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WaterMan

The WaterMan project
Mobile system to disinfect treated wastewater

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Interreg Baltic Sea Region

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Challenge/problem

Our mission is to keep the municipality and city attractive and green (3, 30, 300)

Green means we need to irrigate

Repeated periods of drought showed lack of reliable water supply

Droughts expected to become more frequent and severe in the future

The water we used had quality problems

Political decision not to use drinking-water for irrigation

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Can recycled water be one of the solutions?

Kalmar municipality use old technique in new way to recycle wastewater.

Objectives – questions to be answered

- Can wastewater become a reliable and enduring source for irrigation?
- Will our staff and citizens accept reused wastewater?
- Will their attitude to reusing wastewater change over time?
- Can we produce and use this water within current legal framework?
- Will our technical solution work in practice? (Intermittent operation)
- Will we reach the quality standard that is required? : Will it be safe to handle from a health and environmental perspective?
- Can we expand the areas of use for recycled wastewater besides irrigation?
- Is it reasonable from an economic point of view?

Background

- Policy not to use drinking-water for irrigation in Kalmar municipality
- Kalmar Vatten AB (KVAB) had used treated, but not disinfected, wastewater for cleaning pipes since several years and offered us to use such water for irrigation.
- Nearby golf-courses had used disinfected treated wastewater mixed with drainage water for irrigation with positive experiences.
- Favourable location of UV-pilot from logistic, technical and environmental point of view was identified and accessible.
- Favourable financing through WaterMan (EU) and Swedish government

Stakeholders

- **From start:**
- Kalmar municipality, Department of Parks
- Kalmar Vatten AB (public utility company)
- Kalmar municipality, Dep. of Environment: Formal permission
- Regional Administrative Board Kalmar Län: part in legal process
- **As the project proceeded** and worked well in practice, new areas of use was added:
- Kalmar municipality, Dep. of Streets: cleaning streetgutters
- Kalmar municipality, Dep. of Culture and Sports: irrigate football fields

Solution

- **Container-based disinfection with UV-light chosen mainly because:**
- Very efficient to kill most pathogenic microorganisms.
- Well proven technique.
- Easy to operate and maintain. (Big advantage with numerous and rotating staff).
- No chemicals needed and no effluent or residual discharge to handle.
- Comparatively low cost for investment and operation.
- Intermittent (on/off) operation chosen because:
- Excludes need for storage tank and decreases energy consumption.
- Container makes it easy to move to new location, simple and cheap foundation on site
- Ready to start at delivery, functions tested at factory.
- Ozon-treatment and desalinated seawater were discussed but dismissed for technical, operational and financial reasons.

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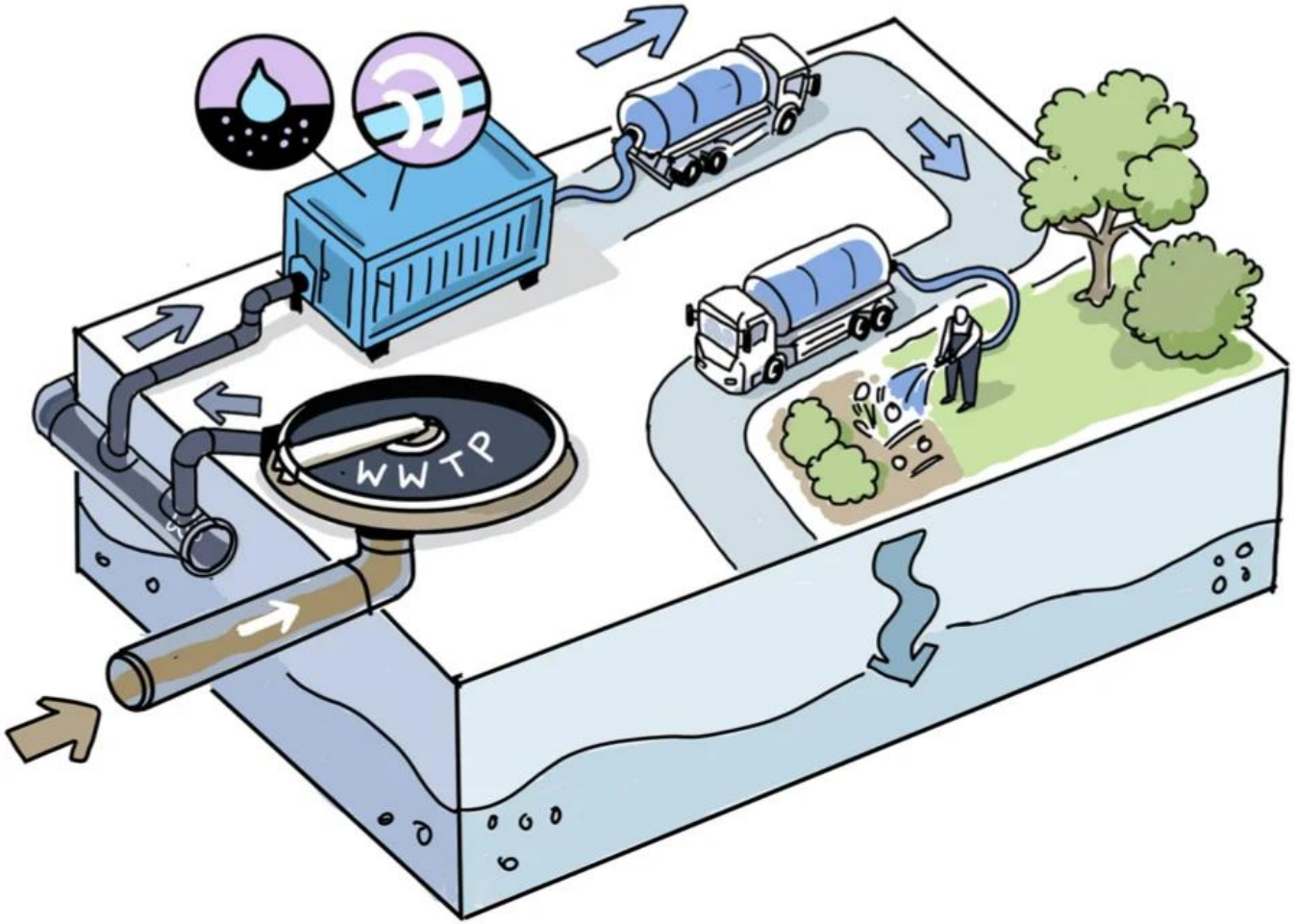
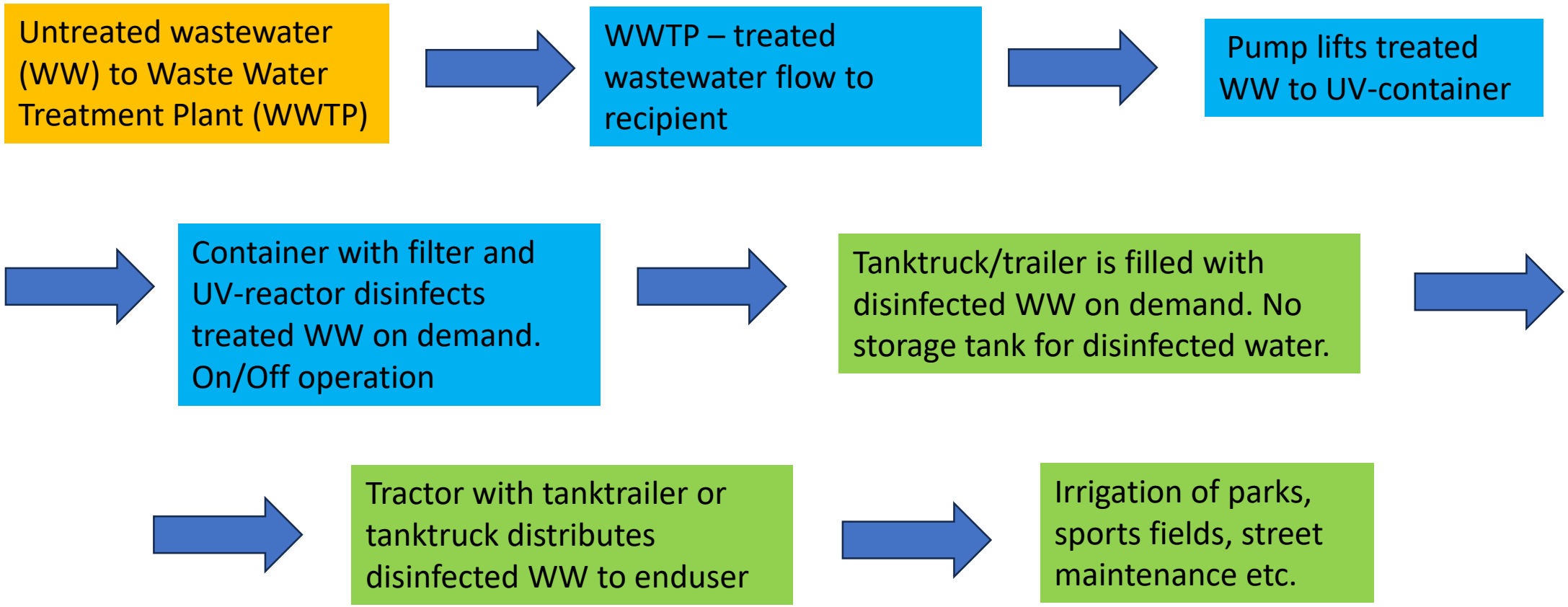
How it works

Schematic picture of recycling water used twice before entering the natural water-loop, thus saving ground and surface water of higher quality.



How it works – schematic picture



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Development & implementation

Research and preparations

Implementation and operation

Prior to start:

- Contact users of recycled wastewater – collect experiences.
- Discuss with experts and manufacturers.
- Collect and compile existing knowledge and experiences – consider pros and cons.
- Present ideas to staff.
- Reactions were mainly sceptical, varied from positive to very negative.
- Involve staff in process at early stage.
- Discussed questions and negative reactions within staff in a serious, sensitive and responsive way.
- Found relevant answers to their questions and we were transparent with risks.
- Involved experts and staff in risk analysis and forming action-plans.
- Allowed learning process to take time.
- Convinced sceptics through knowledge.
- Identified legal framework relevant to our production and use (EU 2020/741).

Tests before design and procurement.

- Analysis of water quality: particles, microorganisms (E.coli), turbidity, transmittance.
- Test of different filter-sizes: Particles affect efficacy of UV-light.
- April 2023: Filter-test and UV-efficacy tested in small scale equipment (add picture)
- Users of similar technology and design - farmers and staff at golf courses interviewed.
- May 2023: Tests, water analysis and experiences from others showed it was possible to design a disinfection plant that would meet our requirements within budget.

Small scale test – April 2023.

- Equipment to test UV-efficacy with different grade of filtration.
- Results from test used in procurement process and designing UV-pilot plant.

Legal process

- November 2022: **Agreement** between Dep. of Parks and Kalmar Vatten AB regulating diversion and use of treated wastewater, was signed.
- February 2023: Dep. of Parks **notified** environmental authority with description of our plans, production and use, risks etc.
- May 2023: **Legal permission** to produce and use disinfected treated wastewater for irrigation in parks etc. issued.
- August 2023: Building-permit for UV-pilot container issued.

Tools and methods

- Risk analysis carried out together with staff and experts.
- Likelihood x consequence = risk value = action plan
- Relevant measures outlined together with staff and experts.
- Measures to handle risks described in action plan: Describes who is responsible to implement those measures and when to be ready.

Procurement process

- Decided to buy a **function** (producing class A-water at a certain capacity, intermittent operation etc.), **not a specified technical design**.
- Function compared to specified design reduce risk for client but most likely come with a higher price for the plant but a lower total cost.
- We used expertise to outline procurement documents.
- October 2023:Tender documents published in TendSign.
- November 2023: First bid above our budget.
- December 2023: New modified (class B-water) procurement resulted in one bid that fulfilled our requirements within budget.
- January 2024: Contract signed

Installation and start of operation

- February – March 2024: Preparing site for installation, groundwork, foundation, electric connection.
- April 2024: Education of staff: Risks and how to handle them.
- April 2024: Delivery and installation of UV-pilotplant.
- May 2024: Test operation with quality control of function and produced water. Water analysis showed < 10 E.coli/100 ml.
- Mid May: Start using recycled disinfected treated wastewater for irrigation.

Delivery of pilot-plant in April 2024

- UV-pilot built ready to use in manufacturers factory.
- Only feeder-pump and pipes to be installed on site.

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Lessons learned

What we expected and what really happened

Lessons learned

- Initial, expected, negative reactions within staff turned to positive.
- We believe involving staff early in process and being transparent with risks was crucial for a smooth process and achieving our goals in time.
- Expert help necessary but practical experiences from users and supplier of equipment has been very valuable in avoiding mistakes.
- Close cooperation with Kalmar Vatten AB has been vital for succeeding.
- Extensive research of technical solutions, legal prerequisites, different risks, local conditions and costs is well worth the time and effort.
- We expected more technical problems in start-up phase but experienced few.

Lessons learned

- Communication with KVAB at interruptions can be improved.
- Validation process (for class A-water) more complicated than expected.
- No laboratories found in Sweden that can make analysis of CP spores.
- Choose location of plant with future expansion in mind.
- Regrowth of bacteria has not been a problem – that opens for storage tank and UV-plant with lower capacity (flow/h). Possibly lower cost?
- Particularly interesting if tank can be placed underground (= low temperature), or natural pond is available.

Lessons learned

- Temporary staff (vacation) and newcomers requires resources for education and support.
- Good support from manufacturer is very important in start-up phase.
- We expected plenty of water during the season and round the clock regardless of drought or not – our main reason to choose effluent waste-water as a water supply source.
- We found instead that substantial variation in effluent flow caused problems for pumps to start early mornings.
- Solution is identified but not yet implemented.

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Scalability

Scalability

- The concept and design can be scaled up or down, depending on need.
- Designed for mobility: Since most equipment are installed inside the standard 10" container, it can be installed wherever there is electricity supply.
- Upscaling might need larger container and larger electric capacity but design is based on standard components and can be adopted to various capacities.
- Upscaling can be economically viable depending on volume. Produced volume is one crucial factor, large volume normally means lower cost per m^3.
- Means of distribution is also a crucial factor for cost. Long pipelines are expensive to build but can carry large volumes efficiently.
- Distribution with truck/tractor is very flexible, cost varies with volume and distance.
- Correct estimation of volume now and in future as well as logistic conditions is therefore very important in deciding optimal capacity of plant and way of distribution.

Transferability

- The concept, UV-disinfection built in container, can be applied in many different cases where there is a need for disinfection of water.
- Quality of incoming water (resource) must be analyzed for correct design and function of plant. (Filtration, UV-effect)
- Location is dependent on electricity supply (grid or off-grid supply) and access by truck or tractor.
- Area of use determines way of distribution. Sprinkler irrigation requires delivery of disinfected water in pressurized pipes.
- Volume, distance and way of distribution are vital factors in calculating costs and deciding which solution is most economically and environmentally viable.

Final reflections

Biggest surprise:

- Smoother and faster process than expected. Legal uncertainties regarding permission for production and use was sorted out quickly.
- Less technical problems than expected.
- Higher microbial quality in treated wastewater than stormwater used previously positive insight.

Final reflections

Moments of doubts:

- Acceptance among staff, negative attitude to wastewater at first.
- High investment cost, how can it be financed?

What happened?

- Involvement, learning process and taking part in practicians experience changed negative attitude to positive within staff.
- We now use water with quality adopted to need.
- External financing through EU Baltic Interreg Fund and Swedish government made it financially possible.

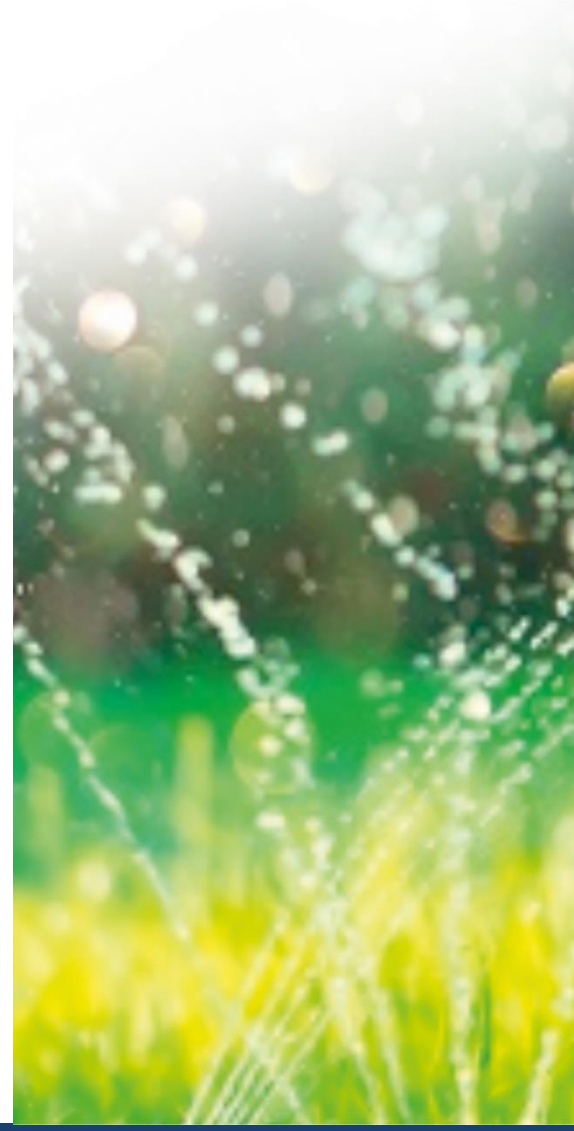
Final reflections - recommendations

- Undertake extensive and thorough research before decisions.
- Investigate different technical solutions adopted to local specific conditions:
- Quality required, volume now and in future, location related to logistics etc.
- Talk to experts and practitioners to discover advantages and disadvantages with different solutions.
- Procurement documents very important to get what you want.
- Choose supplier with recognized knowledge and capability regarding, design, construction, delivery time, support and spare-parts.

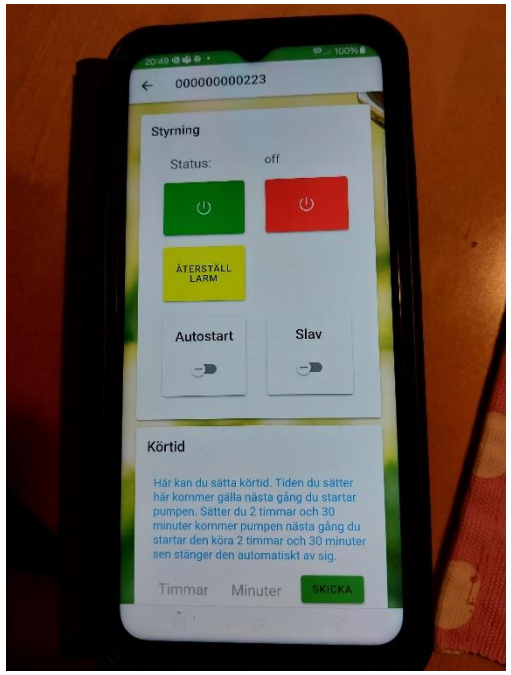
Final reflections - recommendations

Wish:

- All parts of the installation built for sub-zero conditions.
- Connect UV-plant to sprinkler-irrigation in nearby football field.
- A clear and distinct legal framework regarding how to use recycled wastewater in other areas than agriculture.
- *Example:* How to price water with other quality than drinking water.
- Better knowledge of what substances (other than microorganisms) treated wastewater contains. For what purposes is it suitable to use?



Filling tank trailer with disinfected treated wastewater. UV-plant operated with smartphone



Irrigation with recycled treated wastewater from UV-pilot

Reporting filled volume in smartphone

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The „BSR Water Recycling Toolbox" was elaborated as part of the WaterMan project, which is co-financed by the European Union (European Regional Development Fund) and implemented within the Interreg Baltic Sea Region Programme. More information:

eurobalt.org/WaterRecyclingToolbox
interreg-baltic.eu/project/waterman

WaterMan promotes a Baltic Sea Region-specific approach to water recycling, which makes use of the alternation of too much and too little water that has become typical for humid areas in the EU to strengthen the resilience of local water supply. Building on this approach, the project supports municipalities and water companies in adapting their water supply strategies.