Process Water Management & Reuse Technologies

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RAMBØLL

Bright ideas.
Sustainable change.

Agenda

About Ramboll

Industrial water and circularity

Water stewardship

Effluent reuse

Ramboll in brief

Independent architecture, engineering, and consultancy company

Creating sustainable solutions across energy, real estate, transport, water, waste, industry, finance, technology, healthcare and public sectors

Founded 1945 in Denmark

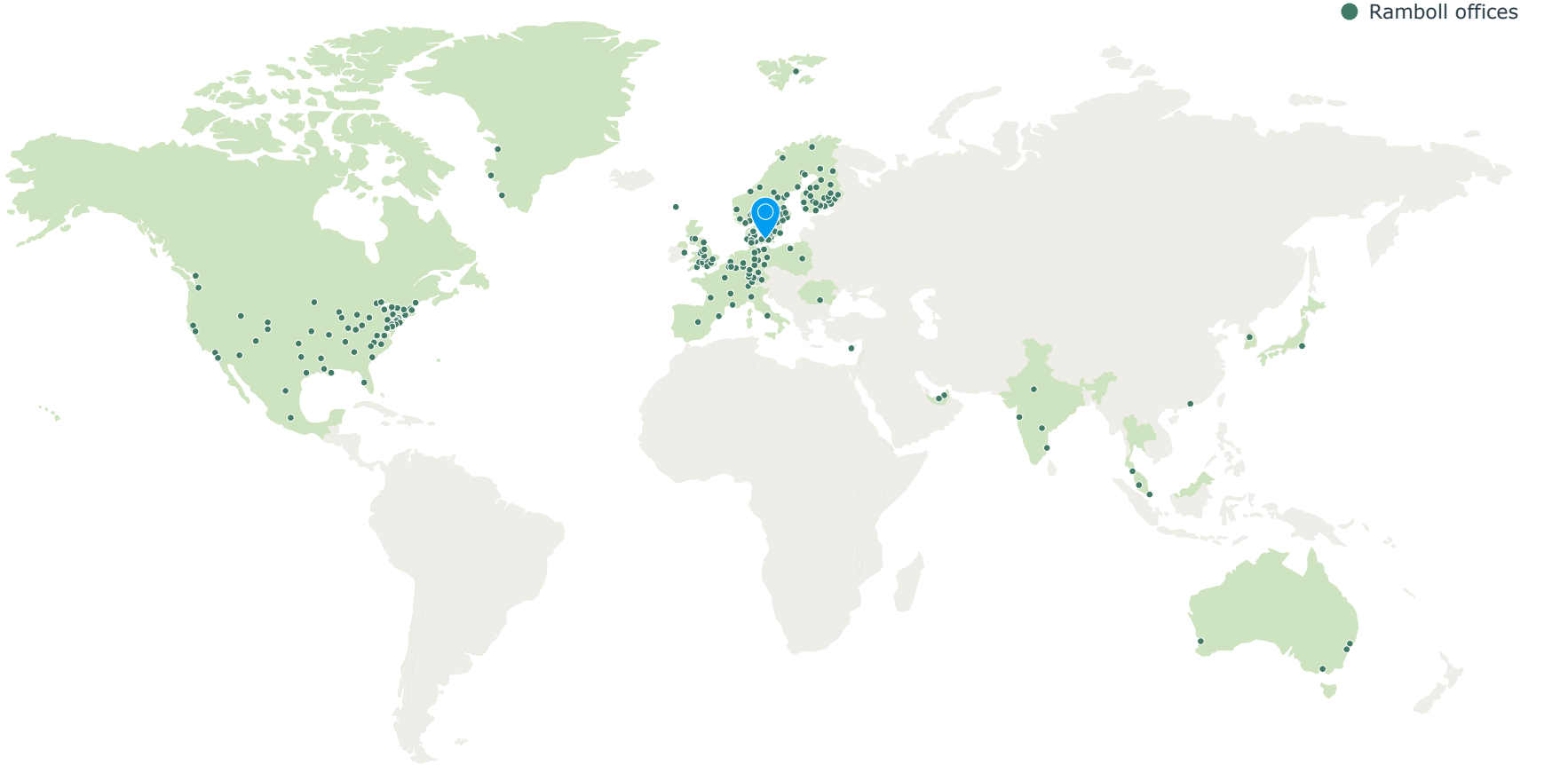
Owned by Rambøll Fonden – The Ramboll Foundation providing long term stability

35
Countries covered by global office network

>18,000
Experts

2.3 Bn
Global revenue, in 2024 across all markets

Geographical footprint



Industrial wastewater & water services - USA

TREATMENT PLANT ENGINEERING

- Feasibility studies
- Conceptual process selection
- Innovative technology development
- Treatability laboratory/pilot testing
- Preliminary/detailed design engineering
- Project delivery
- Source control plans

OPERATIONS & MAINTENANCE

- Operations troubleshooting
- Performance/cost audits
- Operator training
- Process control management of data
- On-site or remote technical support

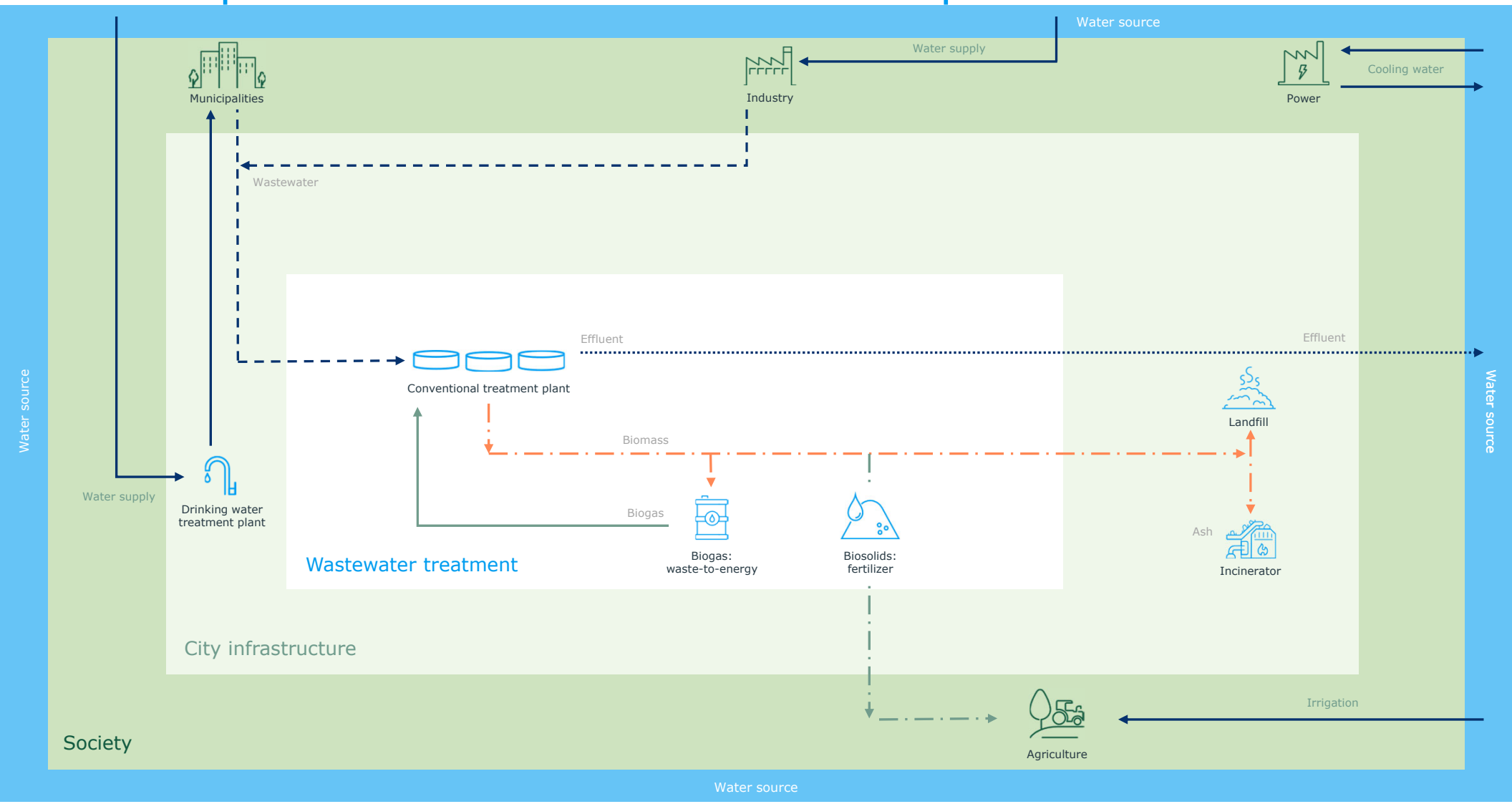
PERMITTING & PLANNING

- Water use audits
- Source water risk and protection plans
- Water supply and scarcity assessments
- Water withdrawal and sustainable use
- Wastewater discharge authorizations
- Aquatic toxicity testing
- Stormwater planning

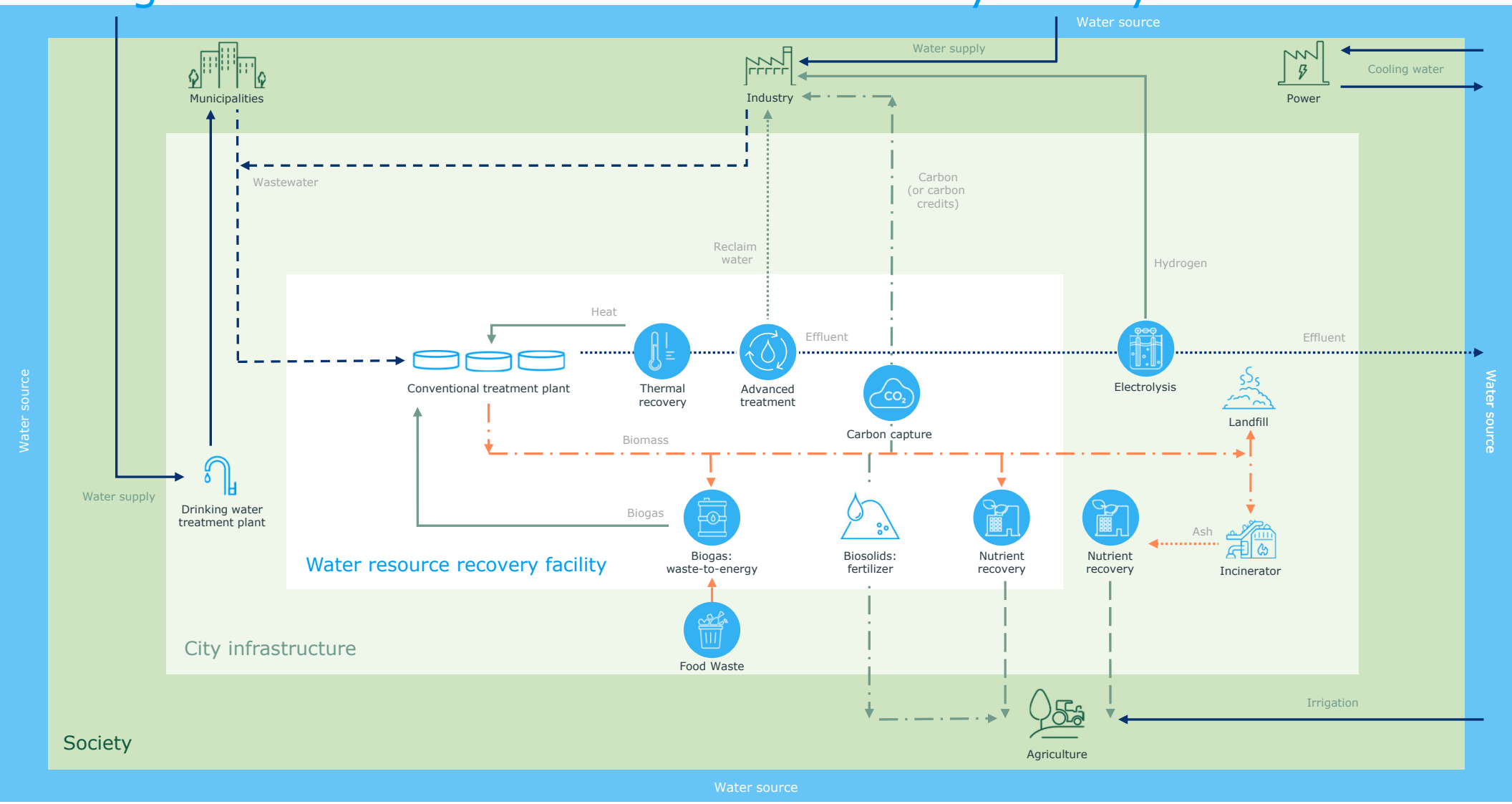
CONSTRUCTION SERVICES

- Procurement
- Construction
- Commissioning and startup
- Performance testing

Current practice: Wastewater treatment plant



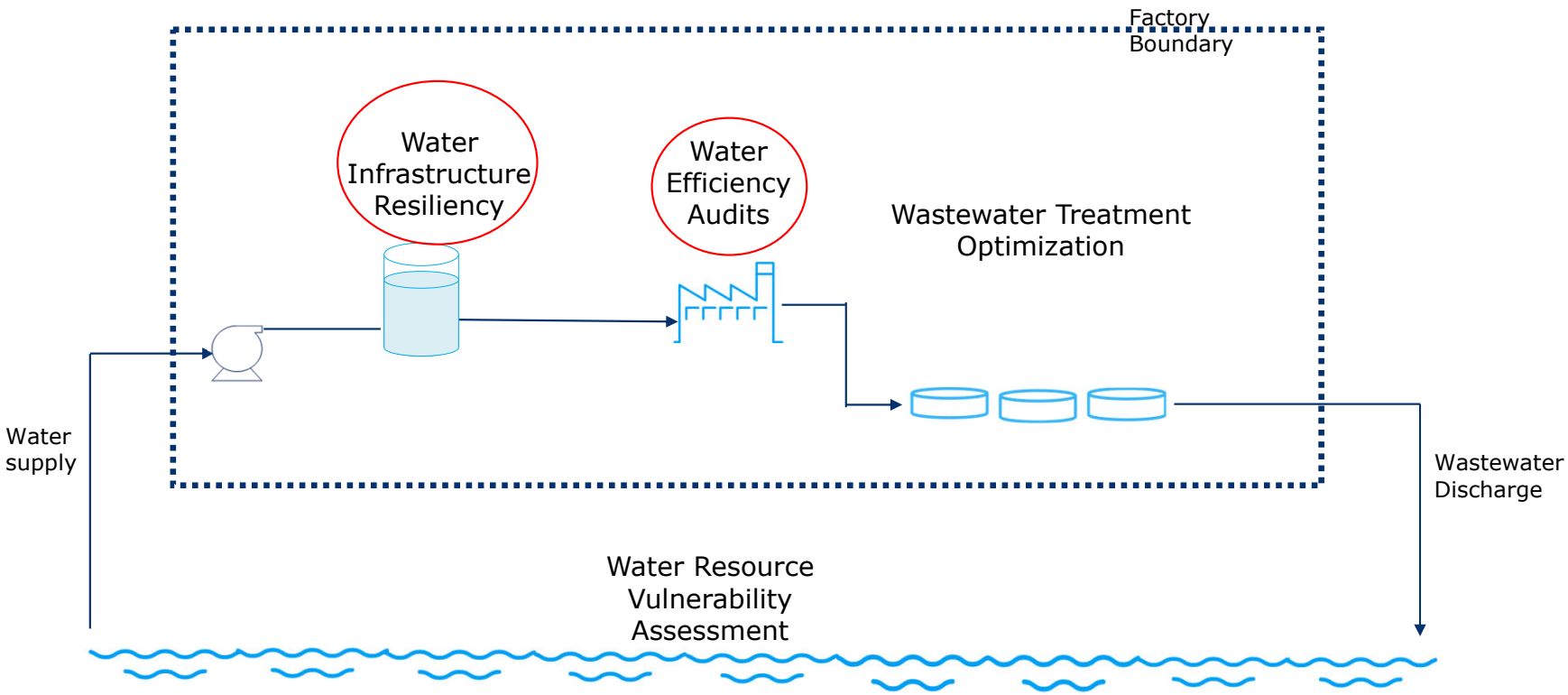
Design for future: Water resource recovery facility



Industrial Water Stewardship Drivers

- Published water sustainability goal
- Economic cost of water & wastewater
- Community “License to Operate”
- Physical Scarcity (or competing interests)
- Brand Reputation (w customer & consumer)
- Corporate Reporting of Material Risks

Industrial water stewardship opportunities



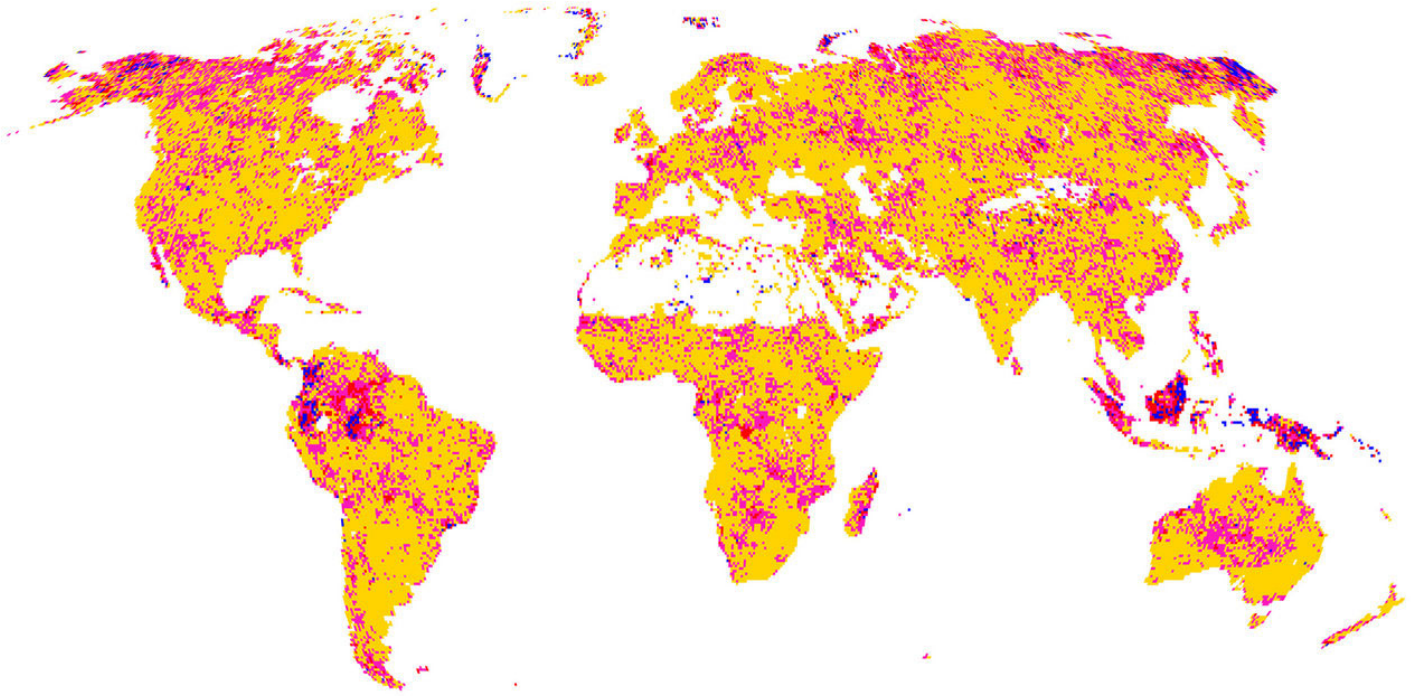
Water infrastructure resiliency

Goal

- Pharma water sustainability goal to implement strategic water management plans at priority locations

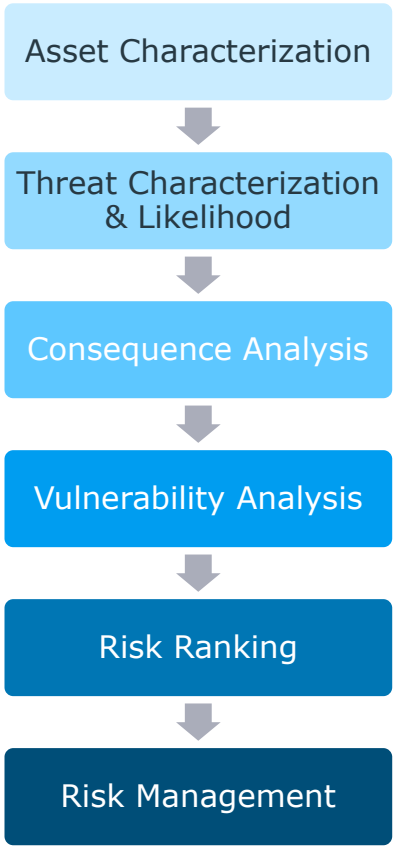
Approach

- Risk based assessments of the resilience and potential risk that a site would not maintain an adequate supply of water
- For sites with (indirect) water utility supply, evaluations included utility resilience
- Identify the highest risk assets and possible mitigation measures



https://climate.nasa.gov/news/2617/study-finds-drought-recoveries-taking-longer/

Water resilience and risk evaluation



Water Resilience and Risk Evaluation (WRRE) involves collecting data, conducting a site visit, and defining the water supply risk

American Water Works Association (AWWA) J-100 Standard (Risk and Resilience Management of Water and Wastewater Systems) used to provide a basis for a consistent quantification of threat probability

Definition of Risk (R) = Threat (T) * Consequence (C) * Vulnerability (V)

Planning level cost indices developed for mitigation measures

Cross checks using Water Stress indices/tools, such as “Aqueduct”

Threats

Natural Hazards

Includes all storms, floods, wildfires, and other natural events that have or could reasonably occur in the location of the facility.

Dependency Threats

Includes all interruptions of utilities, suppliers, employees, customers, and transportation.

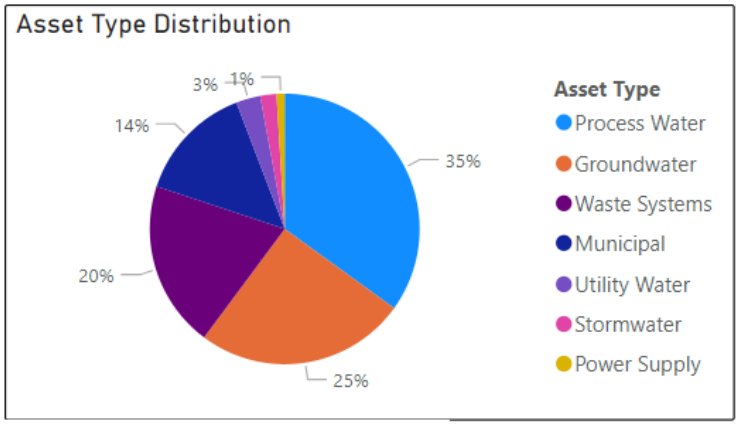
Proximity Threats

A threat associated with being near another facility that could impact operation.

Malevolent Threats

Includes various modes of attack and various magnitudes of attack by both inside and outside bad actors.

Asset	Threat	Risk Rating
WWTP transfer pumps and piping	Major earthquake	97
Boiler feed/sterilizer feed	Utility interruption	78
Raw water tanks and pumping	Major earthquake	39
Groundwater supply	Contamination chemical or pathogen	24
WWTP transfer pumps and piping	Utility interruption	24
Sand filters, softeners & carbon filters	Service delivery interruption - Key suppliers	22
Boiler feed/sterilizer feed	Process sabotage physical insider	19



Value of results

Risk based capital asset renewal planning by site

Prioritization of top projects with objective cost to benefit ratio

System wide program advantages:

- Insights on recurring resilience threats allows opportunity for uniform response
- Share innovation and ideas for best practices in sustainable water management

Industrial water auditing

You Cannot Manage What You Cannot Measure

Quantity
Quality

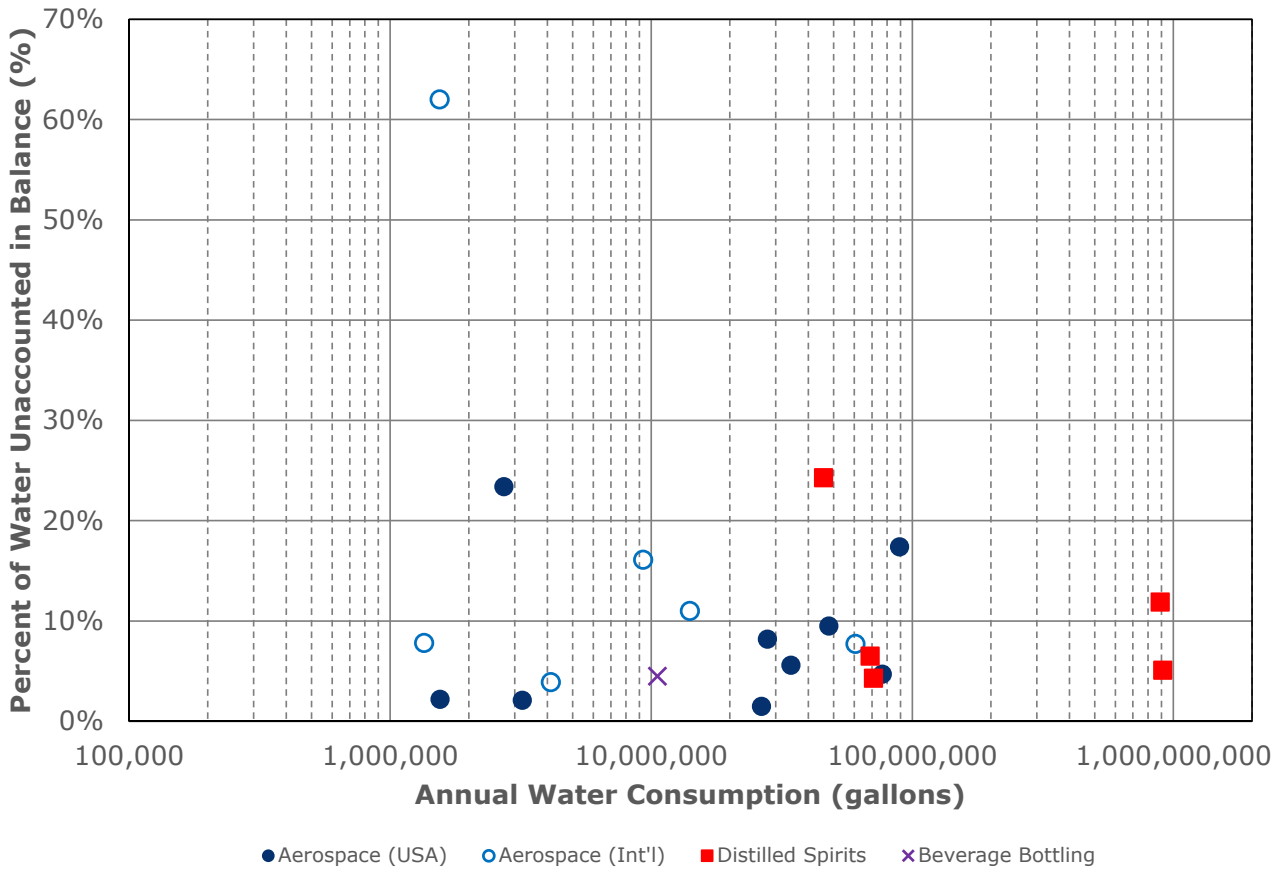
Beyond the Four Rs

Reduce
Recycle
Reuse
Replenish

What Counts Can't Always Be Counted

Full impact

Unaccounted water



Elements of a comprehensive water audit

Project Components

- ❑ Review Facility Operations – Water/Salt Balances, Energy Utilization
- ❑ Review Water Resources and Intakes
- ❑ Identify Opportunities for Reduction
- ❑ Rank Opportunities Based on Expected Payback

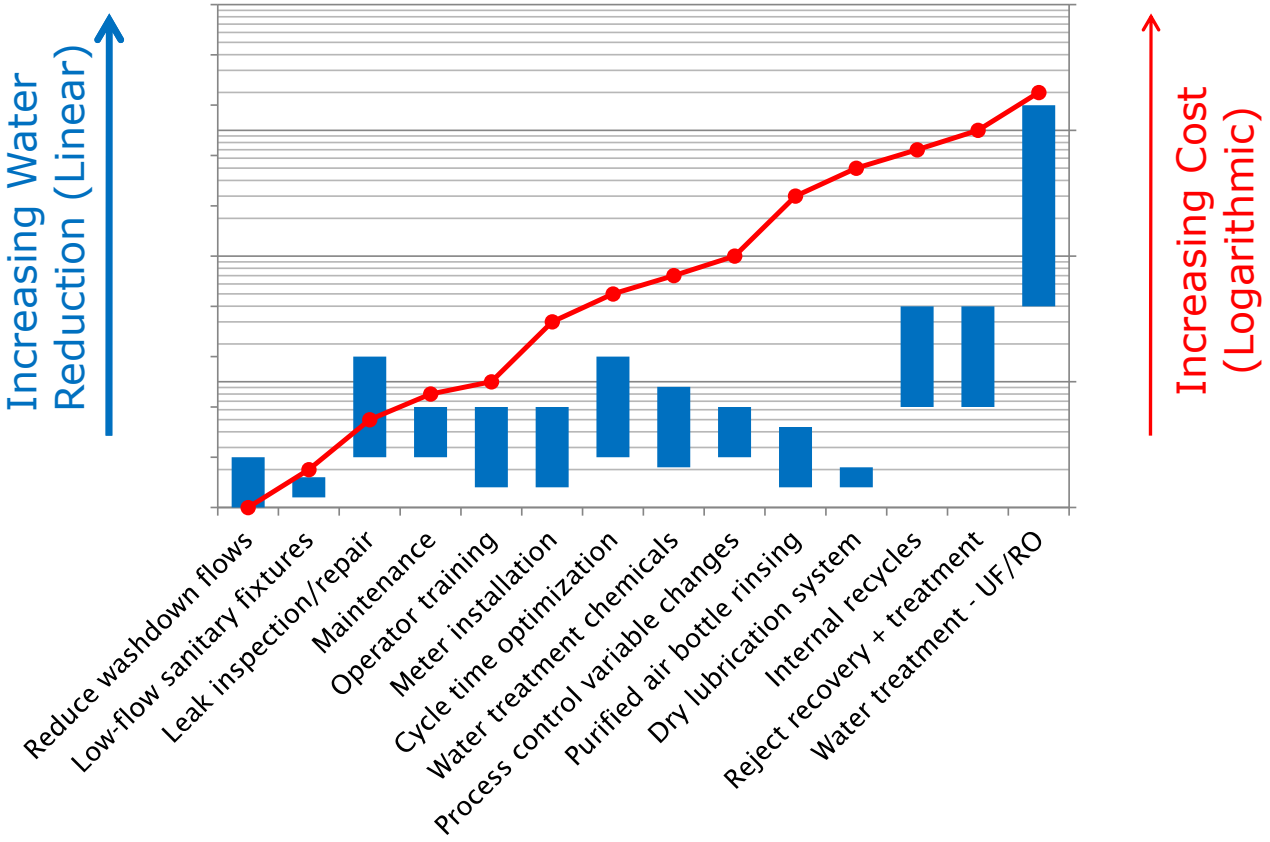
Targets of Opportunity

- Manufacturing activities
  - Raw Material, Washing & Cleaning, Transfer
- Water Supply
  - Boreholes, Water Treatment, Reuse options
- Heating Systems
  - Boilers, Hot Water/Steam
- Cooling Systems
  - Cooling Towers, Chillers
- Personnel Utilities
  - Restrooms
- Wastewater disposal
  - Treatment system, treatment optimization, reuse options

Holistic Evaluation

- ✓ Quantity vs. Quality Impacts
- ✓ Trading Water for Energy
- ✓ Reaching sustainable water management
- ✓ Transfer lessons learned to sister sites

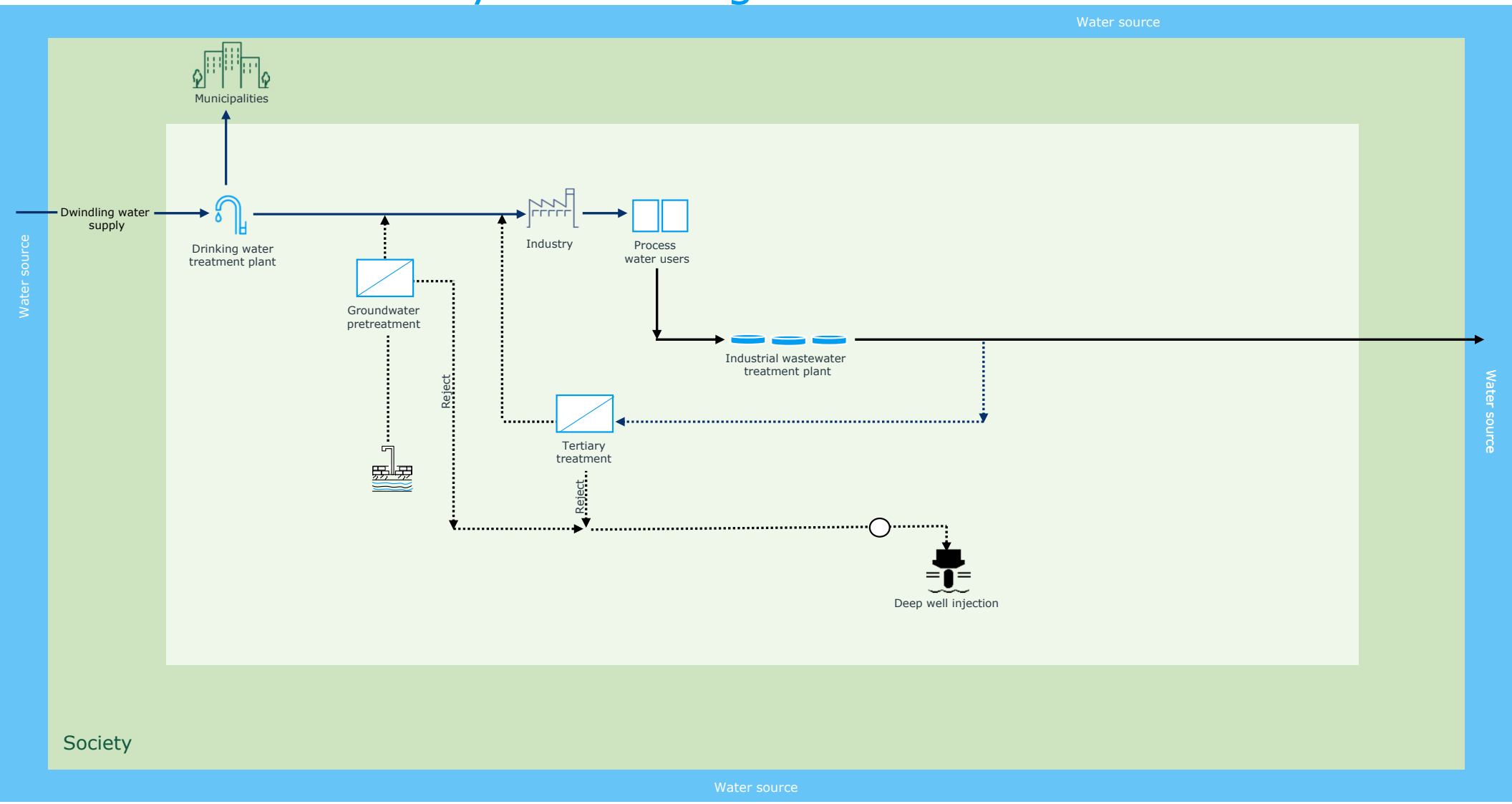
Cost-benefit analysis - streamlining water usage



Reuse case study
Steel client – US gulf coast region

Evaluation of alternative water sources to reduce or eliminate reliance on local utility	• Future water use restrictions due to regional water scarcity • Goal to eventually become a Zero Liquid Discharge (ZLD) facility.
Options for alternative water sources:	• Groundwater from existing source well • Tertiary treatment and reuse of process wastewater facility's treated wastewater • Both alternative sources are significantly saltier than the current water source
Complicating factor: Pending whole effluent toxicity limit on existing wastewater discharge, additional RO reject will exacerbate	• Deep well injection and evaporation ponds evaluated for RO reject management • Deep well lead case • RO reject from additional wastewater treatment for reuse expands the deep well permitting
Groundwater treatment with deep well for RO reject current lead case	

Steel mill case study: block diagram



Rapid growth of existing industry creates new regional water demands on existing infrastructure

Data Centers substantially reduce their energy consumption through use of evaporative cooling in cooling towers.

Potential sources for industrial cooling water:

- Public (potable) water supply
- Raw surface water or groundwater, treated as needed
- Harvested rainwater
- Treated effluent i.e. "reclaimed wastewater" or "reuse water"
- Combination of sources

Master planning & pre-engineering services

- Identify potential available water resources and discharge pathways
- Facilitate discussions with local water/wastewater service providers and/or regulators
- Identify local permitting requirements
- Review of existing infrastructure and identification of necessary improvements for service
- Identify treatment requirements
- Evaluate alternative water supplies (reclaimed water, raw water, harvested rainwater, a combination of sources)
- Advise on risk and resilience (on-site storage, redundancy, etc.)
- Evaluate alternative pathways for water discharge (surface water, beneficial reuse, zero liquid discharge)
- Develop potential timeline for service
- Engineering opinion of probable cost

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Key points

Utilization of potable water supplies competes with their higher value uses, such as drinking water, fire protection, and sanitation.

Public opposition focuses on use of available public water supply that was intended to support planned growth.

Availability of treated effluent increases with time for growing communities, rather than decreases.

Harvested rainwater may be attractive but is usually only a partial solution and requires substantial space for storage.

A combination of reuse water, on-site storage, potable supply, and/or harvested rainwater, may be ideal.

Consider the quality and quantity of spent cooling water. Disposal of spent cooling water may be as/more challenging than finding a source of supply.

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