WAT Project Course
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Extraneous water in sewer networks

Porvoon Vesi & HSY

OUR FINDINGS

Every time it rains heavily, something happens beneath your feet!

In wastewater systems, not all the water flowing in the sewer should actually be there. Rainwater, stormwater and groundwater can enter wastewater networks through faulty connections, leaking manholes, broken pipe joints, or aging infrastructure.

This is "Extraneous Water"

... and it creates major problems for both utilities and the environment.

About the project

Our project looks at extraneous water in the context of HSY and Porvoon Vesi, especially how stormwater from private housing areas may enter the wastewater network.

We wanted to understand not only the problem itself, but also its scale, impacts, and which solutions could realistically reduce it.

Wastewater treatment plants are designed to treat wastewater, not large amounts of rainwater and groundwater. When extra water enters the sewer, it increases flow, raises pumping and treatment costs, and can contribute to overflows and pollution.

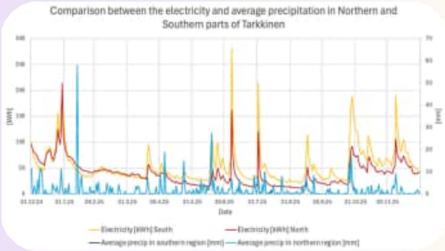
To study this, we combined different types of data, including precipitation, flow, and electricity consumption from pumping stations. We also reviewed case studies from other utilities to connect our local findings with wider patterns and possible solutions.

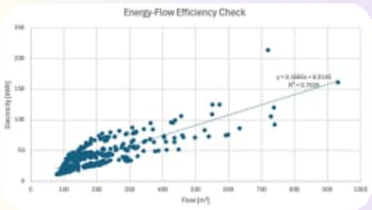
Let’s look at some of the data analysis we have conducted...

Tarkkinen (Porvoo)

This graph compares electricity use and rainfall over time in the Northern and Southern parts of Tarkkinen. Electricity use often rises during rainfall events, especially during the bigger peaks. The Southern side shows higher and more frequent peaks, which suggests it may be more affected during wet-weather periods.

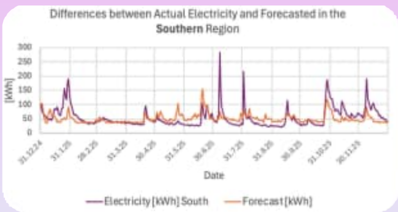
Because the response is not identical in every event, the two areas may have different inflow, leakage, or drainage conditions. Overall, the graph suggests that extraneous water is linked not only to sewer flow, but also to higher pumping energy use.



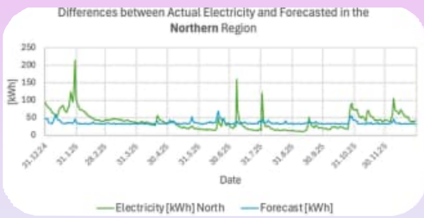


This scatter plot shows the relationship between pumped water volume (flow) and electricity use. The trendline ($R^2 = 0.7028$) suggests a fairly strong positive relationship, meaning higher flow usually leads to higher energy use.

Points far above the line may indicate inefficient pumping events. In the context of extraneous water, these could be moments when storm inflow increases pressure on the system. The slope (0.1665) suggests that pumping 1 m^3 of water requires about 0.16 kWh on average.



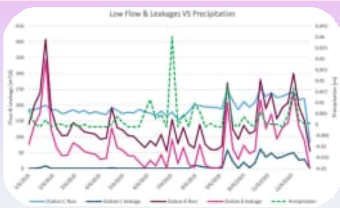
This graph compares actual and forecasted electricity use in the Southern region. In many periods, the two lines stay quite close, which suggests pumping energy is fairly predictable under normal conditions. However, there are several clear spikes where actual electricity is much higher than forecasted, especially around late January, late June, late July, and late October to November. These peaks may reflect wet-weather inflow or leakage events that increase pumping demand.



This graph compares actual and forecasted electricity use in the Northern region. The forecast stays fairly stable, while the actual electricity use shows several sharper peaks. The biggest differences appear around late January, late June, mid-July, and near the end of the year. This suggests that actual pumping conditions are not always captured well by the forecast, and the sudden peaks may indicate inflow or infiltration events that require extra pumping energy.

Helsinki

This tracks low flows and leakages at two monitoring stations (B and C) in the Helsinki area throughout 2025, plotted against precipitation. Station C shows a relatively stable flow around 180–240 m^3/d across the year, while Station B exhibits much more leakage, with sharp spikes particularly in February and December. The precipitation peaks (notably in Jul–Aug) don’t always correspond directly to leakage spikes, suggesting that extraneous water infiltration is influenced by factors beyond just immediate rainfall, such as soil saturation or infrastructure condition.



In our literature review we found several examples that were combined together to address the issue.

Practical examples include sewer lining, manhole sealing, CCTV inspection, flow meters, rainfall monitoring, storage basins, detention/retention ponds, bioretention, permeable surfaces, and other green infrastructure approaches. This was useful for our project because it showed that the most realistic path is a combination of measures, better information (such as prediction and monitoring data), local planning, and preventative actions, including more nature-based approaches like bioswales, permeable pavements, etc.

Let's look at some examples of possible interventions...

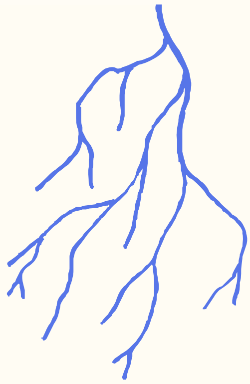
1. Sewer rehabilitation (relining / pipe renewal)
Used to reduce groundwater infiltration through cracks, broken pipes, and defective joints. It's suitable for old or damaged sewer networks and the main benefits include the reduction of infiltration and the improvement of the system condition.

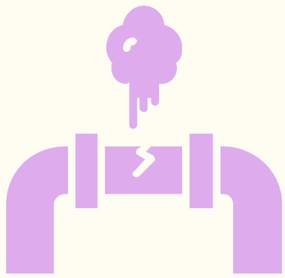
2. Repair of manholes and covers
Targets leakage through deteriorated manholes, frames, and covers.
Use: Important in areas with high groundwater or direct inflow.
Main benefit: Can reduce weak points in the network.

3. Removal of faulty stormwater / roof drain connections
Used to stop stormwater from entering sanitary sewers.
Use: Relevant in old properties and separate sewer systems.
Main benefit: Reduces inflow, especially during rainfall.

4. Separation of combined sewer systems
Stormwater and wastewater are directed into different systems.
Use: Large-scale measure for combined sewer areas.
Main benefit: Can strongly reduce inflow, but is expensive.

5. Measures at private properties
Includes fixing private laterals and correcting wrong connections.
Use: Important because part of I/I often comes from the private side.
Main benefit: Can be practical and cost effective





Homeowner engagement

During our project, we became more interested in private properties as part of the extraneous water problem. Stormwater from roofs, yards, and paved areas may still enter the wastewater network and create unnecessary load for the utility. This part of the issue is often discussed less clearly than the larger municipal network, even though its impact can be significant. Because of this, we see homeowner engagement as an important part of the solution, alongside technical improvements and better stormwater guidance for residents.

Our main takeaway is: when rainwater ends up in the wrong pipe, the consequences are bigger than they first seem. By understanding where the extra water comes from, how it behaves, and what it costs, utilities can make better choices.

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Thanks for reading this far.