Review of drinking water treatment in Estonia

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Surface water

- Estonian lakes
  - Lakes comprise approximately 5% of the territory
  - There are 1200 reservoirs larger than 1 ha.
  - There are no very deep lakes in Estonia
  - Lake Peipus and Võrtsjärv belong among the largest lakes in Europe
  - In the 1970s and 1980s, Estonian lakes were heavily influenced by fertilizers and sewage
  - **Tallinn is drinking lake water**

Surface water

- Estonian rivers
  - Estonian rivers are short, with a small catchment area
  - The river system, however, is dense
  - **Narva is drinking river water**
History

- Hydrogeological survey started in mid 19-th century
- First deep boreholes were made in Tallinn in 1842–1945 (91.5 m), and large quantity of artesian groundwater was found.
- Deepest boreholes ca 600 m
- Very well drilled country

Natural background of ground water

- Hydrogeologically Estonian area is a typical artesian basin with 5 main aquifers divided into a greater or lesser extent by impervious beds:
  - Devonian (D) in Southern Estonia
  - Silur-Ordovician (S–O),
  - Ordovician-Cambrian (O–C)
  - Cambrian-Vendian (C–V) in Central and Northern Estonia.
  - The uppermost aquifer is the Quaternarian.
- Groundwater can be found everywhere in Estonia.
Shaped by Ice Age

Bedrock: granite

Natural background

- The total amount of groundwater is about 2000 km³, being fed on precipitation about 70 mm (3.2 km³/y).
- The most intensive infiltration areas are uplands, which form only 16% of Estonian territory, at the same time when 40% of takes place there.

Surface: precipitation

Deep: fossil
Natural background

- The groundwater till the depth of 200 m is of HCO$_3$–Ca–Mg type with a mineralization of 0.3–0.4 g/l.
- On the coastal areas occurs the ground water of HCO$_3$–Cl–Na–Ca or even SO$_4$–Cl–Na–Mg types with a mineralization of up to 3 g/l.
- The salinity of ground water increases downwards. In the Southern Estonia the salinity of Cambrian and Vendian groundwater is 2–17 g/l (at a depth of 410–780 m), containing relatively high bromine concentration.

Catchment. Intake.

- Surface water (potable – 42.5% (2011. a.))
  - Surface water dominates in Europe
  - In Estonia we drink surface water in Tallinn (360 000 pe) and in Narva (64 000 pe)
  - We take surface water for industry and fish
- Groundwater (potable – 57.5%)
  - In all settlements
  - Partly in Tallinn too
Tallinn

- Early years – water supply was based on shallow wells
- Early documents from 1417. Wooden wells and pipes.
- Ülemiste lake (positioned at city, high above the city)
  - Water supply through open channels
  - Pollution
- New waterworks 19-the century
  - Cast iron pipes (10 km, 1867)
- Suburbs had no water supply
- Industry had their own water supply
  - Water purification since 1927.

Tallinn water supply

- Tallinn is located on the area naturally rather poor in water.
- The town is supplied with water from Lake Ülemiste, which in turn takes its waters from other surface waters.
- There are two major water reservoirs and several canals backing up the supply for the town.
The legendary-mythological "Ülemiste Elder" is believed to live in the lake.

If anyone should meet him, then he is believed to ask: "Is Tallinn ready yet?".

If then the other person answered "yes", then he would flood the city.

Thus, the correct answer would be: "No, there is much to be done yet".

Waterworks

Health authority inspects 1136 waterworks (ca 2012)

As characteristic to Estonia, we have huge number of waterworks with small production

What does it mean?

<table>
<thead>
<tr>
<th>Year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
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<th>2008</th>
<th>2009</th>
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<th>2011</th>
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</thead>
<tbody>
<tr>
<td>Number of waterworks</td>
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<td>1210</td>
<td>1288</td>
<td>1274</td>
<td>1239</td>
<td>1237</td>
<td>1235</td>
<td>1203</td>
<td>1165</td>
<td>1154</td>
<td>1136</td>
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</table>
Waterworks for single industry

- These waterworks are:
  - educational and research institutions;
  - health authorities and pharmacies;
  - the food industry;
  - catering facilities;
  - gymnasiuims and pools in remote areas;
  - penalty institutions (prisons).
In order to use groundwater as drinking water, it usually needs to be purified from various chemicals of natural origin the content of which is larger than usual and which ruin the quality of drinking water.

- Priority: iron, manganese, hydrogen sulphide,
- Secondary: ammonium, fluorides, chlorides, sulphates, boron, barium.

Quality of water in public waterworks

- The quality depends on hydrogeological properties.

- Microbiological parameters – exceeding limits will harm personal health.
- Chemical parameters – exceeding limits will harm personal health.
- Indicators – organoleptic properties are not necessarily direct risk. However, unpleasant water affects our quality of life.
Microbiology

- No water-related diseases since 1996.
- Before that - yes!
- Between 1945 and 1996 we have had 150 water-related cases:
  - 84 düsenteeria
  - 31 hepatiiti A
  - 35 kõhutüüfus ja paratüüfus B

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Where is business?

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-compliant microbiological properties (%)</th>
<th>Non-compliant chemical properties (%)</th>
<th>Non-compliant indicators (%)</th>
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<tr>
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<tr>
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<tr>
<td>2011</td>
<td>0,01</td>
<td>0,99</td>
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</tr>
</tbody>
</table>
**Ozone & ozonation**

- Pioneer: Tallinn Water treatment plant, 90-ies

- Rein Munter, Tallinn University of Technology

**Removal of Fe**

Tartu Anne WTP
Small waterworks
Desinfection
Fluoride

Fluoride
Removing radionuclides.
5/2010

- Due to their carcinogenic effect, radionuclides (radon, radium, uranium) can bring about serious health risks.
- The OÜ Water Technology Partners has developed a relatively simple, chemical free and environmentally friendly technology for purifying groundwater from radionuclides.
- The theoretical preliminary study was followed by pilot trials using a test device of the Viimsi water treatment plant (capacity 3 m³/h).
- Sludge! That’s new.

Rein Munter, Tallinn University of Technology, Tiit Kivimäe, Water Technology Partners OÜ

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Tapwater is safe to drink at all times

- No water shortage in Estonia
- I pay 2,04 €/m³ (incl sewerage and tax), max 6 €/m³.
- Actual consumption <100 l/d (143 l/d as designed)
- Quality is reasonable, some treatment is required (mainly Fe and Mn)
- Water is hard (not good for heating & industrial purposes)
- Mainly groundwater, surface water in 2 towns
- Mining area, draining mines & wasting water
Drinking water treatment

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