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SUSTAINABLE WATERS
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Water Recycling Toolbox

Recycling treated wastewater for irrigating green spaces

Kalmar Municipality

Interreg Baltic Sea Region

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Introduction to the pilot measure

Recycling treated wastewater for irrigating green spaces

Kalmar Municipality

15 March 2023

Project WaterMan

Kalmar Municipality

Kalmar kommun

Swedish Agency
for Marine and
Water Management

Kalmar Vatten

Kalmar

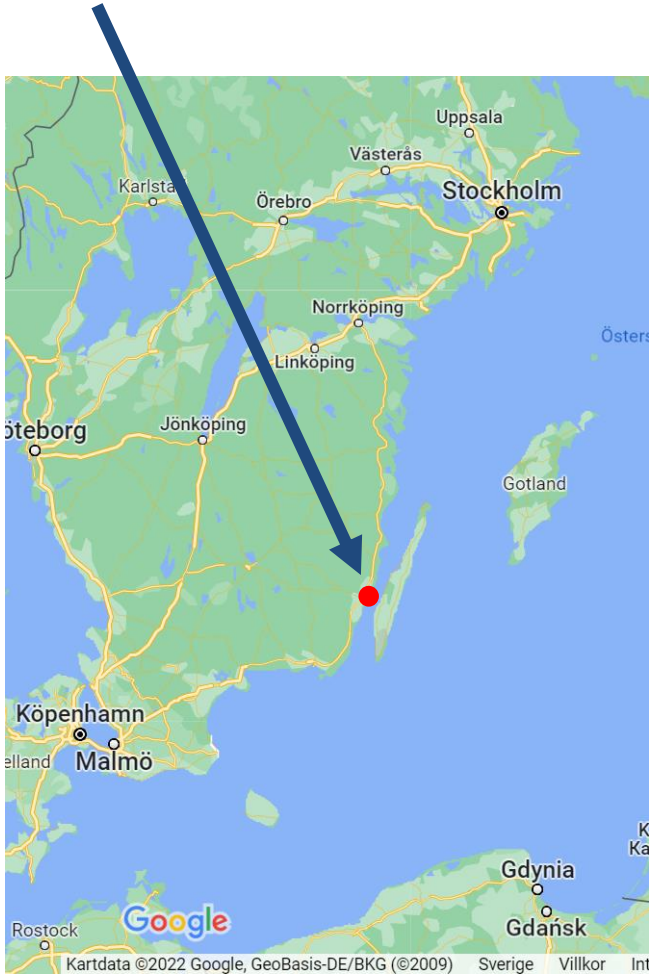
Location: at the Baltic Sea.

Rural / agriculture / forestry.

Climate resilience challenges:

- higher sea levels,
- dryer summers,
- increased frequency of intensive rainfall,
- threatened aquatic ecosystems.

The consequences will most likely be increased water scarcity



Water Management in Kalmar Municipality

- **1996**: First water innovation park: Wetland Park “Kalmar Dämme”
  Water affected by run off from airport, built environments and agriculture
- **2010- now:** Project financed restoration of wetlands and streams, building storm water retentions ponds and sedimentation basins.
- **2020:** Local action plan for good ecological status in water bodies.
- **2022:** Conclusion of the LIFE SURE project.
  Invented robots for low impact removal of soft sediments in lakes, basins and bays plus new solutions for the beneficial use of sediments
- **2027**: New Waste Water Treatment plan - Water Recycling Plant will include components for re-using reclaimed water

Pilot project idea: Reuse of wastewater in Kalmar

Reuse wastewater from Kalmar municipal WWTP after UV-treatment in additional disinfection stage for irrigation of parks, trees etc.

Be prepared for changing climate conditions

Secure long term supply of water for irrigation also under severe drought-periods

Save water resources

Gain experiences to be used in other future projects - soccerfields, street-maintanence

Inform staff and public of background, purpose and increase acceptance for reuse of wastewater

Current situation

- Irrigation of trees and other plants
- Manual irrigation, tanktrailer with hosereel
- Consumption ca 1 500 m³ per year - mainly young trees
- Watersource: Retained run-off water from streets etc. stored in dams
- Sensors used for water management in some areas. (LORA WAN)

Stormwater ponds have mainly two problems:

- Often contains harmful substances (streets, parkinglots, industry outlets)

- Mismatch between demand and supply:
  - not enough water during long periods of drought
  - damage to fauna at low levels, legal limits may apply

Waste Water treatment plants ”never” run out of water: Reuse sewage water!

Extend use to other areas, soccer fields etc. Huge quantities can be saved!

Waste water: Disgusting and dangerous!? Not if handled properly!

- Waste water contains harmful bacteria
- Be aware of the risks
- Handle with respect to risks
- Reduce levels of bacteria
- Monitor quality (disinfection efficacy)
- Educate staff
- Be transparent
- Inform the public

UV-light treatment

- Very effective to reduce most microorgansims
- No need for additional chemicals
- Moderate energy consumption – run only on demand
- Easy to use – quick start-up
- Plug-In concept, install where need is. Built in container, easy to move

UV-treatment plant built in a mobile standard container:

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1st Peer-review session

Recycling treated wastewater for irrigating green spaces

Kalmar Municipality

5 Sept 2023

WaterMan pilot projects:
”Reuse of wastewater for irrigation of trees and parks”

Klas Eriksson

Department of Parks, Kalmar Municipality

Peer-review, Ringsted 2023 09 06

Kalmar kommun

Outline

- Short project reminder, what and why?
- Requirements and regulations
- Stakeholders involved
- Risk assessment
- Technical set-up
- Decisons and lessons learned
- Implementation plan and timeline
- Remaining concerns

What and why?

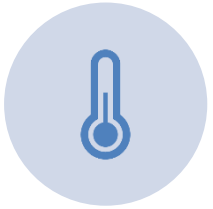
“Re-use of wastewater for irrigation by UV-light disinfection”

Background and current situation:

- Irrigation of trees and other plants
- Manual irrigation, tanktrailer with hose reel
- Consumption ca 1 500 m³ per year mainly young trees
- Watersource: Retained rainwater from streets etc. stored in dams
- Uncertain supply during long lasting drought, quality issues
- Dep. of sportfields also looking for alternative to drinkingwater

Project goals: Reuse of wastewater in Kalmar

Reuse wastewater from Kalmar municipal WWTP after UV-treatment in additional disinfection stage for irrigation of parks, trees etc.



Be prepared for changing climate conditions

Secure longterm supply of water for irrigation also under severe drought-periods

Save water resources

Gain experiences to be used in other future projects - soccerfields, street-maintanence

Inform staff and public of background, purpose and increase acceptance for reuse of wastewater

Requirements and regulations

- Legal standard: EU 2020/741
- Desired quality of water: Class A since some public plantations have edible berries.
  - E.coli < 10/100 ml
  - BOD and TSS < 10 mg/l
  - Turbidity (NTU) < 5
- National, regional and local legal permissions needed are either granted or under processing.


File:Kalmar slott nordostra sidan.jpg - Wikipedia

Stakeholders involved

- Other stakeholders are overall positive

Kalmar Municipality:	• Department of Parks, implementation and operation • focal authorities issuing legal permissions • financing
Kalmar Water AB (KVAB):	• supplier of drinkingwater, handles and treat wastewater • partner in implementation and operation of UV-plant
County Administration Board:	• regional authority issuing legal permissions, financing
Region Kalmar County:	• coordinating and financing

Results from filter-test

Table 1. Preconditions and results filtertest and UV-light. To evaluate what filter size and type that would be suitable for disinfection of wastewater by UV-light, we monitored wastewater and disinfection effect of UV-light at different **f**iltersizes: 5, 25, and 50 microns (textile filters). UV-light effect = 0,023 kW/m3 (*as estimated based on lamp effect and flow through*). The test was carried out during a 6 day period at the planned accesspoint; 4 samples on 4 different days.

	Water in	Water out	EU 2020/741
E. Coli	> 2420/100 ml	0 – 2/100 ml	< 10/100 ml
TSS	16 mg/l (13-18)	9 – 12 mg/l	< 10 mg/l
Transm. 254/1	37.7 – 41.5%	39.3 – 43.5%	NA
BOD, NTU, Legionella: Not analysed			

Risk assessment and management

Hazards are identified and risks are assessed for:

- Staff – regarding health and working conditions
- General public – regarding health
- External environment – regarding soil, water, flora, fauna
- Department of Parks – regarding operational needs for irrigation water

- The identified hazards and risks as well as proper management and mitigation procedures and methods for avoidance and minimization are described in a risk analysis and management plan.
  - Designated persons have defined responsibilities in that plan.

- More detailed management plans must be outlined when design is known and before start of plant.

Technical solution – UV-light disinfection

- Very effective to reduce most microorgansims
- No need for additional chemicals, less risk for staff and environment
- Moderate energy consumption – run only on demand
- Fairly easy to use – quick start-up, relatively low need for maintenance
- Built in container, easy moving and flexibility – install where need is

Technical setup as planned

- UV-light as method for disinfection
- Filters to increase efficiency of UV-light
- Pumps to feed wastewater through UV-light and filters, fill tanktrailer
- Minimum capacity: 600 l/min
- Processors to direct and control operation (PLC)
- Portable, built in a container
- Intermittent operation, direct feed to tanktrailer, no storage tank
- Remote control using smartphones
- Different safety measures built in, quality of water, overfilling etc.
- Distribution with tanktrailers
- Manual application with hose

Clarifications to technical set-up:

Why such high flow?

-Efficiency when filling tanktrailer/trucks beacause we wanted to avoid storing the water in between fillings due to risk of regrowth of microorganisms in storage tank.

- A storage tank would require a buidling permit – probably difficult to aquire in this type of environment.

Location UV-plant – access WW, water filling station

- Easy access-point to wastewater-source
- Favourable location for distribution within Kalmar city and vicinity

Inside feeding point wastewater to UV-plant →

Technical solution – potential design UV-plant

External view UV-plant in 10-foot container

Inside 10-foot container

Desicions made:

- ✓ to use UV-light for disinfection although there are other methods
- ✓ to buy a plant that can work intermittently although function is not proven
- ✓ to buy a function, not a technically specified plant
  - ✓ the function is to deliver Class A – water according to EU 2020/741
- ✓ that it must be built inside a standard freight container (max 15”)
- ✓ that it must be in operation before april 20th, 2024

Lessons learned:

- ✓ It takes much longer time than planned.
- ✓ Rules concerning funding, reporting and procurement is sometimes difficult to understand. Experience from previous projects cannot always be used. *E.g.,* Experts on public procurement processes seem to have different views how to interpret and apply the rules.
- ✓ Informing concerned staff about objectives and methods and engaging them in an early stage of the process helps to ”pave the way”and shorten the time needed to reach the goal.

Remaining concerns

- Filtertest indicate very good disinfection, will those results be valid also when using steelfilters and running it intermittent?
- Filtertest may show increasing number of various coliform bacteria over time, possibly indicating forming of a ”biofilm” inside pipes.
- What kind of cleaning-measures and how often do we have to apply in order to keep ”biofilm” and number of E.coli at the desired level?
- Will it be necessary to use acids?
- Can such cleaning be automised?
- Life time of UV-lamps might be shorter in intermittent operation. Is this really a problem for us? Total operation time is still low.

Remaining concerns

- How to avoid regrowth of bacteria in tanktrailers?
- How about remaining UV-treated water in tanker trailers?
  - Necessary to empty overnight? Over weekends?
  - Dry out / ventilate?
- Filter and UV-techniques? Are there big differences in efficiency, reliability and need for maintenance? Variation in TSS?
- Can we estimate time needed for service/cleaning per week?
- Risk when temperature is below zero: empty or insulate?

1st Peer & expert review session: Recommendations & conclusions

- Reconsider the choice of the trees & plants that you intend to irrigate with the treated water. Only plants/ bushes with edible fruits will need to be watered with water complying with Class A according to the EU Water Reuse Regulation 2020/741. Other trees may be irrigated with treated water of quality Class B or C. This could reduce the treatment and removal validation efforts considerably.
- We understand that the disinfection is needed for the safety of staff / people in contact with water. By adjusting the irrigation method, you could avoid many problems related to contact of water with people, and reduce the quality requirements for the treated water, too. For example, if you would use hoses in the ground with holes to supply the water directly to the roots, staff / people would have no contact with the water. This change of the irrigation methods may allow to use water of Class B/C instead of Class A – and could improve the economic balance of the reuse scheme.
- Disinfection process: The UV-light disinfection process is very effective, but only at the time of disinfection. After the disinfection, regrowth of bacteria is likely to occur in the tank. With only UV-light disinfection, therefore, you should take into account regrowth in the subsequent system (e.g. storage tank, hose, water tank) and integrate it into your monitoring scheme.
- Filtration before disinfection:
  - To minimize backwashing and to enable a stable volume flow, it is recommended to use double-filtration (2-step process). You may use two filters in a row with two different pore sizes. Textile filters could be an option – one bigger, one smaller. Alternatively, you may use one bigger textile filter, along with e.g. a ceramic/ steel filter. You may consider also to use a small sand-filter (e.g. like used in household swimming pools). If you use automatic backwash and a pre-filter, then the smaller size of filter (5 microns) should not be a problem.
  - Check also if you can optimise the filtration process at the WWTP. If the incoming water is of better quality, you may reduce additional filtration needs in the mobile system
  - Keep in mind: You may be able to reach the goals of the disinfection processes (low E.coli), even if the TSS are a little bit higher than the thresholds for Class A water.
- Cleaning demands:
  - The treatment train has to be cleaned manually (despite automatic sweeping function) at least every season. In starting phase, it is recommended to have a more intensive monitoring (incl. visual controls) to see how often cleaning will be necessary.
  - If you aim for Class A water, it may be necessary to empty the water tank every night (because you cannot be sure if there is no regrowth - in Schweinfurt, regrowth in the hoses was observed) or clean the tank from time to time (if emptying does not help since a water film likely remains in the tank). Consider to test & compare water samples from evening and morning.
  - For class B / C emptying the tank every night should not be necessary.
- Lifetime & maintenance of UV lamps:
  - A way to extend the life time of UV lamps is to run them not intermittently, but continuously – with a lower water flow instead.
- In Schweinfurt, the UV lamps run continuously and are not cleaned, but they are exchanged every year.

Pilot replication bluprint: Kalmar / SE: Recycling treated wastewater for irrigating green spaces

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Absorption report

Recycling treated wastewater for irrigating green spaces

Kalmar Municipality

07 November 2023

WaterMan pilot projects: ”Reuse of wastewater for irrigation of trees and parks”

Klas Eriksson,
Department of Parks, Kalmar Municipality

Bornholm 2023 11 07-09

Comments during Peer review in Ringsted

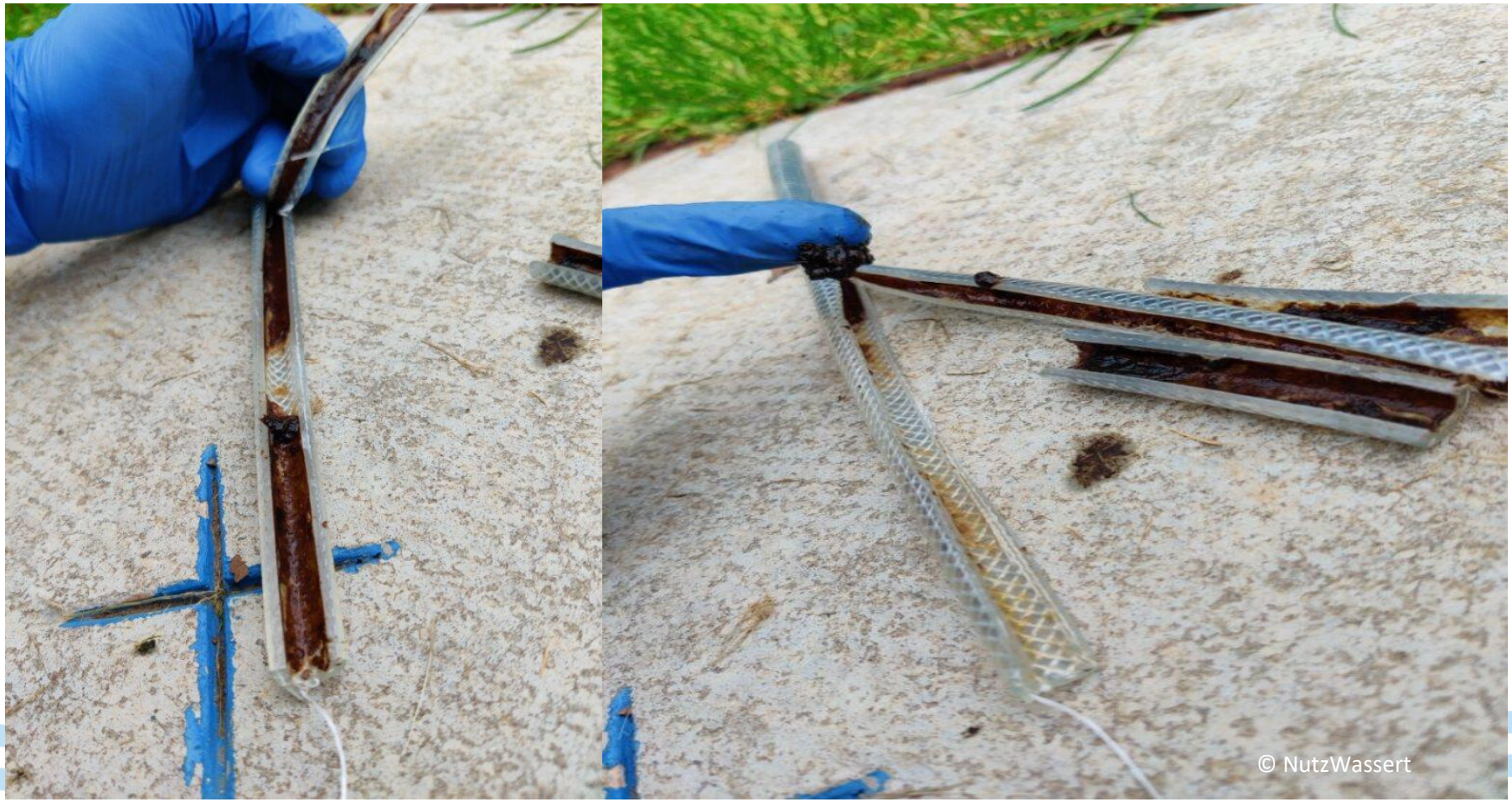
- Likely that we will get problems with grade of disinfection due to high level of particles.
- Filters may clog, more than one filter and/or other filter types discussed.
- Lower the desired quality of delivered water from class A to class B will probably solve the problem.
- Likely that we will have regrowth of microorganisms in pipes and distribution tank.

Adjustments after Ringsted

- No major adjustments. Objections and comments on the design already considered and we do not want to downgrade to class B-water.
- Confirmation that we had not missed vital issues.
- However, the comments and questions in Ringsted made us even more aware that we have to address critical circumstances such as filters, cleaning procedures, monitoring program *etc*.

Potential problems - clogging

Pictures from deposits in pipes in treatment plant in Schweinfurt – NutzWasser - project



Where we are today - timeline:

- We have formulated our demands and the requirements that must be met in our request for tenders.
- Procurement process is ongoing.
- Questions about choice of technique – dialouge with KWB
- Now waiting for offers. Last date to submit tenders is november 10.
- November 13 - 23: opening, assessment, decision.
- Eventual appeals (10 days).
- Placement of order possible in december?

Pressrelease

- A pressrelease on October 13 resulted in 4 republished articles in industry-related publications and webbsites + one notice on the local radiostation the following week.

- No follow up from local media yet.

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SUSTAINABLE WATERS
WaterMan

2nd Peer-review session

Recycling treated wastewater for irrigating green spaces

Kalmar Municipality

7 November 2024

REUSE OF SEWER WATER FOR IRRIGATION

WATERMAN PARTNER MEETING IN BERLIN 5-7 NOVEMBER 2024

PILOT PROJECT - DISINFECTION WITH MOBILE UV-PLANT
Kalmar municipality

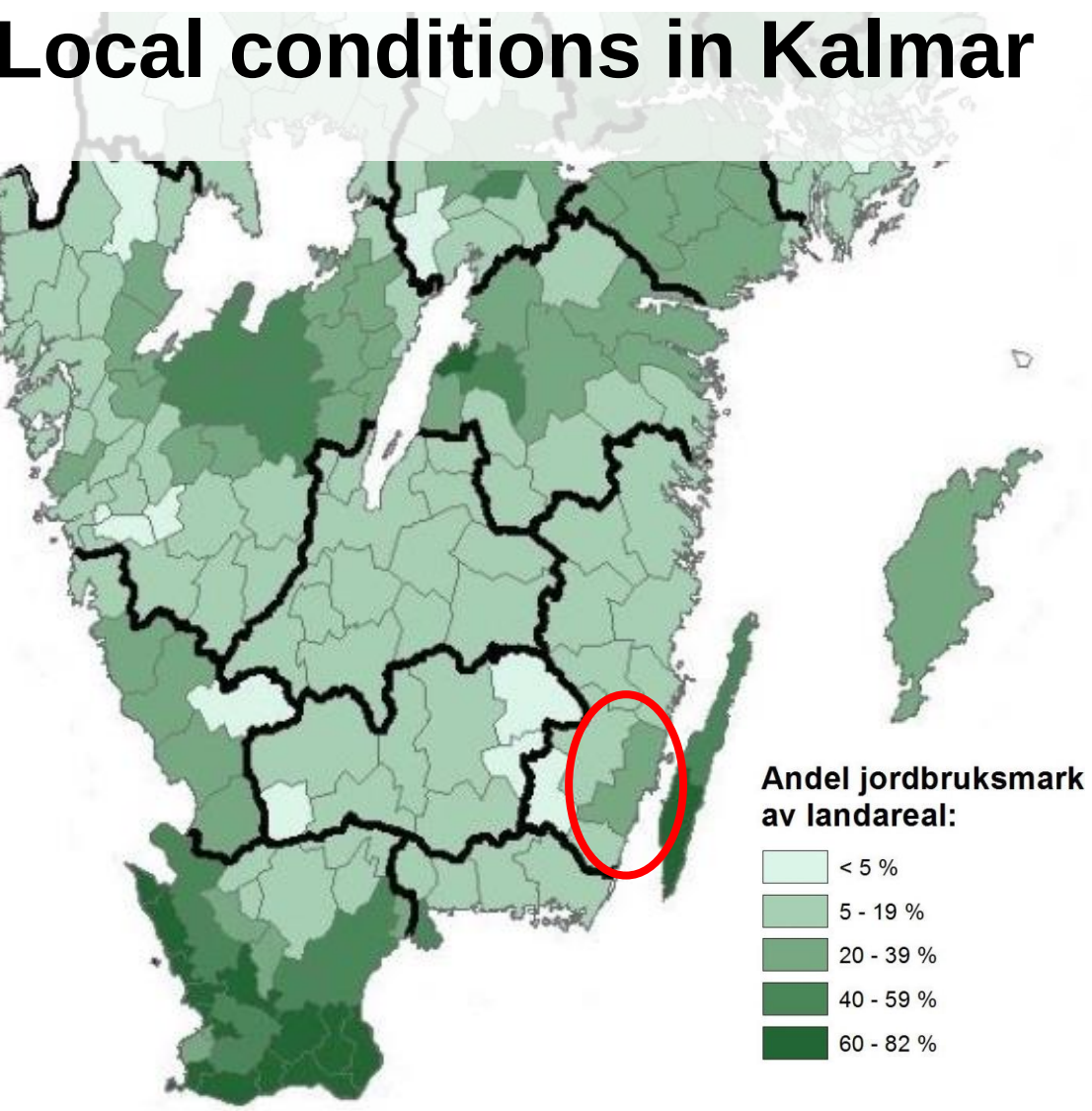

File:Kalmar slott,nordostra sidan.jpg - Wikipedia

Kalmar kommun

Kalmar Vatten

Swedish Agency for Marine and Water Management

Local conditions in Kalmar



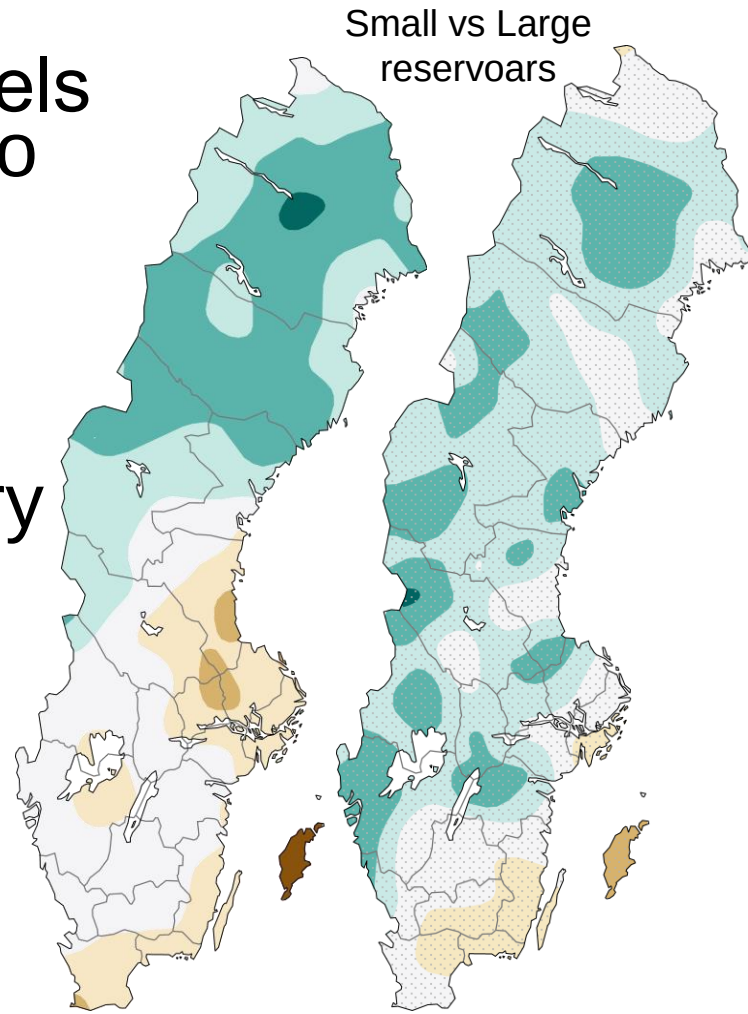
Rural / forestry / agriculture areas are dominating

Large water demands during summer

Comparisons of goundwater levels 1961-2023

- Today's levels compared to all previous years

→ Kalmar region is very exposed!



Pilot project in Kalmar: Recycled water from UV-disinfection plant

We wanted to invest in disinfection of treated sewer water from the municipal WWTP in order to have access to a reliable water supply also during severe drought. The disinfection method is ultraviolet light. It is effective against most microorganisms, simple to handle and relatively cheap.

Aiming for class B-water quality (E.coli) < 100 CFU/100 ml. Comment: We had to settle for class B quality water due to budget constraints. The contractor who submitted the bid could not guarantee class A within a cost that was covered by our budget.

Result in operation: Class A-water (E.coli) < 10 CFU/100 ml)

Controlprogram according to EU 2020/741.

Sampling of water once/week – bacteria E.coli, TSS, turbidity etc.

Aiming to add online turbidity meter for next season to be able to track the incoming quality of water in real-time and shut down in case turbidity is above the threshold for effective UV-disinfection.

Recycled water for non-potable use

Questions adressed:

1. The envisaged user groups of the recycled water

2. The means for involving them into the pilot measure & motivating them to use the recycled water

3. The methods for evaluating the utilisation of the water

Two perspectives used:

A. Internal usage of the water reclaimed through Kalmar pilot
B. Larger perspective: external user of technical water from water booth

1. Envisaged users of recycled water - Kalmar municipality

Department of Parks:

- Irrigation of trees and plants
- Establishing phase – 3 years
- 1500 m³/year

© Kalmar Municipality

1. *Future* envisaged users of recycled water - Kalmar municipality

DEPARTMENT OF STREETS – CLEANING AND DUST REDUCTION

~1 000-1 600 M³/YEAR

DEPARTMENT OF CULTURE AND SPORTS / FOTBALLFIELDS

~10 000 M³/YEAR

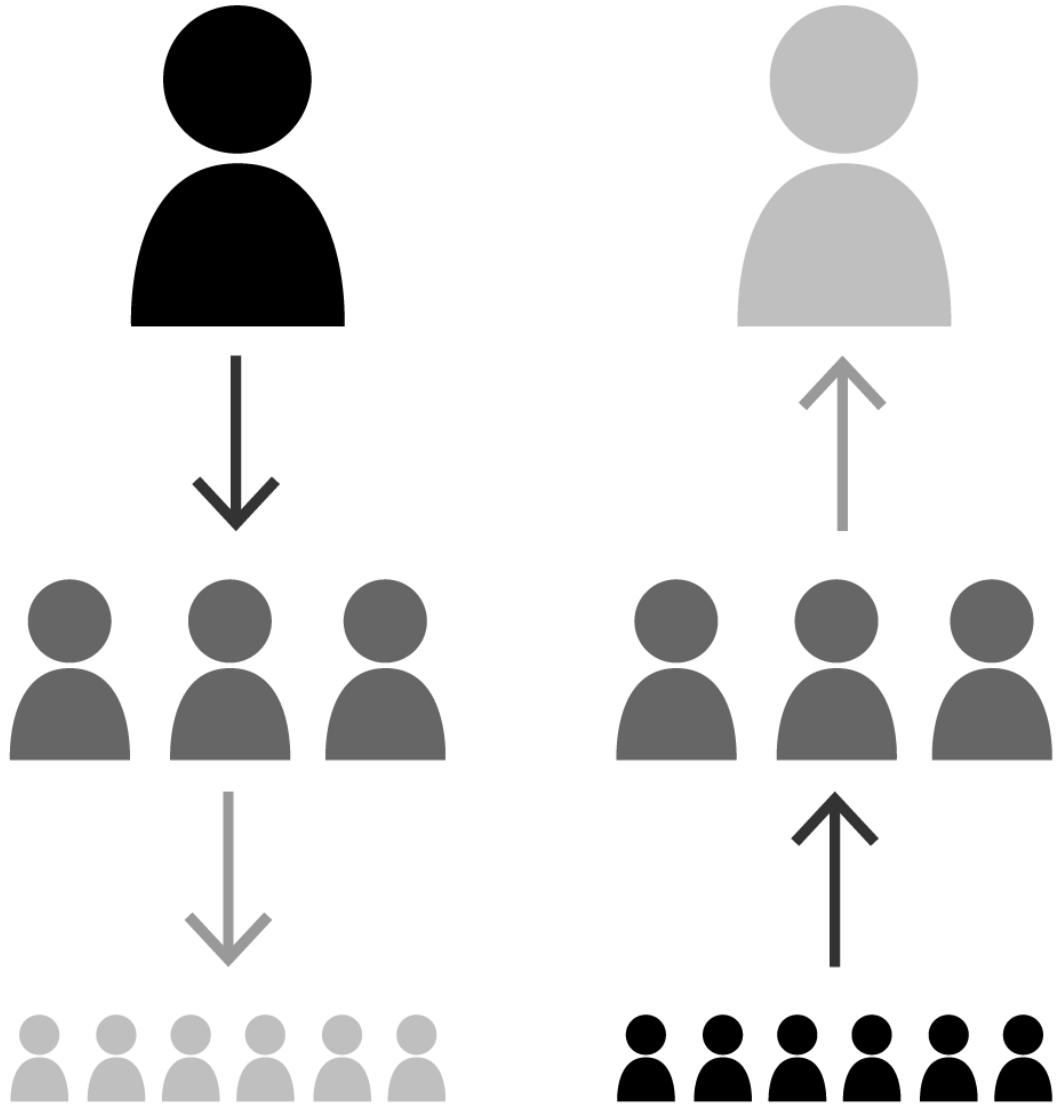
CLEANING OF MACHINERY, TRUCKS

~500 M³/YEAR

2. Involving new users

Communication important!

- Consultation
- Be transparent
- Explain why, how and when
- Be open with risks and how to manage/minimize them
- Involve staff early in process



2. Involving new users

- Personal contact - Explaining background regarding importance of reusing water and the pilot project.
- Invited politicians into the project – show plant in operation, usage of recycled water, present possible additional areas of use.
- Explaining the technique and potential areas of use for reused water.
- Suggesting practical solutions as well as economic and legal (pre)conditions.
- Share experiences from preparations and operation of UV-plant.
- Involve all parties – from management to ”on-the-ground” staff.

3. Evaluation - implemented

- Risk assessment based on the intended use (irrigation)
  - Human health
  - Environmental impact

- Compliance with standards and regulations

- Regular monitoring and validation according to the EU 2020/741 regulation

- Visual inspections of plants.

- Cost-Benefit analysis
  - Measure volumes of drinking water that are replaced by reused water.
  - Operational ease and mantainence.

3. Evaluation – good to have in longer perspective

Soil impact i.e., salinity, pH, nutrients and soil health such as organic material and microbial activity.

Evaluate how the water quality will interact with soil, especially in agricultural settings. High salinity or improper pH levels can affect soil health and crop.

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Potential external users (non – municipal)

→questions around legal issues, economy and financing.

Waste companies

Construction contractor

Transport/Shaft/Garden

2nd Peer & expert review session: Recommendations & conclusions

- Users: only internal (Kalmar Municipality > different departments). Reasons for that: we cannot sell the water (not legal for us), and we cannot compete with other water providers (e.g. Kalmar Water).
- The first demonstration of the pilot to local politicians resulted in that they are now willing to put more money into this direction. So that extension of the purified water volume could be thought by “own funds” from Municipality.
- Work further with “followers” as well.
- Document the user acceptance of the group working with the water (e.g. survey on perception of the employees working with the reuse water – how it has changed). This is also to be processed for the other municipalities into local model strategy (e.g. by Tobias = Kalmar Region).

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Status updates

Recycling treated wastewater for irrigating green spaces

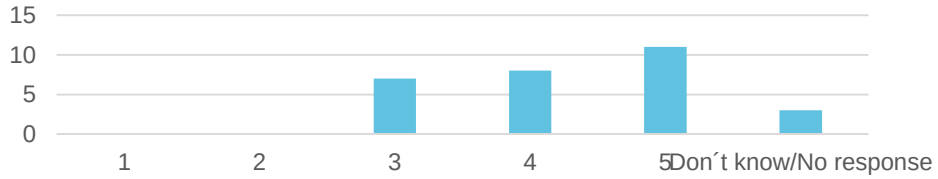
Kalmar Municipality

30 April 2025

Reporting results from survey of user acceptance among staff of Department of Parks

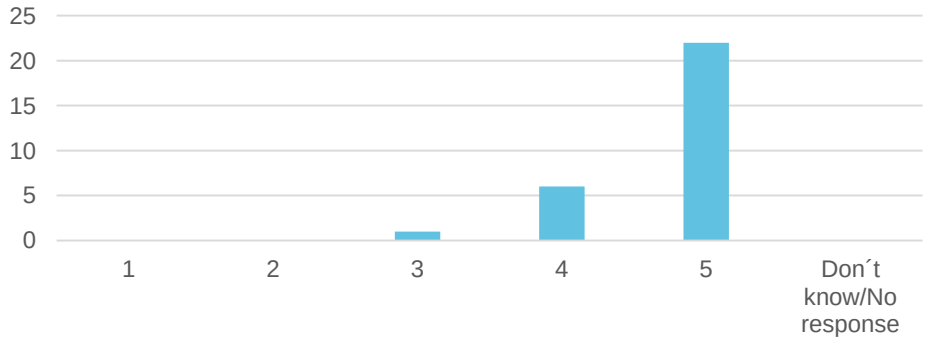
1. How clear were the project's motives and goals to you at the start?

1 = Very unclear, 5 = Very clear



2. What was your initial reaction when you first heard that we wanted to use recycled wastewater for irrigation?

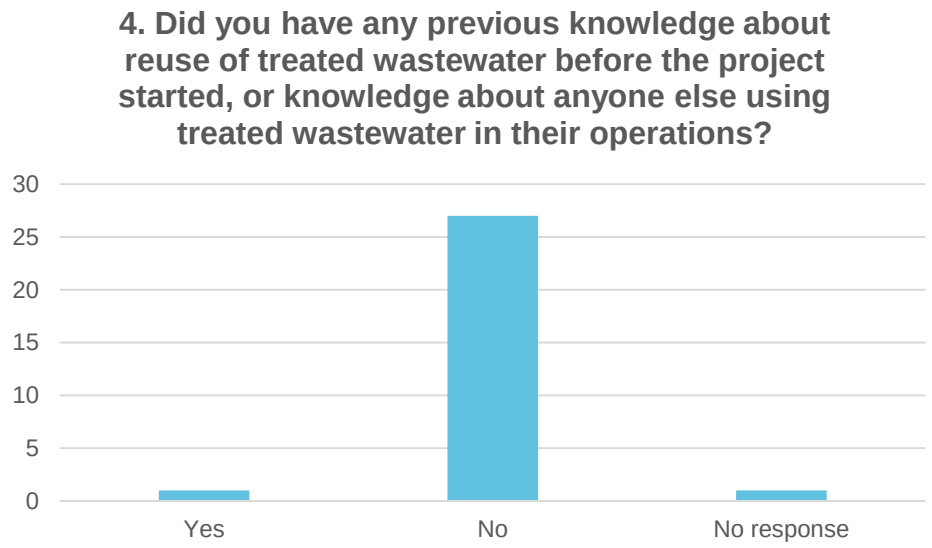
1 = Very negative, 5 = Very positive

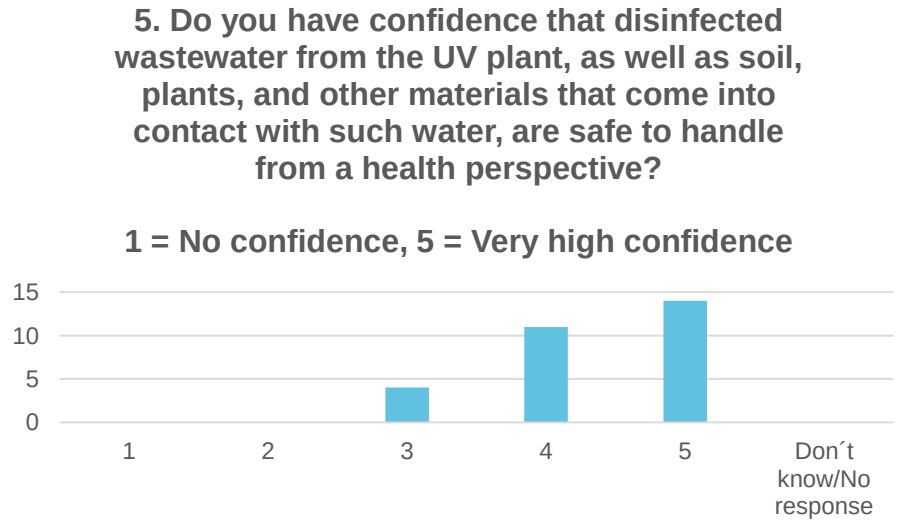


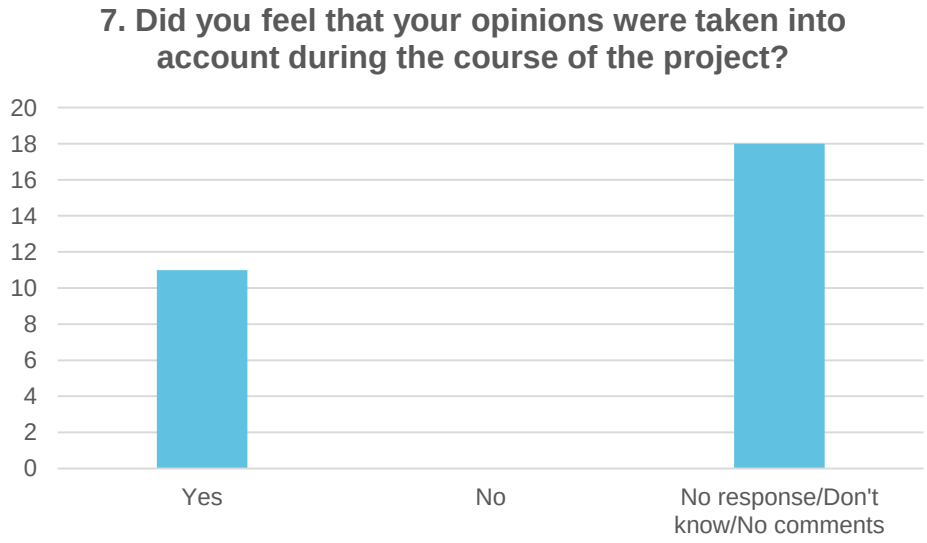
3. Why do you think you had that reaction?

- Reuse is always good.
- Good future outlook.
- Good to save precious drinking water.
- Good for nature.
- It's good to reuse.
- Great to recycle.
- We need to rethink water usage to save resources.
- Because it's good.
- Water is a precious resource.
- Good project, smart solution.
- Sounded like a good thing for the climate.
- If everything improves, it's positive.
- Never heard of anyone doing it before and think it's great to use as many existing resources as possible.
- The possibility of saving water is fantastic.
- Good for the environment.
- I think too much drinking water is used for irrigation.
- Thought it was great.
- Environmental thinking.
- Good to save drinking water.
- Because the idea sounded very positive and sustainable.
- It's good to be able to reuse water instead of using drinking water.
- Good to save drinking water.
- Mostly concerned about the handling of water for health reasons.

Reporting results from survey of user acceptance among working group

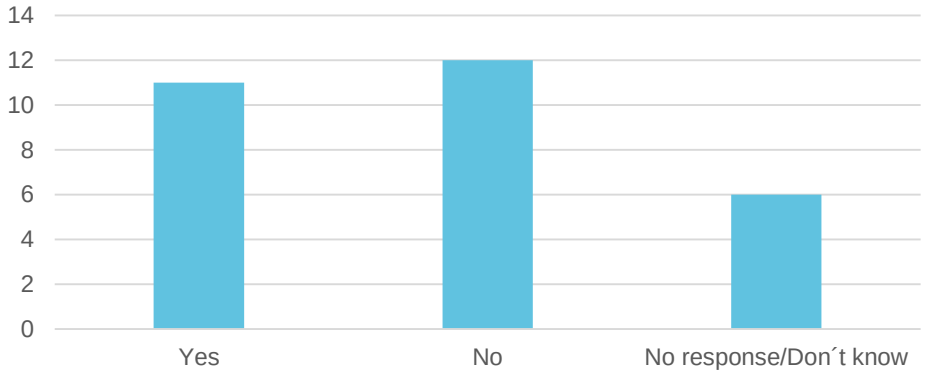




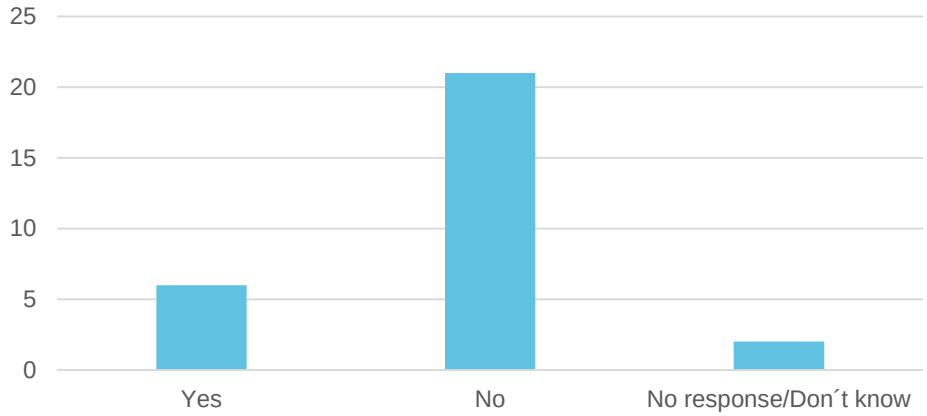


Reporting results from survey of user acceptance among working group

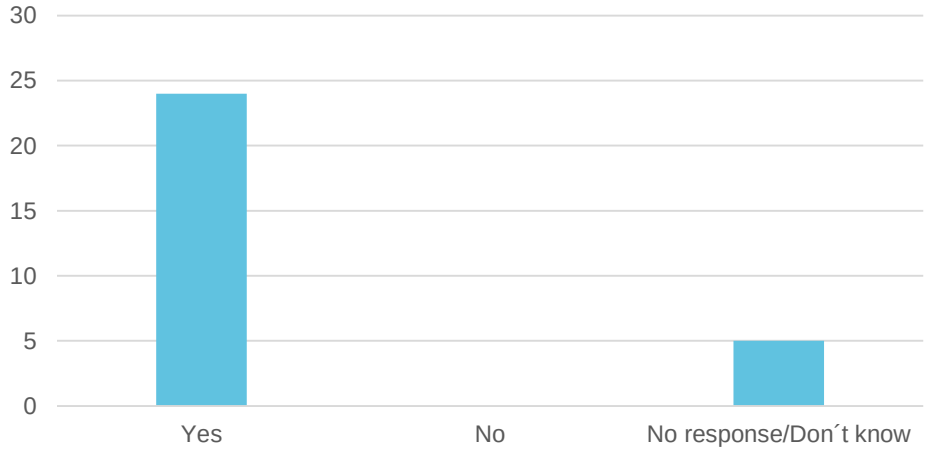
8. Have you or your colleagues changed your attitude towards the use of recycled wastewater since the project started?



9. Have you received any feedback or comments from the public regarding the use of recycled wastewater?



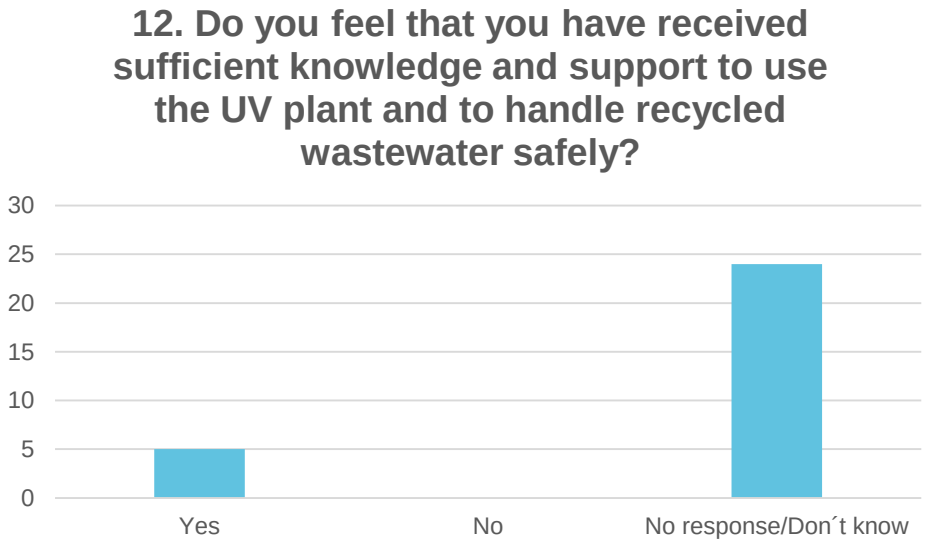
10. Do you think the project's purpose and goals have been achieved?

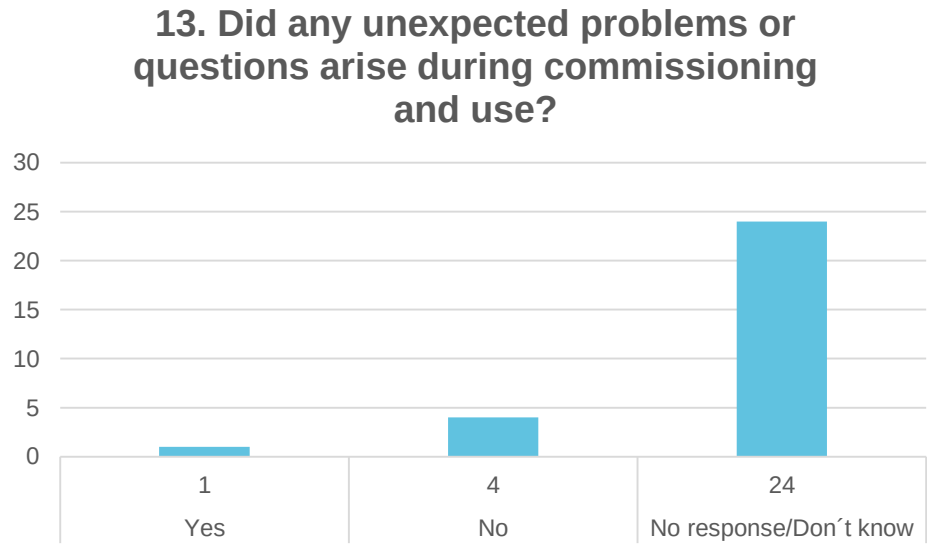


11. What would you like to change or improve for future similar projects?

No responses accept that it has been working good.

Reporting results from survey of user acceptance among working group





Adding coarse filter

Winterservice revealed stones inside the backwash filter.

Before the new season 2025 we therefore added a coarse sieve on inlet to remove gravel particles and prevent them from damaging pressure pump.

Installation of Turbidity meter

When: After first season 2024.

Why: To be able to track the incoming quality of water in real-time and shut down in case turbidity is above the threshold for effective UV-disinfection.

Interreg Baltic Sea Region

Co-funded by the European Union

SUSTAINABLE WATERS WaterMan

Final review

Recycling municipal wastewater for irrigating green spaces

Kalmar Municipality

24 September 2025

Interreg Baltic Sea Region

Co-funded by the European Union

Kalmar kommun

SUSTAINABLE WATERS
WaterMan

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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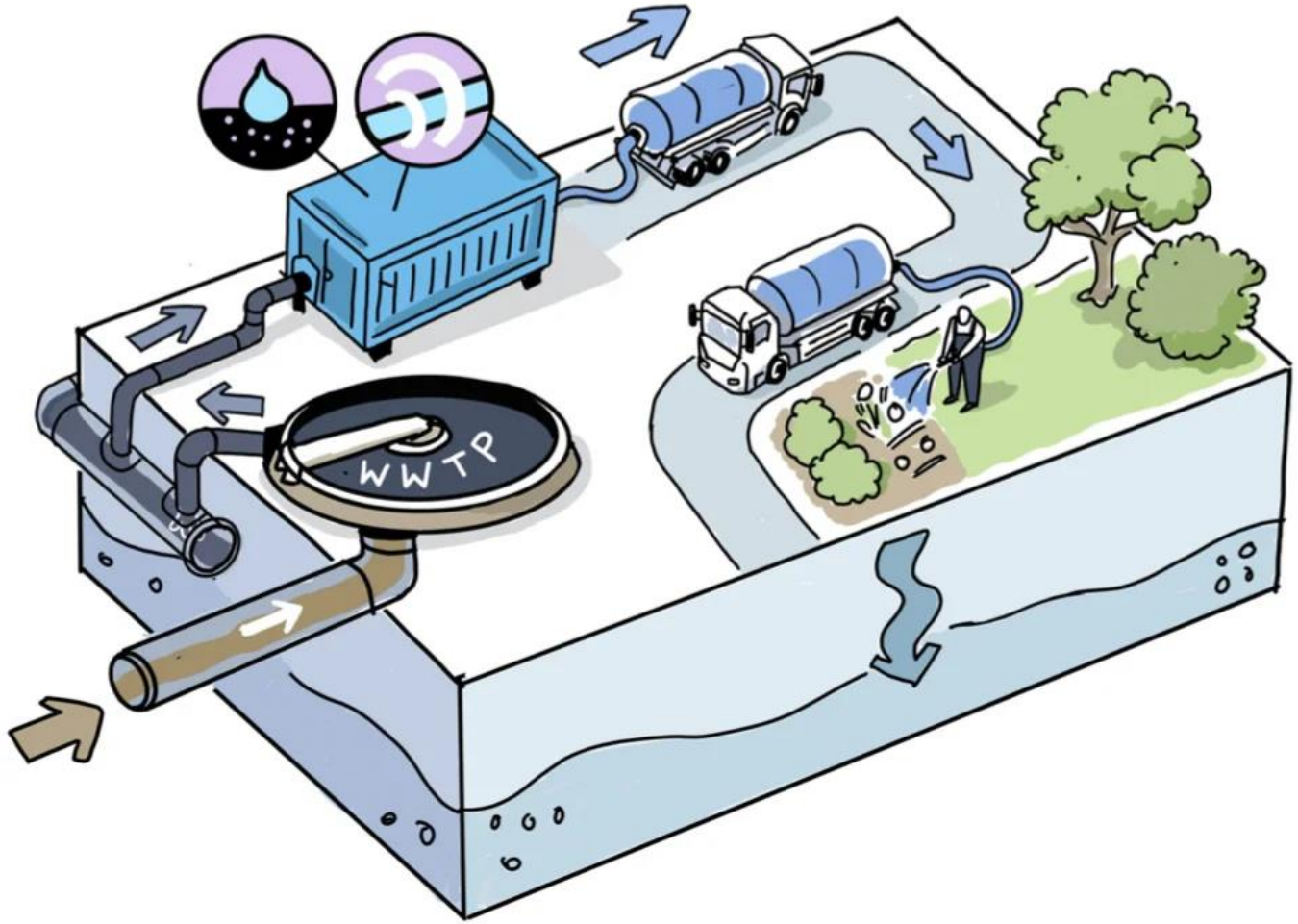
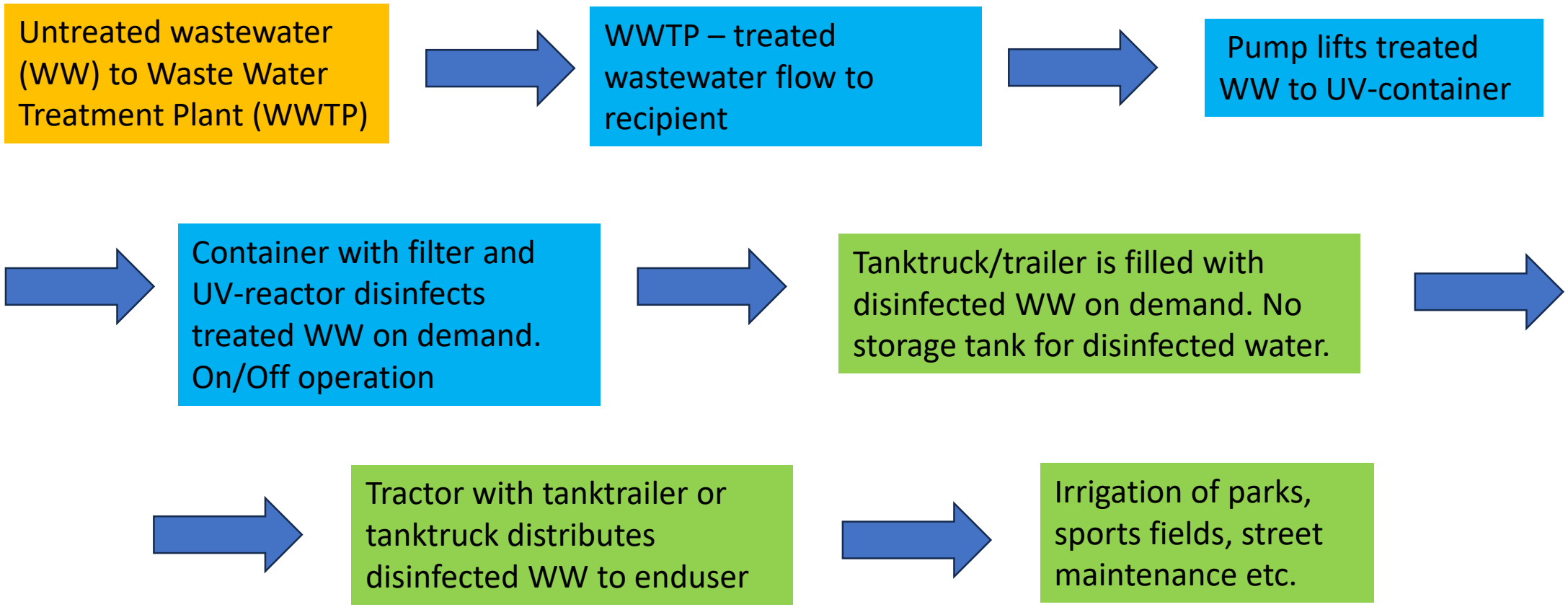
How it works

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.

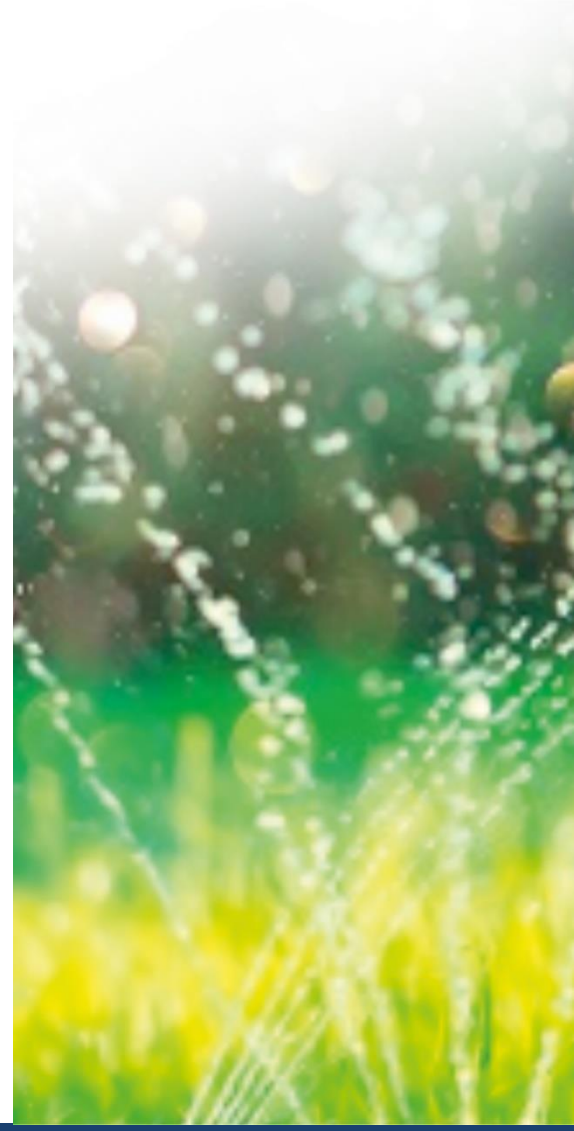
- Equipment to test UV-efficacy with different grade of filtration.
- Results from test used in procurement process and designing UV-pilot plant.

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.

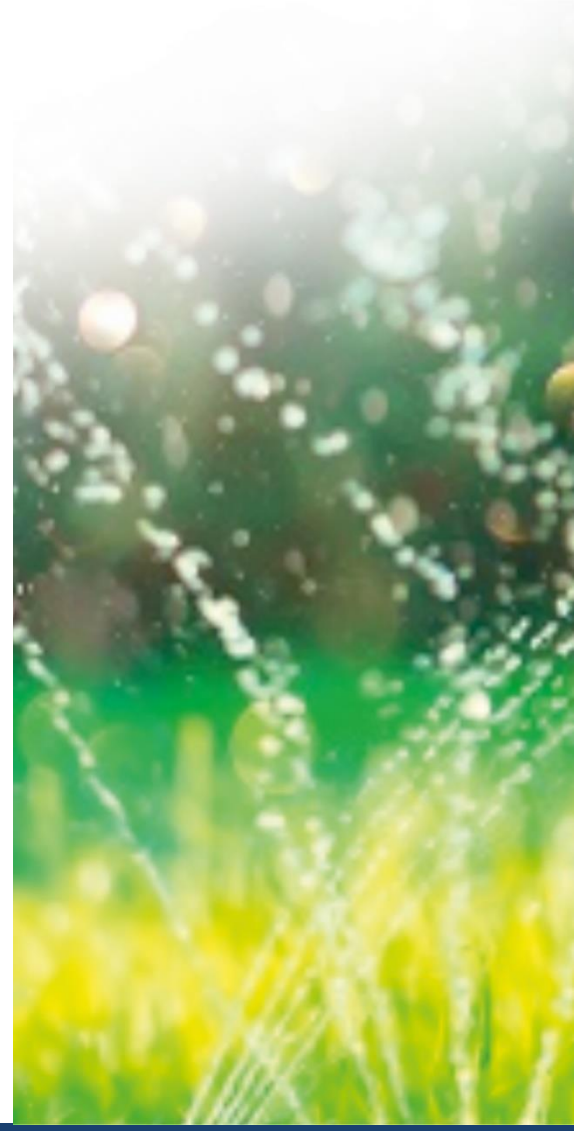
Final reflections - recommendations

- 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.

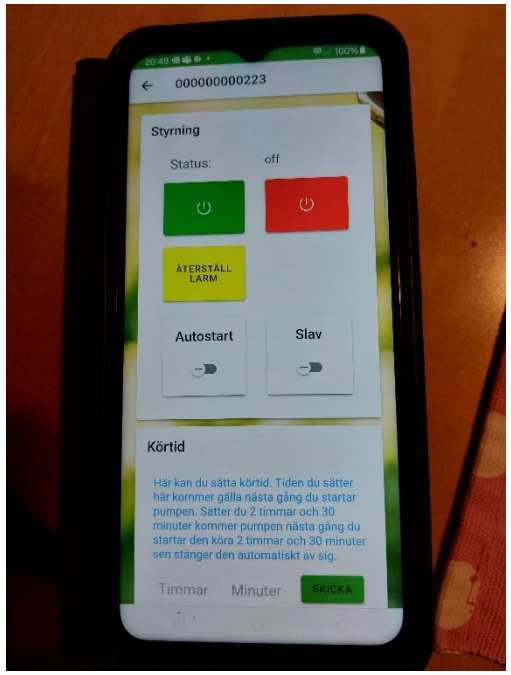
Final reflections - recommendations

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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Helpdesk / Contacts for further information:

Klas Eriksson

klas.eriksson@kalmar.se

+46 10 352 11 60

Hanna Berggren

hanna.berggren@kalmar.se

+46 10 352 12 17

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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.