Using innovation and the engineering design process to address drinking water and wastewater challenges

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Introduction to innovation and the engineering design process

What is innovation?

Definition of innovation:
A new idea, method, or device

Source: Merriam –Webster Dictionary (https://www.merriam-webster.com/dictionary/innovation)

Tools for innovation

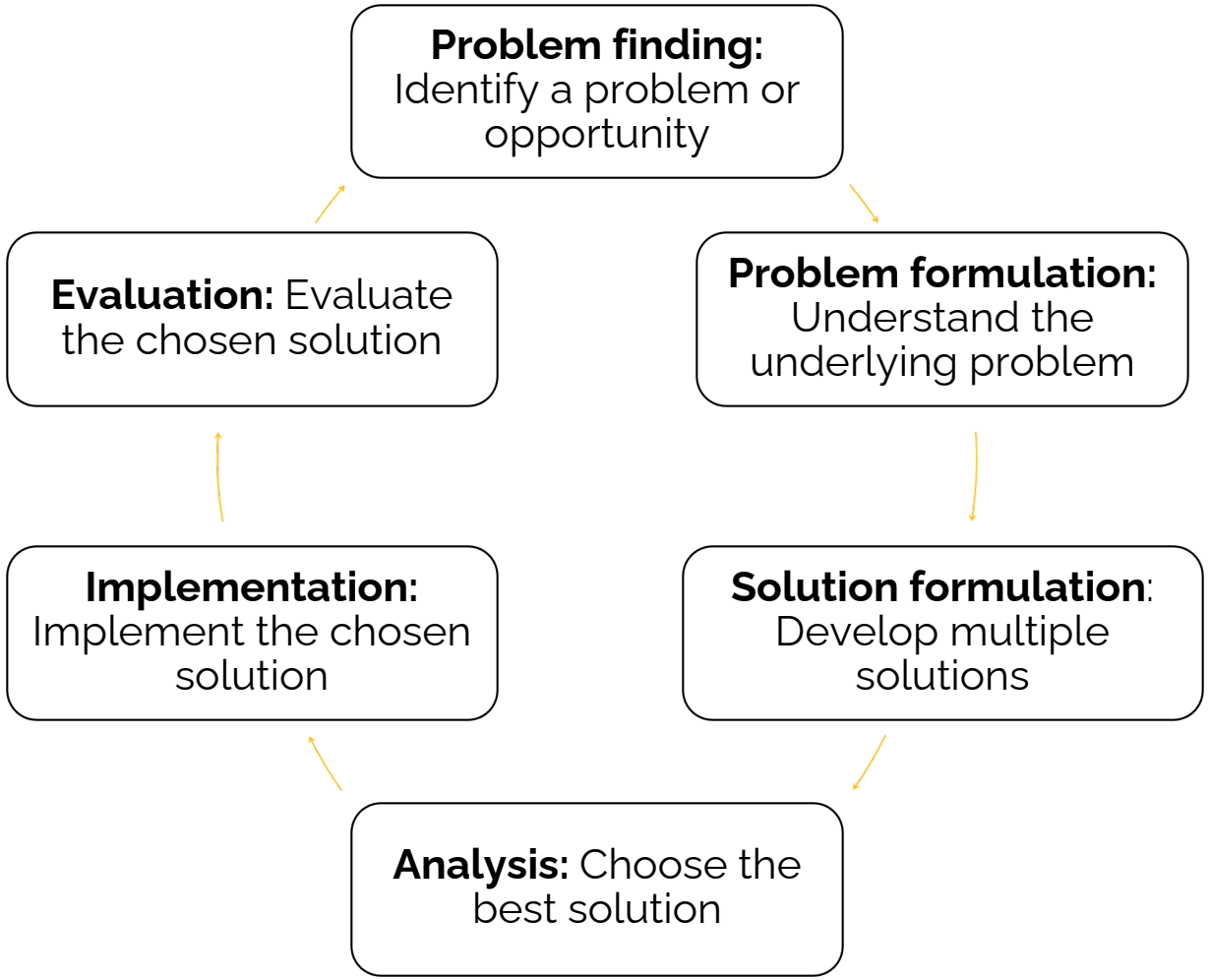
Engineering design process

Deliberate approach to problem solving

Emphasis on finding the real problem(s) before proposing solutions

Includes research, stakeholder consultation, and creativity

Iterative



Source: Gora, Ha, Leung, and Boakye-Yiadom (2022) Solution Formulation, ENG 1102 – Engineering Design Principles

Problem finding and problem formulation

Present state: Current situation where the problem exists

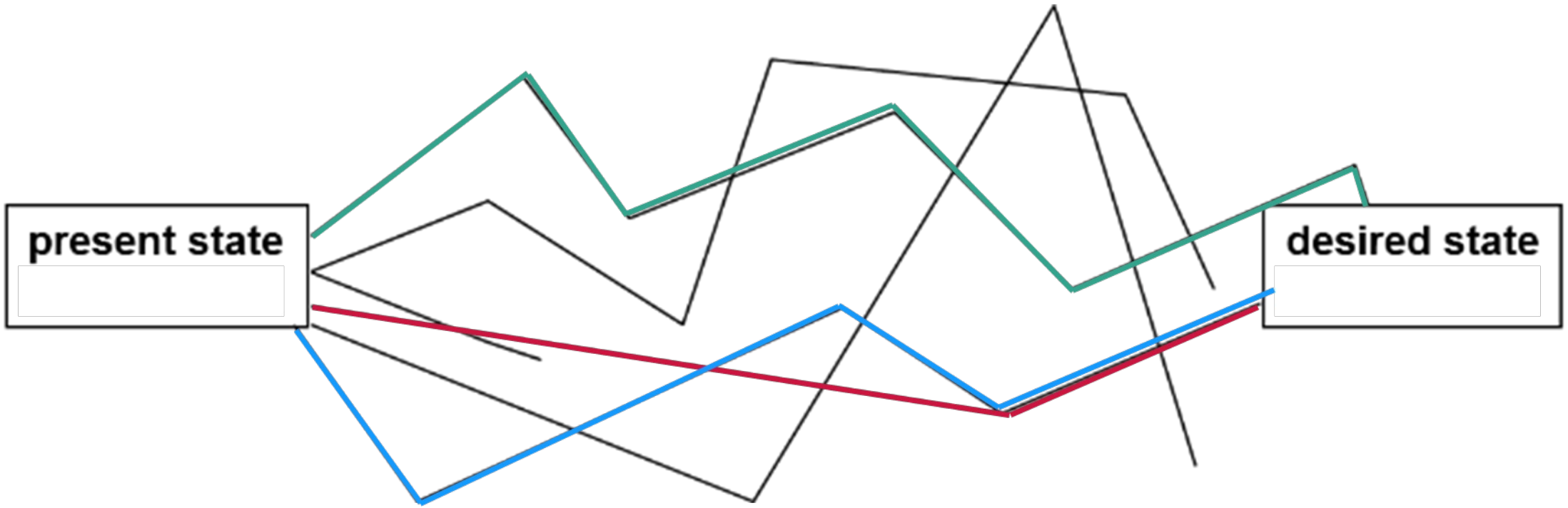
?

Desired state: Future situation where the problem no longer exists

A well formulated problem describes the present and desired states in clear, concise, and exact language.

Source: Gora, Ha, Leung, and Boakye-Yiadom (2022) Solution Formulation, ENG 1102 – Engineering Design Principles

Solution finding



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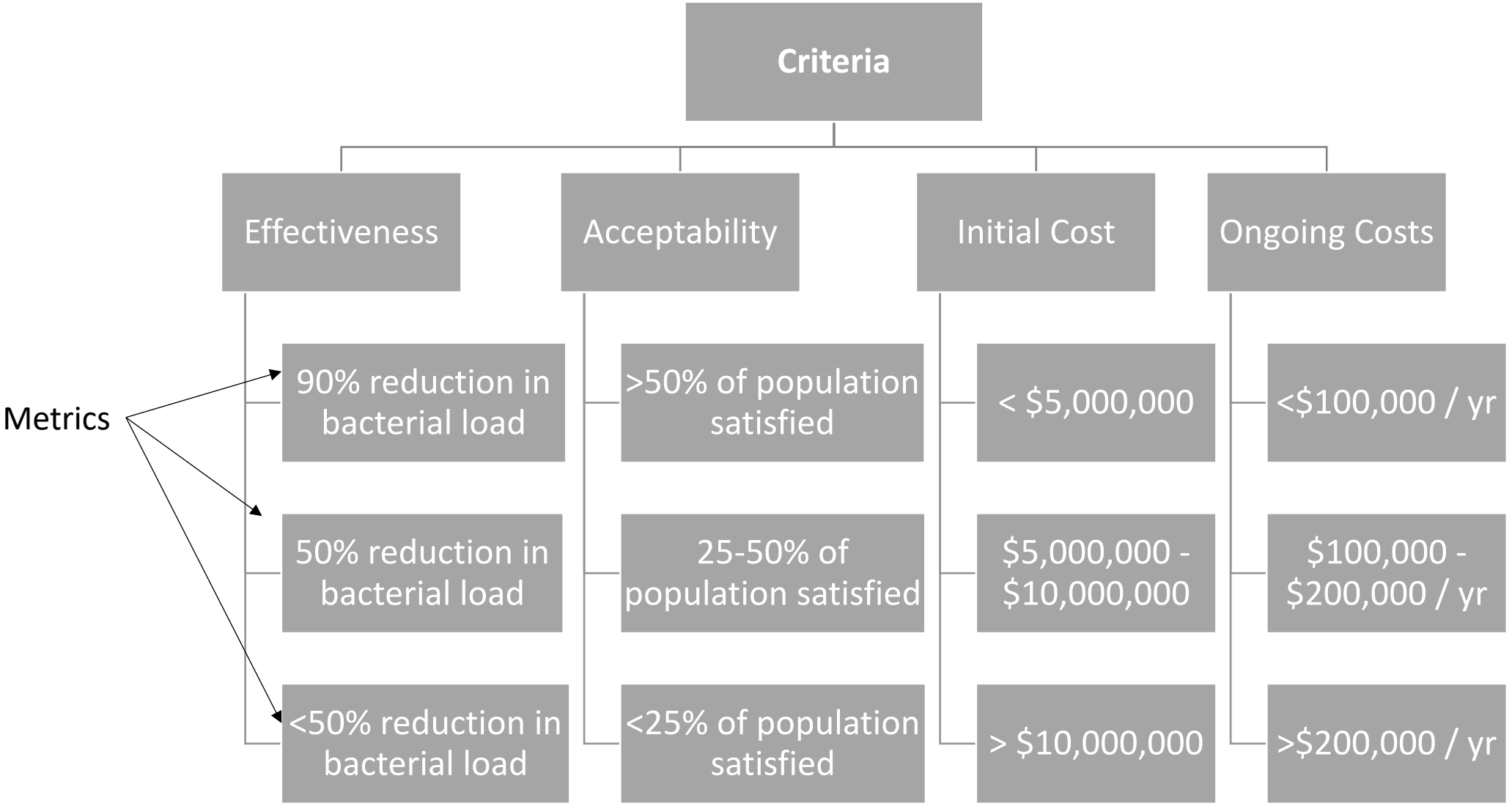
Analysis of potential solutions: Weighted design matrix

Criteria	Effectiveness	Acceptability	Initial Cost	Ongoing Cost	Total
Weights	**2.5**	**0.5**	**1**	**2**	
Solution 1					
Solution 2					
Solution 3					

Source: Gora, Ha, Leung, and Boakye-Yiadom (2022) Solution Formulation, ENG 1102 – Engineering Design Principles

Analysis of potential solutions: Evaluation criteria and metrics



Implementation and evaluation

implement 2 of 2 verb

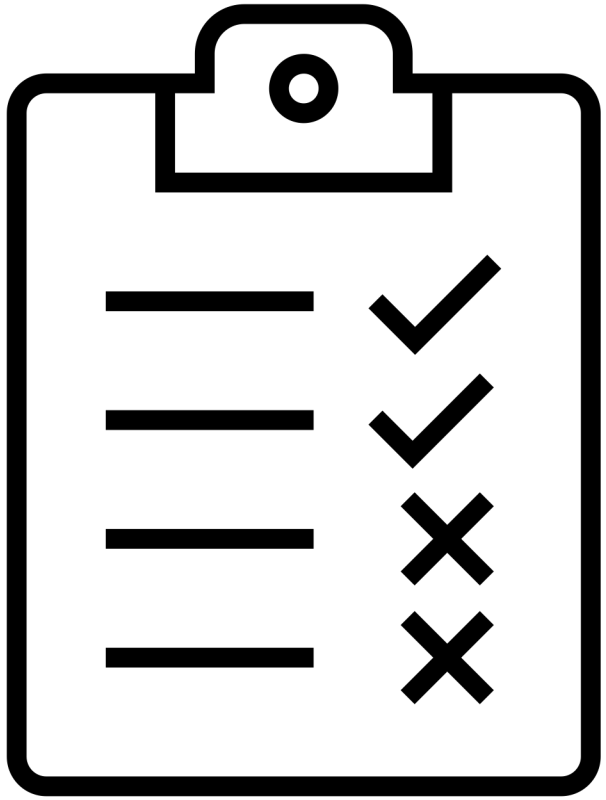
im·ple·ment ˈim-plə-ˌment

implemented; implementing; implements

transitive verb

1 : CARRY OUT, ACCOMPLISH

> *especially* : to give practical effect to and ensure of actual fulfillment by concrete measures



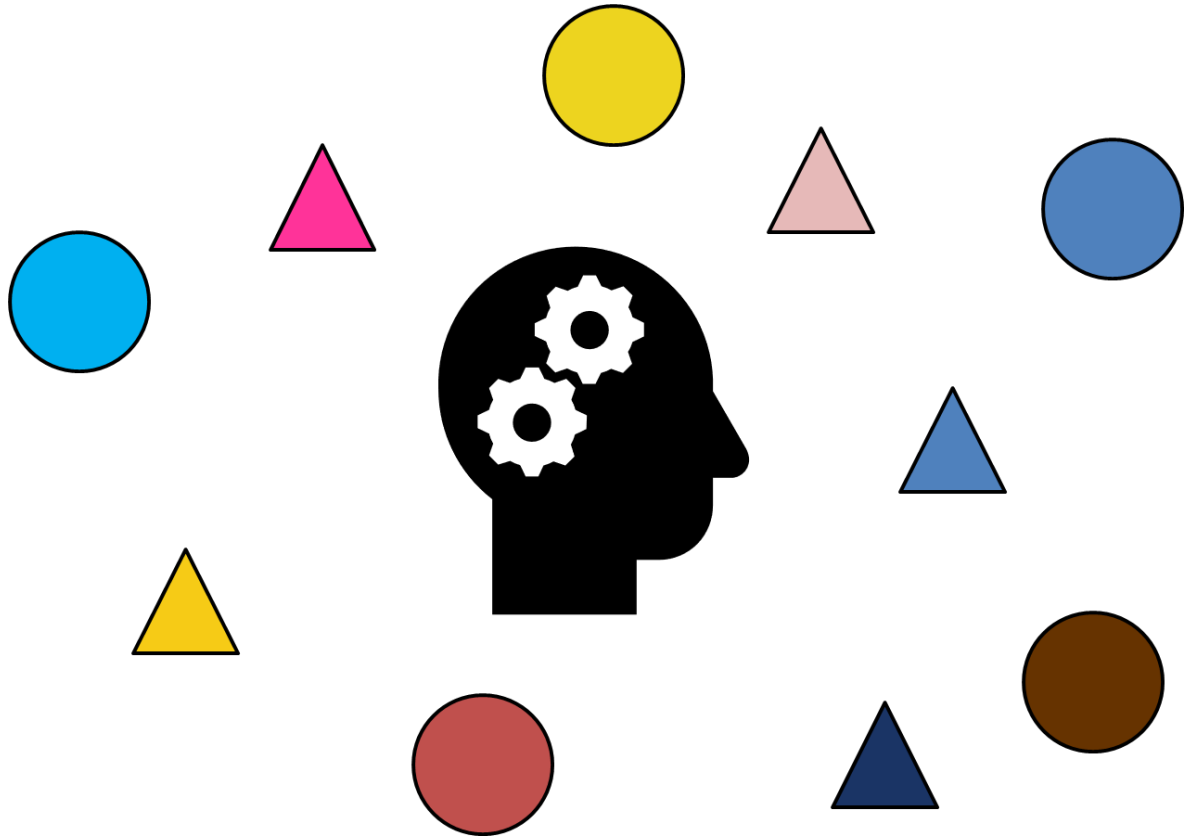
Source: Merriam-Webster Dictionary (https://www.merriam-webster.com/dictionary/implement#)

Tools for innovation: Stakeholder engagement

Tools for innovation

Idea generation techniques

- Drawing on personal experiences
- Consulting with stakeholders
- Conducting research
- Creative thinking techniques (brainstorming, brainwriting, SCAMPER, 5 Whys)



Source: Gora, Ha, Leung, and Boakye-Yiadom (2022) Solution Formulation, ENG 1102 – Engineering Design Principles

Tools for innovation: SCAMPER

Substitute? Who else, where else, or what else? Other ingredient, material, or approach?

Combine? Combine parts, units, ideas? Blend? Compromise? Combine from different categories?

Adapt? How can this (product, idea, plan, etc.) be used as is? What are other uses it could be adapted to?

Modify? Change the meaning, material, color, shape, odor, etc.? Make longer, stronger, thicker, higher, etc.?

Put to other uses? Rethink how an item or idea could be repurposed to solve a new problem

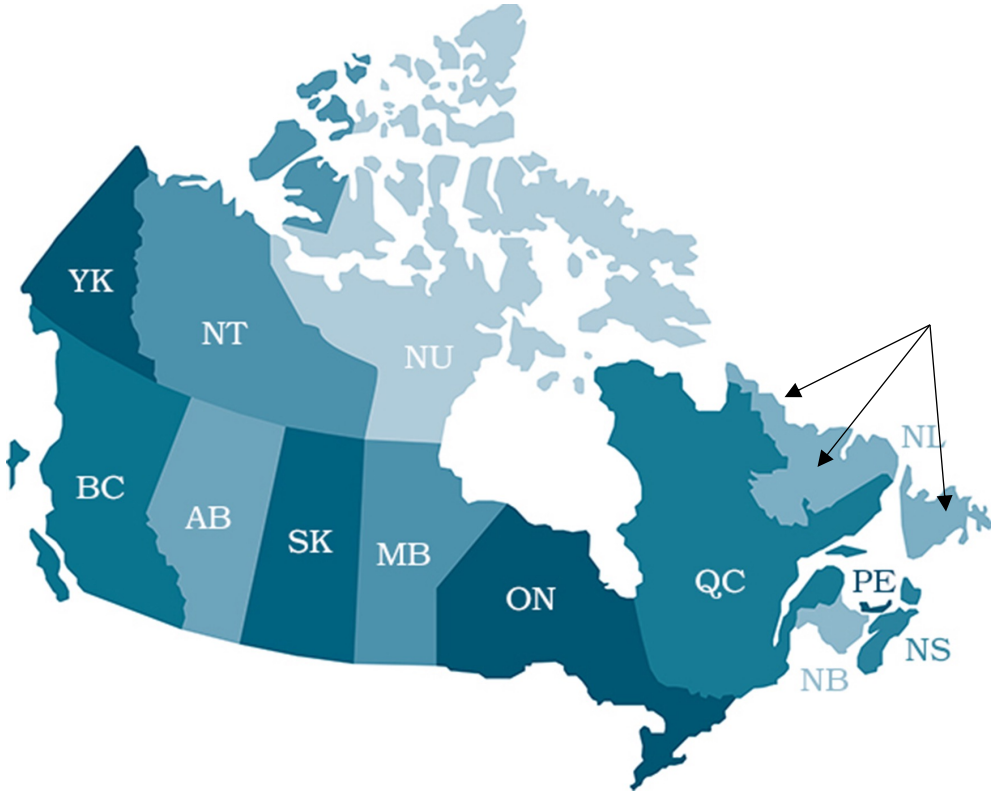
Eliminate? Split up? Take something out? Make lighter, lower, shorter?

Rearrange? Reorganize the elements of an existing design to fulfill a new purpose

Case study: Potable water dispensing systems in Newfoundland, Labrador, and Nunatsiavut, Canada

Problem finding and formulation: Drinking water in Newfoundland, Labrador, and Nunatsiavut

- 150+ boil water advisories at any given time
- Water treatment regulations are less stringent than some other provinces in Canada (e.g. Ontario)
- In some communities, tap water is not of high quality and most people gather water from streams or purchase bottled water



Initial solution: Potable water dispensing units

Subsitute a decentralized potable water dispensing system (similar to dispensing systems at grocery stores) for bottled water / water collected from streams

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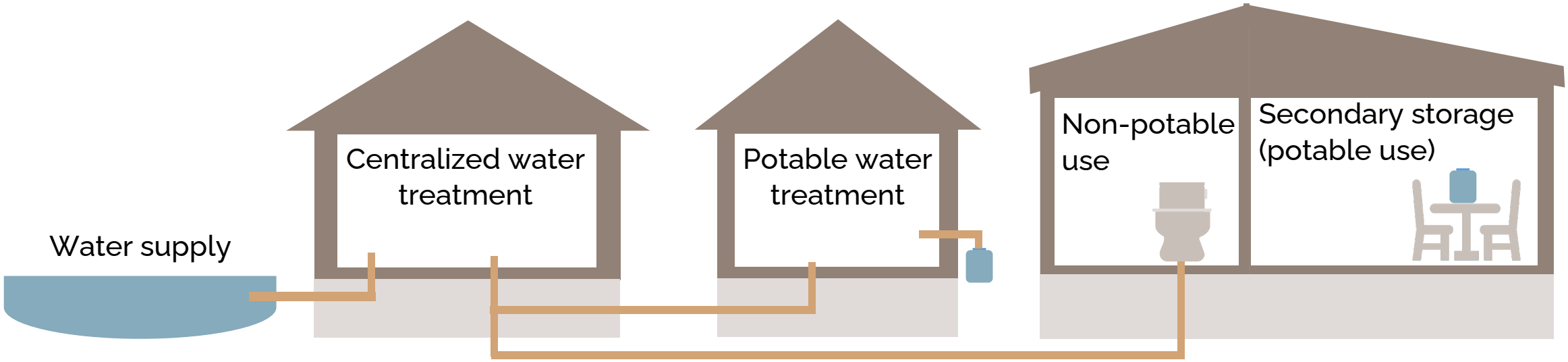

Initial implementation and evaluation:
Potable water dispensing units

The PWDU concept was independently initiated by seven communities in the province:

Sources: CBCL Limited (2010) Evaluation of existing potable water dispensing units and recommendations for design and operational guidelines, prepared for Newfoundland and Labrador Department of Environment and Conservation and Chaulk and Picco (2010) Drinking Water Safety Initiative, Clean and Safe Drinking Water Workshop 2010, Gander, NL

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Locations: Often located at community hall or equivalent

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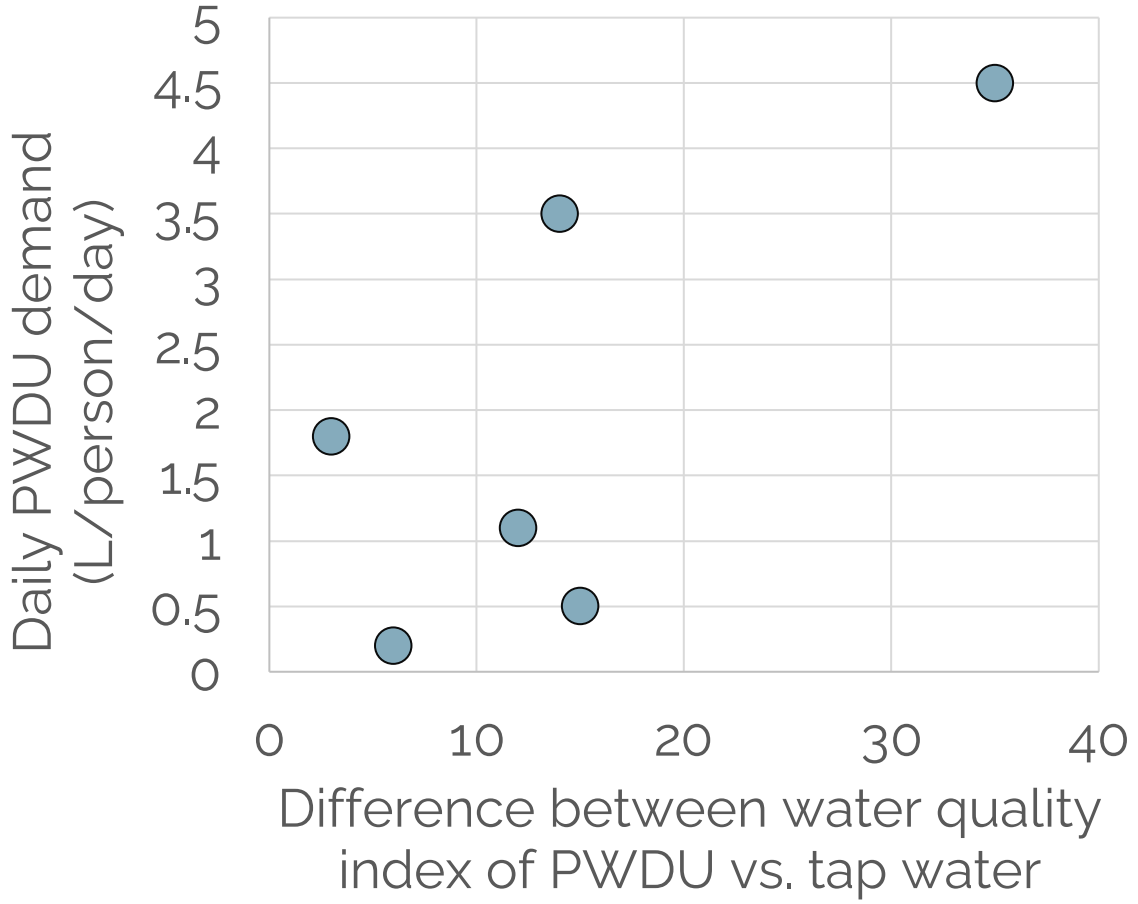
Iteration of problem finding and formulation: Potable water dispensing units

Water quality: Aesthetic quality of influent and finished water were predictors of adoption

Dispensing area: "Quality of dispensing experience" was a predictor of adoption

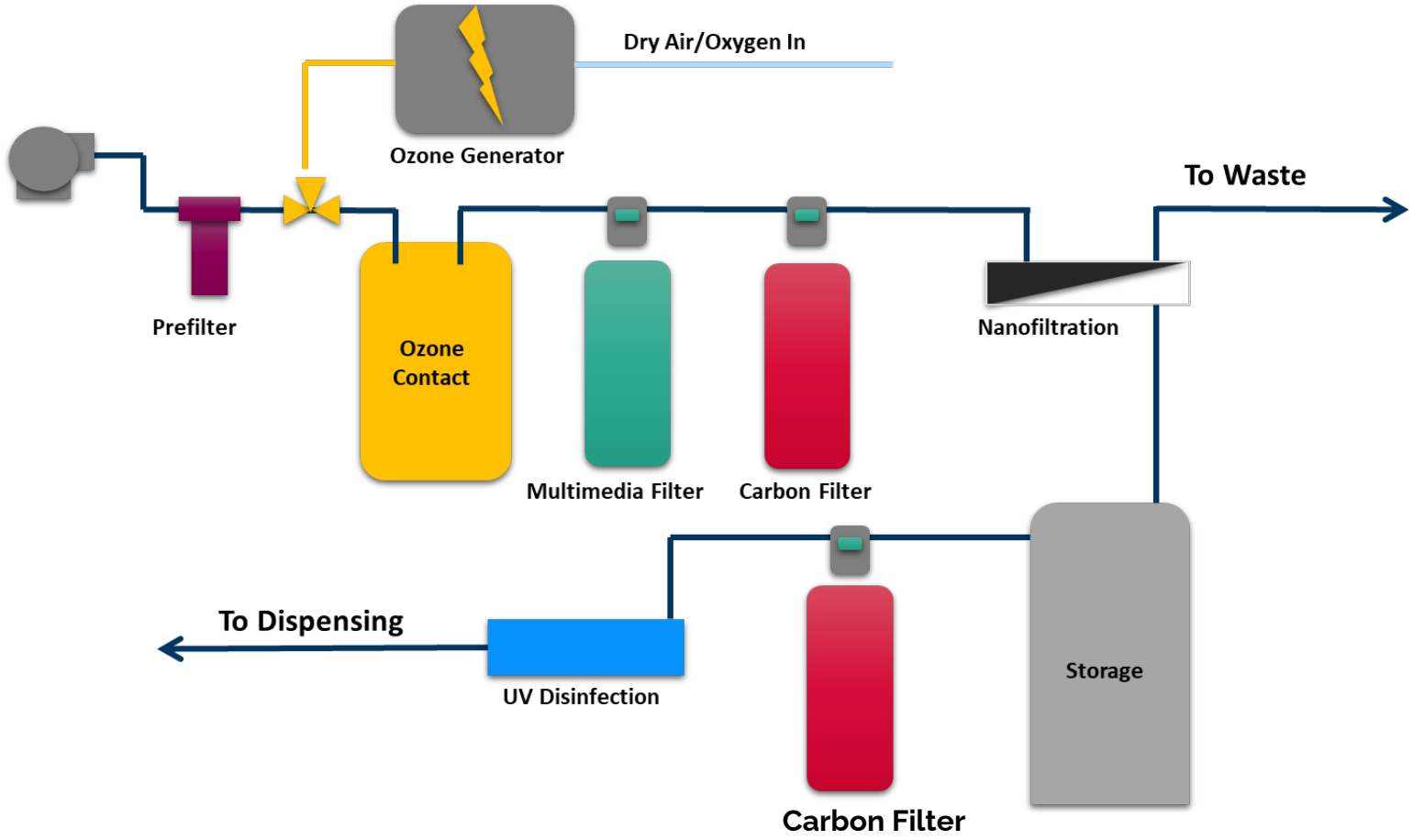
Concerns: Initial and ongoing costs, operation and maintenance, operational and financial capacity



Source: Adapted from CBCL Limited (2010) Evaluation of existing potable water dispensing units and recommendations for design and operational guidelines, prepared for Newfoundland and Labrador Department of Environment and Conservation

Iteration of solution formulation: Potable water dispensing units

Combine water treatment unit processes that can remove pathogens, disinfection byproducts, metals, and aesthetic parameters from water



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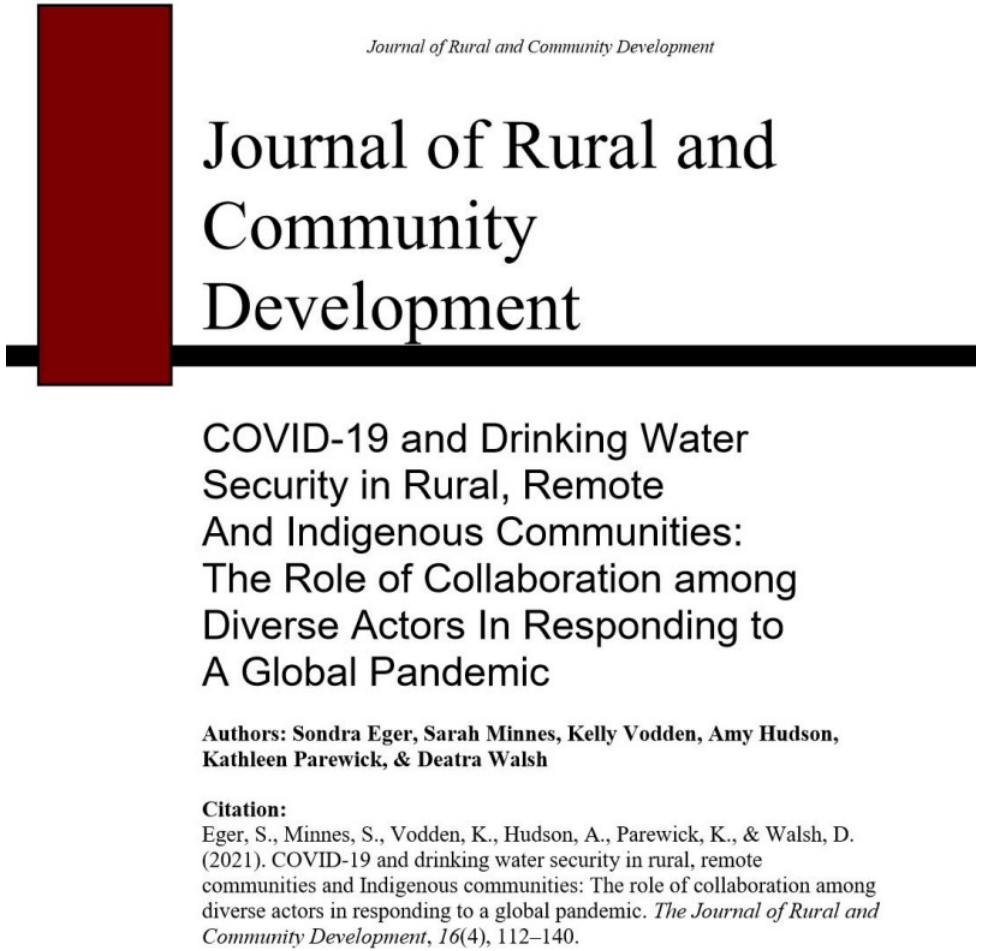
Final implementation and evaluation: Potable water dispensing units

Project uptake: 32 communities have the new PWDUs, 10/32 are Indigenous

Water quality: Dispensed water meets all provincial regulations and is in line with best practices in Canada

Ongoing concerns: Maintenance, operation, and cost

Special concern: Disaster/emergency response (e.g. difficulties implementing COVID-19 protocols at PWDUs)



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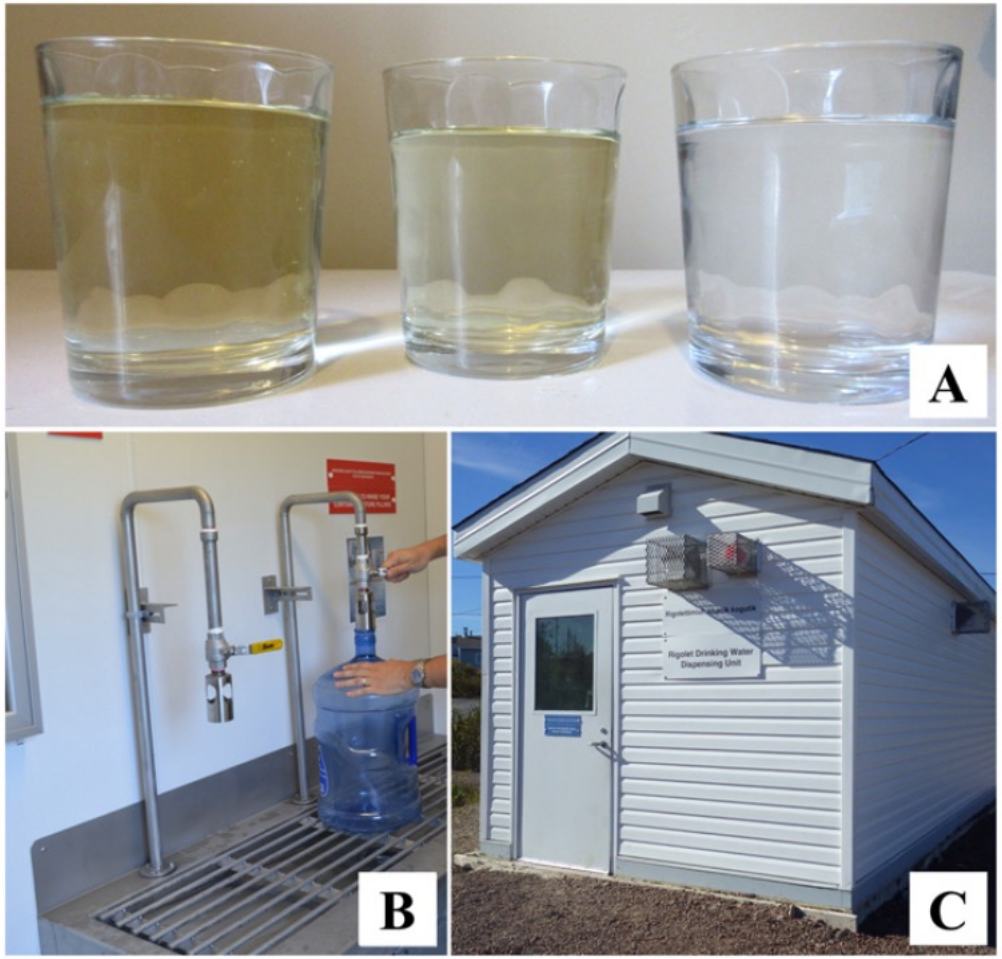

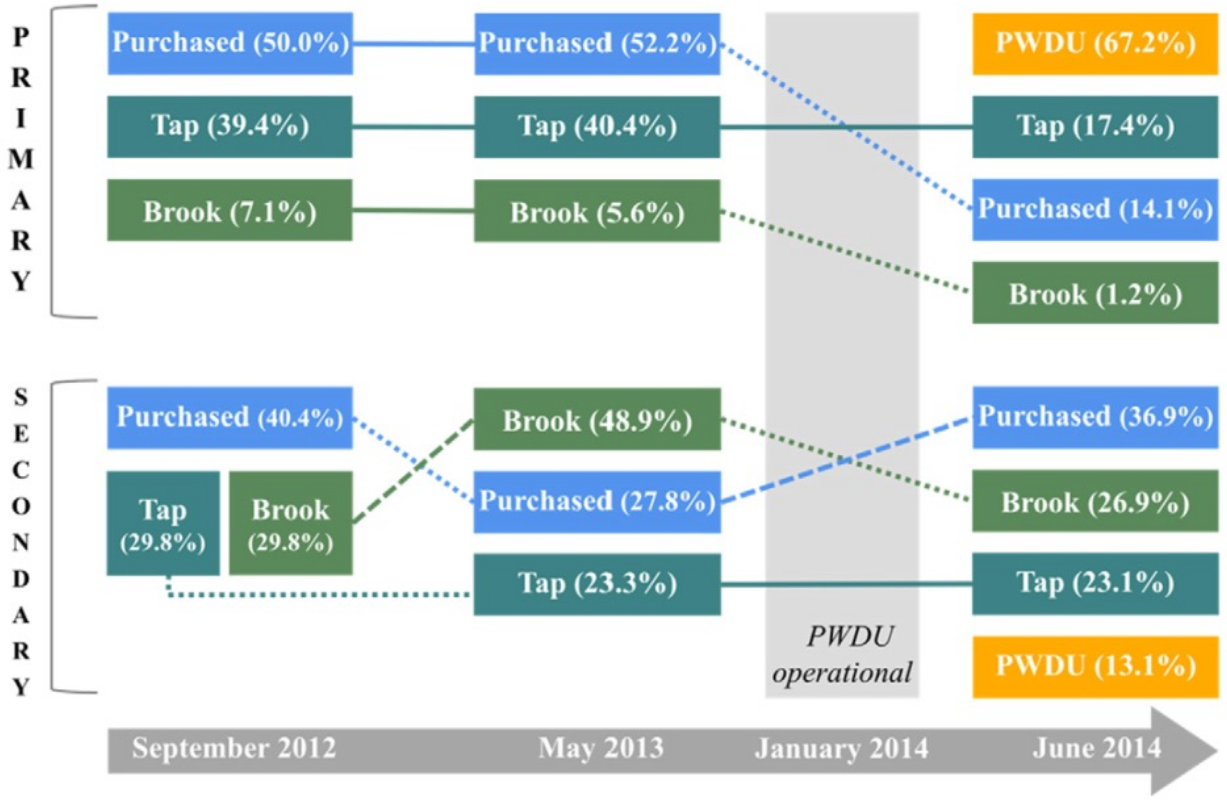

Source: Water usage and public perception of drinking water quality safety in Rigolet, NL (Wright et al., 2018)

SCAMPER:
https://www.youtube.com/watch?v=M2l4PSdt7_8

Five Whys:
https://www.youtube.com/watch?v=BEQvq99PZwo

Brainwriting:
https://miro.com/templates/brainwriting/

CBCL Limited report:
https://www.gov.nl.ca/ecc/files/waterres-reports-drinking-water-093017-00-pwdu-study-final-report.pdf

Thank you!

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