Reclaimed Water Infiltration Study

Task 2: Treatment Effectiveness Evaluation

LOTT Clean Water Alliance

Study Framework

The key question that the overall study is intended to answer is:

What are the risks from infiltrating reclaimed water into groundwater because of chemicals that may remain in the water from products people use every day, and what can be done to reduce those risks?

The overall study has four main tasks designed to answer specific questions.

Task 1: Water Quality Characterization
What is the current quality of our local waters: groundwater, surface water, drinking water, wastewater, and reclaimed water?

Task 2: Treatment Effectiveness Evaluation
What happens to reclaimed water that is infiltrated to groundwater: where does it travel and how quickly, and how does the quality of the water change over time?

Task 3: Risk Assessment
What are the relative risks of replenishing groundwater with reclaimed water?

Task 4: Cost/Benefit Analysis
What are the costs and benefits of various approaches for treating and using reclaimed water?

Overview of Task 2

This fact sheet provides highlights of the second task of the Reclaimed Water Infiltration Study: Treatment Effectiveness. For more details about the study, visit www.lottcleanwater.org.

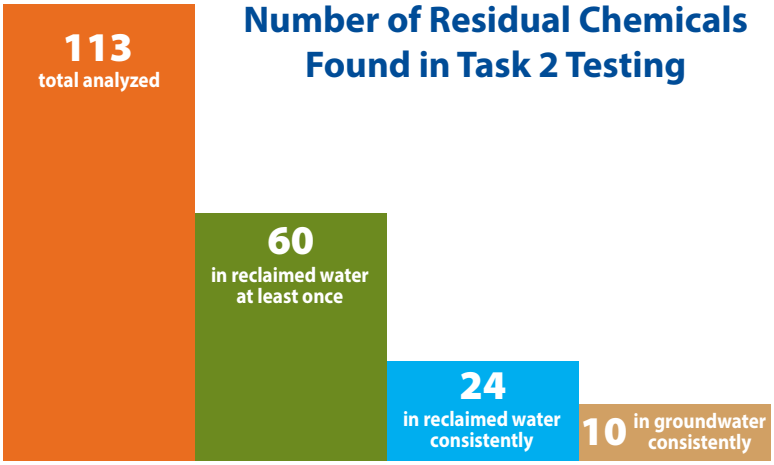
Task 2 of the study focused on three main questions:

- Which direction does groundwater flow in underground aquifers near the Hawks Prairie Basins site?
- Do residual chemicals decrease as reclaimed water travels through unsaturated soil, mixes with groundwater, and moves away from the site?
- Are there residual chemicals that people or wildlife might be exposed to from groundwater and creeks influenced by reclaimed water?

Key Findings

- Reclaimed water infiltrated at the Hawks Prairie site flows south and west in the shallow aquifer and some flows into the deeper aquifer, which flows east.
- Microorganisms in the soil help break down some residual chemicals – this is referred to as soil aquifer treatment.
- Most residual chemicals decrease with time and distance as reclaimed water mixes with groundwater and moves away from the site.
- Some residual chemicals remain at low concentrations in water that may be used by people or wildlife.

Number of Residual Chemicals Found in Task 2 Testing



Gathering Scientific Data

Monitoring Wells

Task 2 involved extensive field work to sample groundwater at LOTT's Hawks Prairie Recharge Basins site and at numerous locations offsite. To do this, LOTT established a network of monitoring wells, including onsite wells owned by LOTT and existing offsite wells owned by others. An additional 14 new wells were drilled to complete the initial monitoring network of 43 wells in the shallow and deep aquifers. Lysimeters installed at varying depths directly below the recharge basins allowed for water sampling in the unsaturated soil. Once computer modeling was underway, an additional six wells were drilled to fill in data gaps and refine the model.

A monitoring network of wells was established

Tracer Test

LOTT conducted a tracer test to track the movement of reclaimed water up to a half mile from the Hawks Prairie Recharge Basins site. Two non-toxic, inert chemicals were added to the reclaimed water before it entered the recharge basins: potassium bromide and sulfur hexafluoride. 26 monitoring wells were sampled for tracers over a 10 month period. Data gathered was used to determine the flow path and travel time of reclaimed water and groundwater. That information was then used to refine the computer model and predict groundwater movement at greater distances from the site.

The tracer test tracked movement of reclaimed water

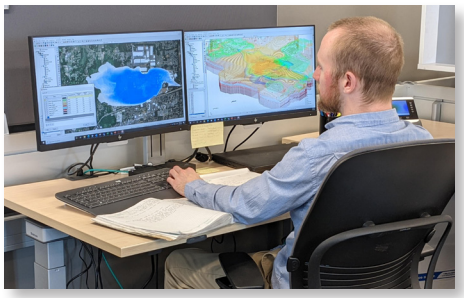
Water Quality Sampling

Quarterly water quality samples were taken from reclaimed water and 13 wells to determine if residual chemical concentrations decrease over time or distance from the recharge site. This is referred to as attenuation. Samples were tested for water quality indicators like nitrate and for 113 residual chemicals.

Water samples were tested for water quality indicators

Computer Modeling

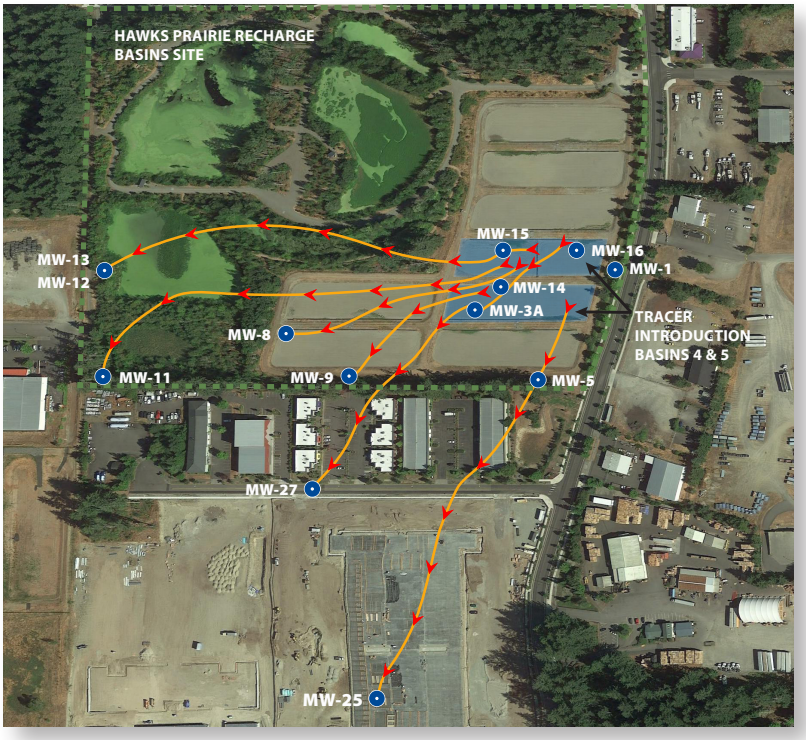
Computer modeling was used to estimate reclaimed water flow paths and residual chemical concentrations within a 30 square mile area, up to 100 years into the future. The model was developed from an existing groundwater model, updated with more recent regional hydrogeologic information and field data gathered from well drilling, tracer testing, and water quality sampling. Model runs were conducted for each year from 2007 through 2020 using the actual infiltration rate for those years. The 2020 model run confirmed that model results were consistent with actual field results from the tracer test and sampling effort. Additional model runs were conducted for the years 2021 through 2121, using estimated future reclaimed water infiltration rates.



Computer modeling was used to estimate future flow paths and residual chemical concentrations

Reclaimed Water Movement

Groundwater flow direction was determined using water level data from the monitoring well (MW) network. Tracer test data confirmed where infiltrated reclaimed water traveled after mixing with groundwater, and provided information about how quickly it moved away from the site. In general, water in the shallow aquifer flows south and west, while the deeper aquifer flows east. Some water from the shallow aquifer flows into the deeper aquifer. The glacial history of this area led to irregular geologic layers and soil conditions that vary widely, which is why there is a wide range of reclaimed water travel times in the study area. While it typically takes 30-40 days for reclaimed water to move through the unsaturated zone prior to entering the shallow aquifer, some reclaimed water can reach the deeper aquifer in about 30 days.



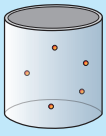
Tracer test data confirmed where infiltrated reclaimed water traveled after mixing with groundwater

Residual Chemical Attenuation

Reclaimed water prior to recharge was tested for 113 residual chemicals – 60 were detected, though only 24 of these were detected in all quarterly samples. Water quality testing just below the recharge basins showed evidence that microorganisms were likely at work breaking down some of the residual chemicals in the infiltrated water. Water quality sampling at monitoring wells showed that as the reclaimed water mixed with groundwater and traveled away from the recharge site, concentrations of many residual chemicals decreased along the flow paths. This indicated attenuation was occurring as chemicals were broken down by microorganisms, adhered to soil particles, or dispersed. The degree of attenuation varied by chemical, showing that chemicals degrade and adhere to soil at different rates.

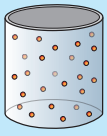
Residual Chemical Attenuation Over Time and Distance

Good Attenuation



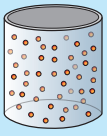
- Atenolol
- Carisoprodol
- DEET
- Dilantin
- Diuron
- Fluoxetine
- Iohexol
- Lopressor
- TCPP
- TDCPP

Moderate Attenuation



- Butalbital
- Meprobamate
- Metformin
- TCEP

Poor Attenuation



- 1,4- Dioxane
- Acesulfame-K
- Carbamazepine
- PFHxA
- PFBS
- PFBS acid
- PFOA
- PFPeA
- Primidone
- Sucralose

These 24 chemicals were detected in each quarter of sampling.

Predicting Future Conditions

Computer modeling was used to predict reclaimed water and residual chemical concentrations likely to occur in groundwater at different distances from the recharge site. This information helped identify which residual chemicals people and wildlife might be exposed to from contact with groundwater or surface water. The amount of residual chemical that they might be exposed to is called the "exposure point concentration" or EPC. The EPC is a key piece of information that was used in Task 3 of the study to assess any potential risks to human or ecological health.

Modeled Extent of Reclaimed Water in Shallow Aquifer

Modeled extent of reclaimed water in the shallow aquifer ranged from 100% (deep blue) to 0% (white).

Summary

Findings from Task 2, Treatment Effectiveness Evaluation, show that some residual chemicals in reclaimed water reach both the shallow and deep aquifers. The number and concentrations of residual chemicals generally decrease with time and distance from the recharge site.

What's Next?

Task 3 will build on the results of Tasks 1 and 2 to consider if there are any risks to human health or the environment from using reclaimed water to replenish groundwater.

Task 4 will examine how risks might be addressed, including the costs and benefits of various options for treating and using reclaimed water.

The study is anticipated to be completed in 2022. Community conversations about study results will help inform decisions about future reclaimed water treatment and use.

Get Involved!

- Learn more or sign up to receive email updates about the study:
  www.lottcleanwater.org
- Share questions or comments by email:
  reclaimedwaterstudy@lottcleanwater.org
- Give us a call:
  (360) 664-2333
- Send comments or questions by mail:
  Reclaimed Water Infiltration Study
  LOTT Clean Water Alliance
  500 Adams Street NE
  Olympia, WA 98501