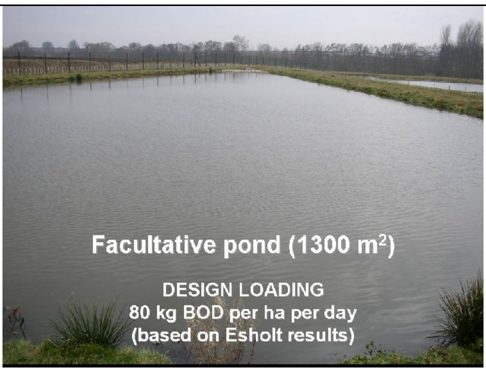
A range of loading rates were investigated and the results from the facultative ponds suggest that a loading rate of 80 kg of BOD per hectare per day is the optimum for ensuring good performance in the UK. This is similar to findings in France and New Zealand for ponds operating in similar climates.

The resulting effluent BOD and SS concentrations comply with the Urban Waste Water Treatment Directive and meet the Environment Agency's requirement of no more than 40 mg of unfiltered BOD and no more than 60 mg of suspended solids per litre of effluent.

However, the ammonia concentration in the facultative pond effluent was between 20 and 25 mg/l in the winter and around 10 mg/l in the summer. This is considered to be a relatively high concentration of nitrogen and the wastewater would require further treatment before discharge.

27.

This slide shows the entrance to Scrayingham Ecological Wastewater Treatment Works, near York in North Yorkshire. It is the only waste stabilization pond system in the England to be owned and operated by a water company since it was specifically requested by the landowner.

28.		The facultative pond is the first pond in the series and covers an area of 1300 square metres. It is designed at a loading rate of 80 kg of BOD per hectare per day, based on the research carried out at Esholt on the pilot-scale experimental ponds.
29.		The facultative pond outlet consists of an integrated limestone rock filter which serves to prevent loss of algae from the pond via the outlet weir. It will also help to filter out any suspended solids from the water column.
30.		The effluent from the facultative pond flows through the outlet weir and into a series of five shallow maturation ponds. Each pond is only 40 cm deep and is separated from the next with limestone rock divides. After the final maturation pond, there is another outlet weir which navigates the flow into a purpose-built fishpond.
31.		The fishpond is the final pond in the series and serves no treatment purpose. It is simply there for the recreational use of the final effluent.

32.		The outlet structure is again a weir which then leads to an inspection chamber…
33.		…which then flows out to the River Derwent.
34.		This natural system has won several awards for its treatment capabilities and sustainable technology. The awards have come from both the engineering and construction industries and praise has been given to the environmentally sound design which attracts many species of birds and insects. The Scrayingham ponds have proved to be a great asset to Yorkshire Water.