Better Plants
U.S. DEPARTMENT OF ENERGY

# Industrial Water Systems
## Virtual Training – Session 4

Session 4
Tuesday – July 7th, 2026
10 am – 12:30 pm

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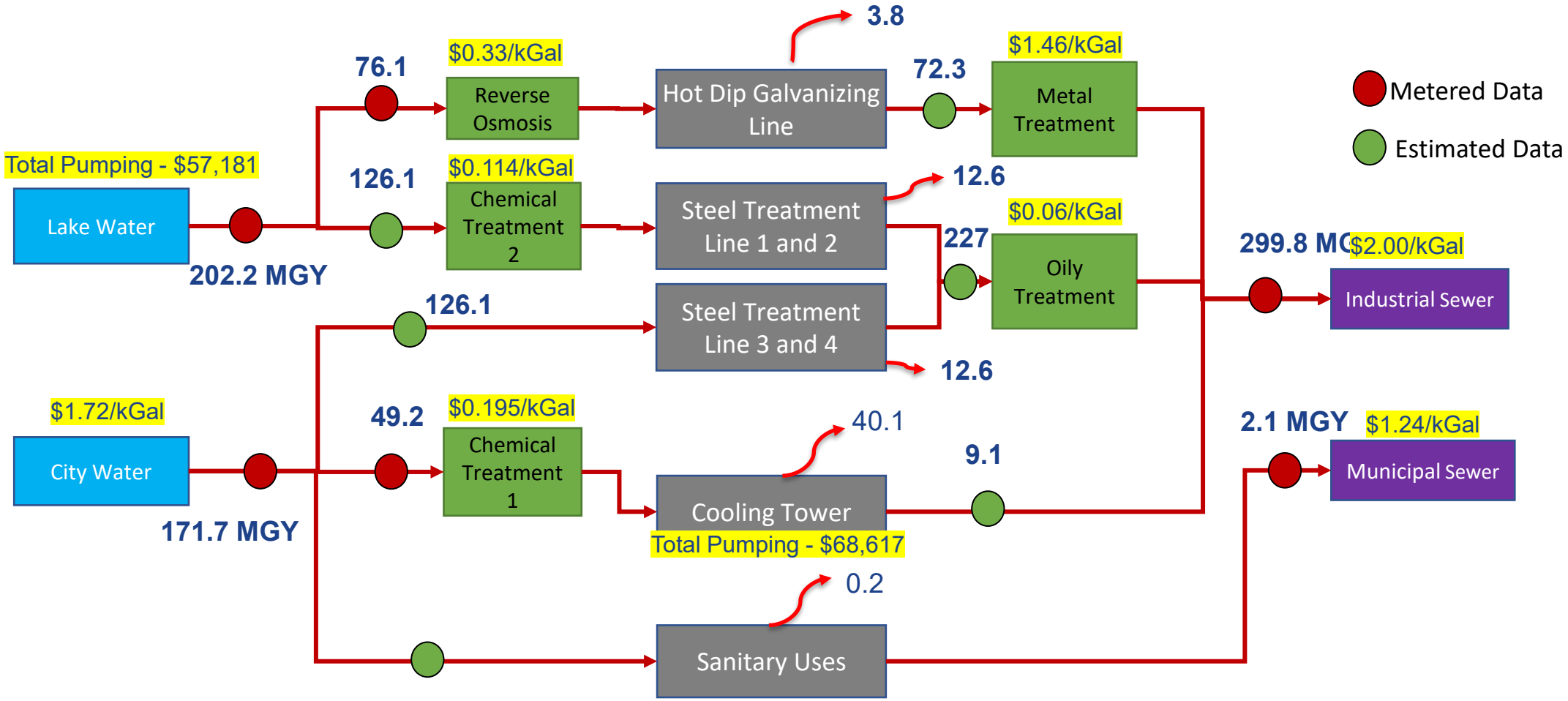
# Water Virtual Training Agenda

- **Week 1 (June 16th) – Introduction to Industrial Water Assessment**
- **Week 2 (June 23rd) – Understanding System Level Water use**
- **Week 3 (June 30th) – True Cost of Water**
- **Week 4 (July 7th) – Water Quality and MEASUR Tool Working Session**
- **Week 5 (July 14th) – Identifying Water Savings Opportunity**
- **Week 6 (July 21th) – Virtual Water Treasure Hunt**
- **Week 7 (July 28th) – Estimating Water Savings Opportunities**
- **Week 8 (Aug 4th) – Industrial Water System VINPLT Wrap-up Presentations**

# Review – Session 1 to 3

- Water Risks
- Industrial Water Assessment
  - Step 1 - Water Baselining
  - Step 2 - True Cost of Water
  - Step 3 – Water Quality Characterization
  - Step 4 - Identifying water savings opportunities
- Water Baselining
  - Plant Water Flow diagram
  - Data Collection (system level and facility level)
- True Cost of Water
  - Data Collection (water intake, discharge, treatment and embodied energy)

# Example Facility – With Data (From Session 3)



# Agenda – Session Four

Today's Content:

- Water Quality and Compliance
- MEASUR Water Assessment Module - Overview
- MEASUR Water Assessment Module – Working Session
- Q&A

# Dr. Naushita Sharma, Oak Ridge National Lab

## Qualification

- Ph.D. (2021) | Environmental Engineering | School of Sustainable Engineering and The Built Environment, Arizona State University
- M.S. (2018) | Civil, Environmental and Sustainable Engineering | School of Sustainable Engineering and The Built Environment, Arizona State University
- B.Tech. (2017) | Mechanical Engineering, Department of Mechanical Engineering, National Institute of Technology
- Certified Energy Manager (2025 – present) | Association of Energy Engineers

## Professional Experience

- R&D Staff (2023 – present) | Oak Ridge National Laboratory
- Water Resources Engineer (2021 – 2023) | Jacobs Engineering Group
- Faculty Associate (2019 – 2023) | Arizona State University
- Adjunct Faculty (2022) | City College of New York

# Water Quality and Compliance

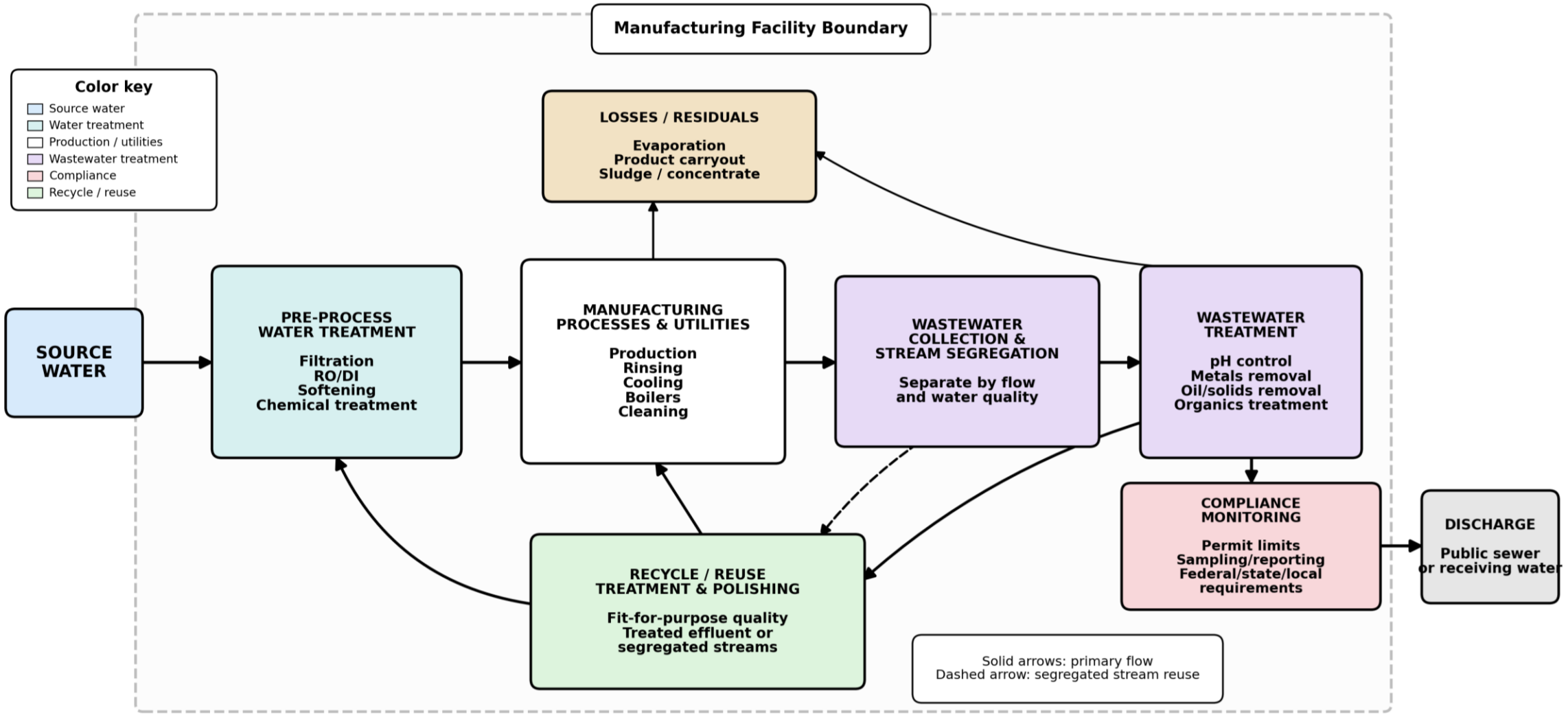
# Purpose of Water/Wastewater Treatment

**Process Requirements:** Process and product specifications determine required input water quality and therefore required pre-process water treatment.

**Regulatory Compliance**: Many industries must treat wastewater to meet federal/state/local environmental regulations before discharging it into public sewers or natural bodies of water.

**Recycling and Reuse**: Treating water to determined desirable standards allow for recycling and reusing within the plant, contributing to volumetric water savings goals and lowers operational costs.

# Water/Wastewater treatment in a manufacturing facility



# Per Process Requirements

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# Typical Source Water Characteristics

| Parameter | Unit | Municipal water | Surface water | Groundwater | Industrial significance |
|---|---|---|---|---|---|
| **pH** | standard units | 6.5–8.5 | 6.0–9.0 | 6.5–8.5 | Corrosion, scaling, treatment chemical demand, process compatibility |
| **Hardness** | mg/L as $CaCO_3$ | 50–250 | 20–200 | 50–500+ | Scaling in boilers, cooling towers, heat exchangers, RO, and process systems |
| **Conductivity** | µS/cm | 200–800 | 50–800 | 200–2,000+ | Indicator of dissolved salts, TDS, salinity, RO need, and reuse suitability |
| **TSS** | mg/L | <5 | 5–500+ | <10 | Filtration/clarification loading, fouling potential, solids removal requirements |
| **Turbidity** | NTU | <0.3–1 | 1–100+ | <1–10 | Particulate/colloidal loading, filter performance, seasonal variability |
| **Iron (Fe)** | mg/L as Fe | <0.1–0.3 | <0.1–1 | 0.1–10 | Fouling, staining, membrane plugging, resin fouling, deposit formation |
| **Silica** | mg/L as $SiO_2$ | 5–25 | 2–30 | 5–60+ | Boiler scaling, RO recovery limitation, cooling tower concentration limits |

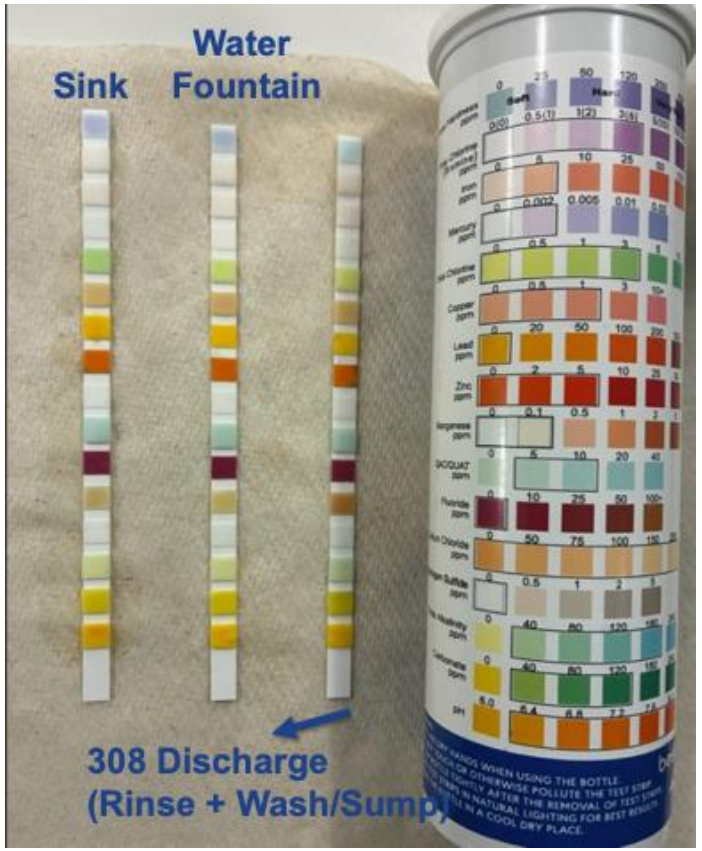
**Values are representative screening ranges for U.S. industrial source-water evaluation and should not be interpreted as design limits or compliance thresholds. Site-specific sampling is required before selecting pretreatment, reuse, or wastewater management strategies.

# Measuring Water Quality

- **Online sensors:** continuous monitoring for real-time control and alarms
  - pH, turbidity, conductivity, temperature, oxidation-reduction potential, dissolved oxygen
- **Spot measurements:** quick field checks using handheld meters
- **Grab samples:** single-point samples for specific conditions or troubleshooting
- **Composite samples:** time- or flow-weighted samples for representative wastewater quality
- **Laboratory analysis:** validated testing for compliance, metals, organics, solids, and detailed chemistry

# Common Water Quality Measurement Practices

- What we use during our In-Plt Trainings for spot measurements
  - Drinking Water Quality Test Strips
  - Multi-parameter water quality analyzer



# Water Treatment for Process Requirements

| Water Type | Typical Water Quality | | Treatment Process | Industrial Applications |
|---|---|---|---|---|
| | Total Dissolved Solids (mg/L) | Conductivity (µS/cm) | | |
| **Softened** | 50–200 | 100–500 | Chemicals and/or ion exchange | • Food & Beverage (cleaning, rinsing)<br>• Automotive/Metal Finishing<br>• Cooling towers<br>• Pretreatment for boilers/Low pressure boilers<br>• HVAC |
| **Filtered** | 50–150 | 10–200 | Reverse osmosis (RO; single-pass) | • Boilers<br>• Recirculating cooling systems<br>• Chemical/on-site laboratories<br>• Electronics manufacturing |
| **Deionized** | 5–25 | 5–10 | Ion exchange<br>RO + chemicals | • Chemical/on-site laboratories<br>• Food & Beverage (liquids)<br>• Pharmaceuticals<br>• Electronics manufacturing<br>• Precision manufacturing in Automotive/Metal Finishing |
| **Ultrapure** | <5 | <5 | Multi-pass reverse osmosis, ultra- or nano-filtration | • Semiconductor<br>• Pharmaceuticals |

# Basic Water Treatment: ***Softened Water***

- **Quality target:** reduce hardness-driven scaling while maintaining stable, cost-effective water chemistry
- **Treatment types**
  - **Screen/filter:** Remove grit and solids via sand-filtration, activated carbon
  - **Softening:** hardness (Ca/Mg removal)
  - **Chemical Addition:** pH, corrosion, biological growth adjustments

# Intermediate Water Treatment: ***Filtered/deionized Water***

- **Quality target:** consistent low-solids and low-ionic-strength water for process reliability and product quality
- **Treatment Types**
  - **Filtration:** media based (ion-exchange/granulated activated carbon)
  - **Reverse Osmosis:** membrane-based filtration

# Advanced Water Treatment
## *Ultrapure Water/Specific process water requirement*

- **Quality target:** water quality is defined by the most sensitive process/product specification, not by source-water quality alone
- **Multi-staged process:**
  - Primary Filtration.
  - Reverse Osmosis/Ion-exchange
  - Electrodeionization/mixed-bed ion-exchange
  - Disinfection via UV or non-chemical based

# Water Quality Characteristics

| Parameter | Contributing Contaminant | Impact | Unit of Measurement | Treatment Technology |
|---|---|---|---|---|
| **Hardness** | Calcium, magnesium ions | Scale formation on equipment and pipes | mg/L as CaCO3 | Ion exchange, lime softening, scale inhibitors (e.g., phosphonates) |
| **Conductivity (TDS)** | Dissolved ions | Enhances corrosivity, affects processes | µS/cm | Reverse osmosis, deionization, corrosion inhibitors |
| **pH** | Acids, bases | Can lead to corrosion or scaling | pH scale | Acid/base neutralization, corrosion inhibitors |
| **Specific Ions (Chloride, Sulfate, Fluoride)** | Natural sources, industrial discharges, water treatment chemicals | Corrosion, toxicity, taste issues | mg/L | Reverse osmosis, ion exchange, activated alumina, corrosion inhibitors |
| **Total Suspended Solids (TSS)** | Soil, organic matter, oil and grease | Clogs filters, harms aquatic life | mg/L | Filtration, sedimentation, chemical flocculation |
| **Turbidity** | Suspended solids, soil, organic matter, oil and grease | Blocks light, carries pollutants | NTU | Filtration, sedimentation, flocculation |

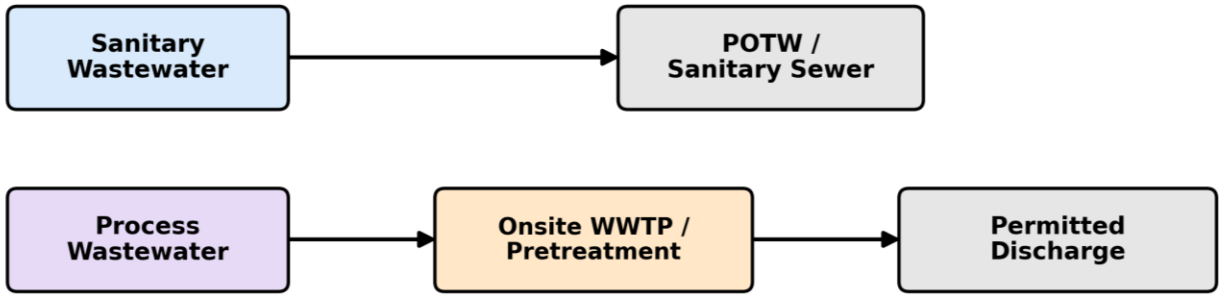
# Per Regulatory Compliance

# Wastewater Management Drivers

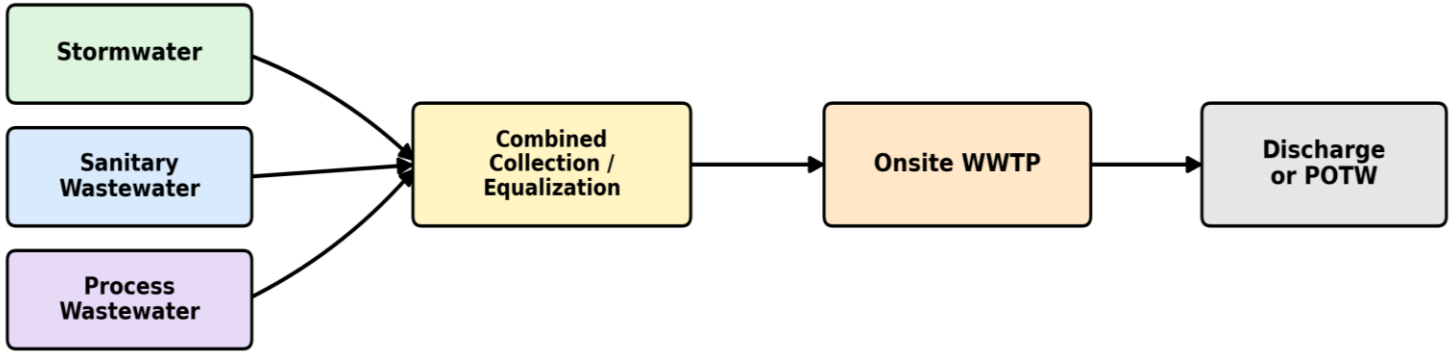
- **Discharge Pathway:** Requirements depend on whether the facility discharges directly to surface water or indirectly to a publicly owned treatment works (POTW).
- **NPDES Permit Limits:** Direct dischargers must meet effluent limits specified in their permit. Limits are typically based on available treatment technology and/or protection of receiving-water quality.
- **State/Local Compliance:** State environmental agencies often administer NPDES programs, while local sewer authorities may impose additional limits for discharges to POTWs.
- **Categorical Pre-treatment Standards:** Industries that discharge into municipal sewage/POTWs.
- **Cost and surcharge exposure:** Wastewater management driven by treatment cost, sewer fees, surcharges, and disposal costs.

# Typical Wastewater Management Configurations

**Configuration 1: Sanitary Separate; Process Wastewater Treated**

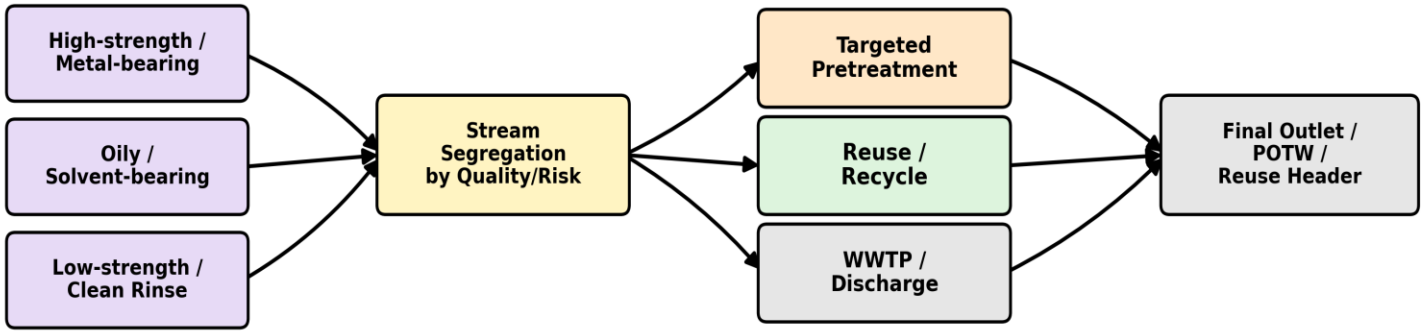



**Configuration 2: Stormwater + Sanitary + Process Wastewater Mixed**



# Typical Wastewater Management Configurations

**Configuration 3: Segregated Waste Streams Before Treatment or Reuse**




**Configuration 4: Third-Party Disposal**

# What does Regulatory Compliance typically look like?

Applicable Standards: Local Limits

| Parameter | Concentration (mg/L) | Daily Max Limit (mg/L) |
|---|---|---|
| Cadmium, Cd | <0.00027 | 0.42 |
| Chromium, Cr | 0.00063 | 6.30 |
| Copper, Cu | 0.015 | 6.00 |
| Lead, Pb | 0.026 | 0.62 |
| Nickel, Ni | 0.0083 | 2.18 |
| Silver, Ag | <0.00053 | 1.34 |
| Zinc, Zn | 0.045 | 1.23 |
| pH (field) | 8.52 | Between 5.5-9.5 SU |


Permittee Name _____ NPDES Permit No. _____ EPA Lab Code _____

EPA **Chemistry/Microbiology Analyte Checklist** DMR-QA Study 45 **2025**

| Analyte Test | Test Required | Method Number Used (Optional) | Laboratory's Graded Result: Acceptable | Laboratory's Graded Result: Not Acceptable (Corrective Action Required) | Analyte determined by state-certified lab* |
|---|---|---|---|---|---|
| ***Microbiology*** | | | | | |
| E. coli, MF or MPN | ☐ | | ☐ | ☐ | ☐ |
| Fecal Coliform, MF or MPN | ☐ | | ☐ | ☐ | ☐ |
| Total Coliform, MF or MPN | ☐ | | ☐ | ☐ | ☐ |
| ***Trace Metals*** | | | | | |
| Aluminum | ☐ | | ☐ | ☐ | ☐ |
| Antimony | ☐ | | ☐ | ☐ | ☐ |
| Arsenic | ☐ | | ☐ | ☐ | ☐ |
| Barium | ☐ | | ☐ | ☐ | ☐ |
| Beryllium | ☐ | | ☐ | ☐ | ☐ |
| Cadmium | ☐ | | ☐ | ☐ | ☐ |
| Chromium, total | ☐ | | ☐ | ☐ | ☐ |
| Chromium, hexavalent | ☐ | | ☐ | ☐ | ☐ |
| Cobalt | ☐ | | ☐ | ☐ | ☐ |
| Copper | ☐ | | ☐ | ☐ | ☐ |
| Iron | ☐ | | ☐ | ☐ | ☐ |
| Lead | ☐ | | ☐ | ☐ | ☐ |
| Manganese | ☐ | | ☐ | ☐ | ☐ |
| Mercury | ☐ | | ☐ | ☐ | ☐ |
| Mercury (Low-Level) | ☐ | | ☐ | ☐ | ☐ |
| Molybdenum | ☐ | | ☐ | ☐ | ☐ |
| Nickel | ☐ | | ☐ | ☐ | ☐ |
| Selenium | ☐ | | ☐ | ☐ | ☐ |
| Silver | ☐ | | ☐ | ☐ | ☐ |
| Thallium | ☐ | | ☐ | ☐ | ☐ |
| Vanadium | ☐ | | ☐ | ☐ | ☐ |
| Zinc | ☐ | | ☐ | ☐ | ☐ |
| ***Demands*** | | | | | |
| 5-day BOD | ☐ | | ☐ | ☐ | ☐ |
| 5-day Carbonaceous BOD | ☐ | | ☐ | ☐ | ☐ |
| COD | ☐ | | ☐ | ☐ | ☐ |
| TOC | ☐ | | ☐ | ☐ | ☐ |
| ***Minerals*** | | | | | |
| Alkalinity, total ($CaCO_3$) | ☐ | | ☐ | ☐ | ☐ |
| Chloride | ☐ | | ☐ | ☐ | ☐ |
| Fluoride | ☐ | | ☐ | ☐ | ☐ |
| Hardness, total ($CaCO_3$) | ☐ | | ☐ | ☐ | ☐ |
| Specific conductance (25°C) | ☐ | | ☐ | ☐ | ☐ |
| Sulfate | ☐ | | ☐ | ☐ | ☐ |
| Total Dissolved Solids (180°C) | ☐ | | ☐ | ☐ | ☐ |
| ***Nutrients*** | | | | | |
| Ammonia as N | ☐ | | ☐ | ☐ | ☐ |
| Nitrate as N | ☐ | | ☐ | ☐ | ☐ |
| Nitrite as N | ☐ | | ☐ | ☐ | ☐ |
| Orthophosphate as P | ☐ | | ☐ | ☐ | ☐ |
| Total Kjeldahl-Nitrogen as N | ☐ | | ☐ | ☐ | ☐ |

https://www.epa.gov/npdes/about-npdes

# Wastewater Quality Characteristics

| Parameter | Contributing Contaminant | Impact | Unit of Measurement | Treatment Technology |
|---|---|---|---|---|
| **Turbidity** | Suspended solids, soil, organic matter, oil and grease | Blocks light, carries pollutants | NTU | Filtration, sedimentation, flocculation |
| **Biochemical Oxygen Demand (BOD)** | Organic matter, food waste, oil and grease | Indicates potential oxygen depletion | mg/L | Activated sludge, trickling filters |
| **Chemical Oxygen Demand (COD)** | Organic and inorganic pollutants, oil and grease | High pollution levels, treatment challenges | mg/L | Chemical oxidation, biological processes |
| **Nutrients (Nitrogen, Phosphorus)** | Agricultural runoff, wastewater, fertilizers | Causes eutrophication and algal blooms | mg/L | Biological nutrient removal, chemical precipitation |
| **Toxic Organic Compounds** | Pesticides, solvents, industrial chemicals | Hazardous to health and environment | mg/L or µg/L | Advanced oxidation, activated carbon, bioremediation |

# Wastewater Quality Characteristics

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| **pH** | Acids, bases | Can lead to corrosion or scaling | pH scale | Acid/base neutralization, corrosion inhibitors |
| **Specific Ions (Chloride, Sulfate, Fluoride)** | Natural sources, industrial discharges, water treatment chemicals | Corrosion, toxicity, taste issues | mg/L | Reverse osmosis, ion exchange, activated alumina, corrosion inhibitors |
| **Heavy Metals** | Industrial discharges, mining runoff | Toxicity, bioaccumulation | mg/L or µg/L | Chemical precipitation (ferric chlorides), ion exchange, Adsorption (activated carbon) |
| **Total Suspended Solids (TSS)** | Soil, organic matter, oil and grease | Clogs filters, harms aquatic life | mg/L | Filtration, sedimentation, chemical flocculation |

# Per Recycling and Reuse

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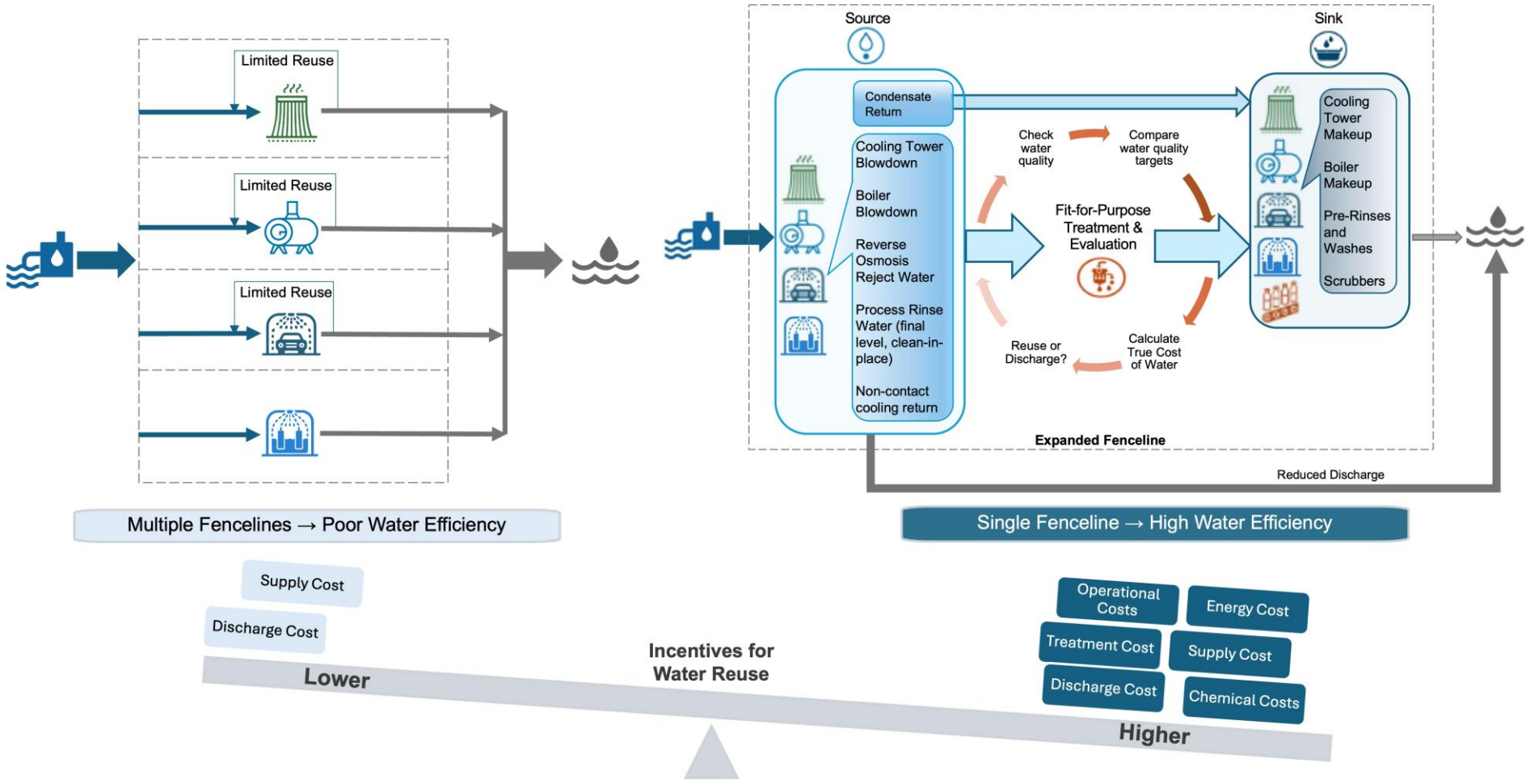
# Mapping facility water sources to sinks




Sharma, N., & Lemar, P. (2026). Redrawing facility boundaries to promote industrial water reuse. *Nature Reviews Clean Technology*, *2*(5), 323-324.

# Best Practices

- Knowing the process requirements from water quality perspective
- Coordinate and communicate the manufacturing process operations with environmental compliance group and treatment vendors
- Segregation of process wastewater streams
- Measurements and awareness of water quality at treatment reject streams, post-wastewater treatment
- Coupling flow measurement areas with water quality measurements
- Stormwater segregation and management when possible

# MEASUR Software Toolsuite

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# DOE Industrial Software Tools

## Designed to help energy and sustainability teams identify savings opportunities in their operational energy usage and emissions

### Energy Systems

**MEASUR**
Electrification for Decarbonization
Compressed Air Scoping Tool

### Energy Management

VERIFI
50001 Ready Navigator
Energy Footprint Tool
Plant Energy Profiler
Implementation Guidance Toolkit

### Carbon, Water, & Waste

Plant Water Profiler
Plant Carbon Footprint &
Decarbonization Assessment Tool
Carbon Emissions Calculator
Waste Stream Energy Content

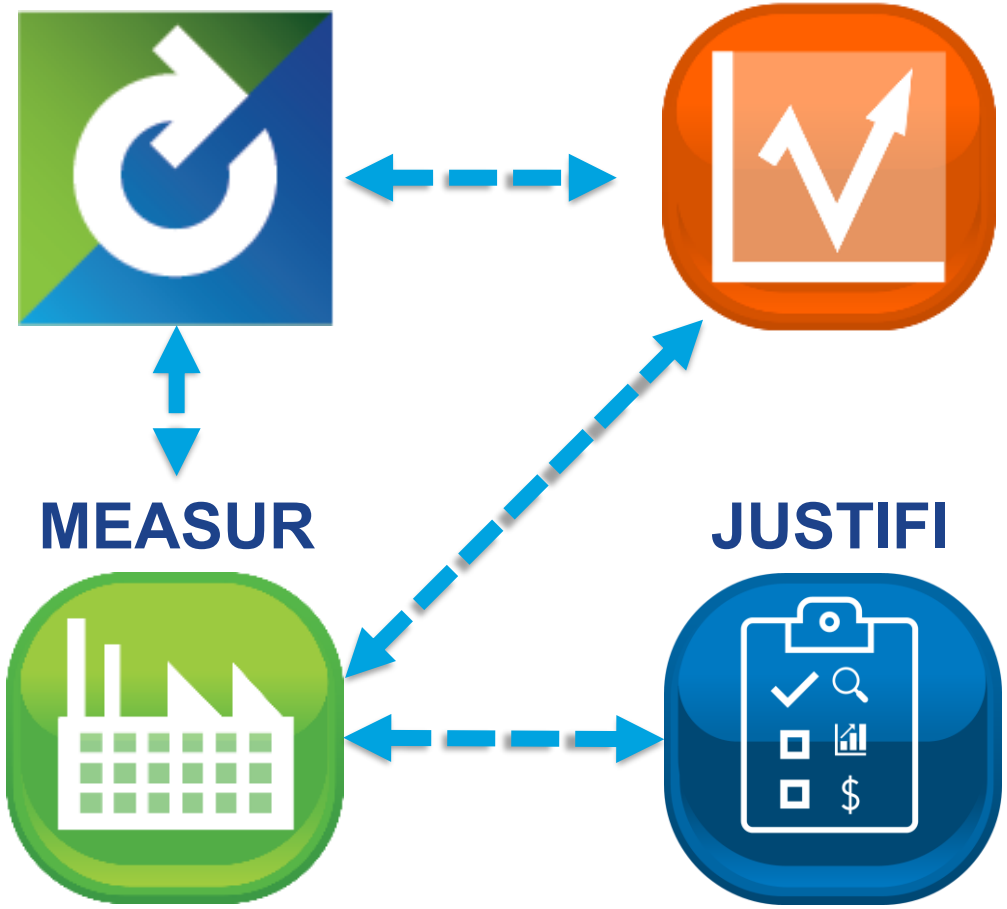
# Software Tools help implement energy projects

**50001 Ready Navigator**

**Energy management**
- Resources
- Track progress

**VERIFI**

**Facility energy use**
- Utility bill tracking and analysis
- Utility/ GHG savings analysis



**MEASUR**

**System energy use**
- Industrial System Analysis
- Treasure Hunts
- Inventory

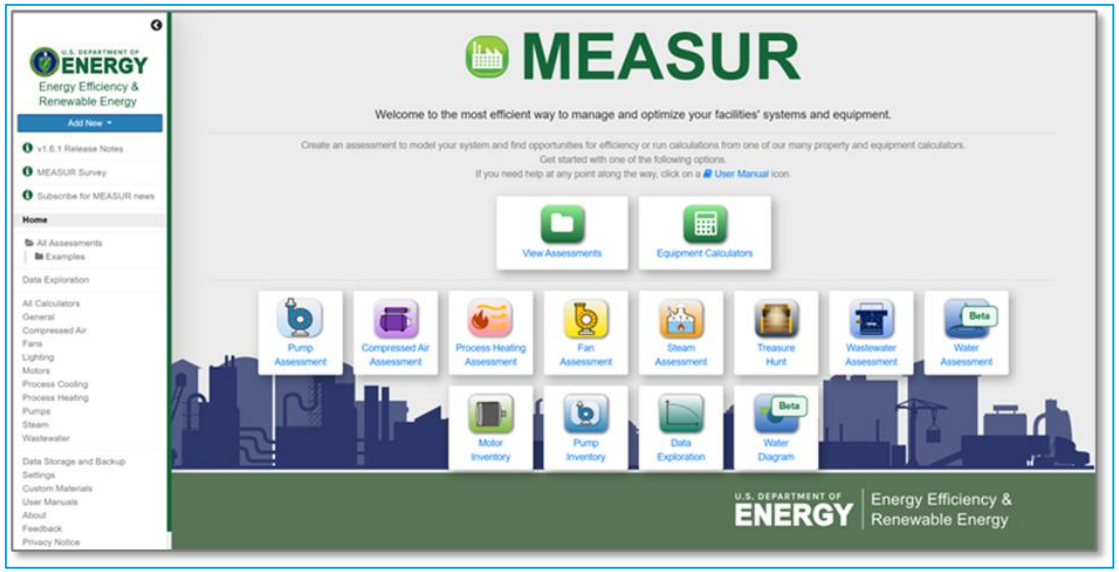
**JUSTIFI**

**Additional impacts**
- Financial & performance metrics impacts of energy projects

# MEASUR is an Integrated Energy Assessment Tool

Helps **identify, assess, and quantify** energy **savings** opportunities in operations and energy support systems.

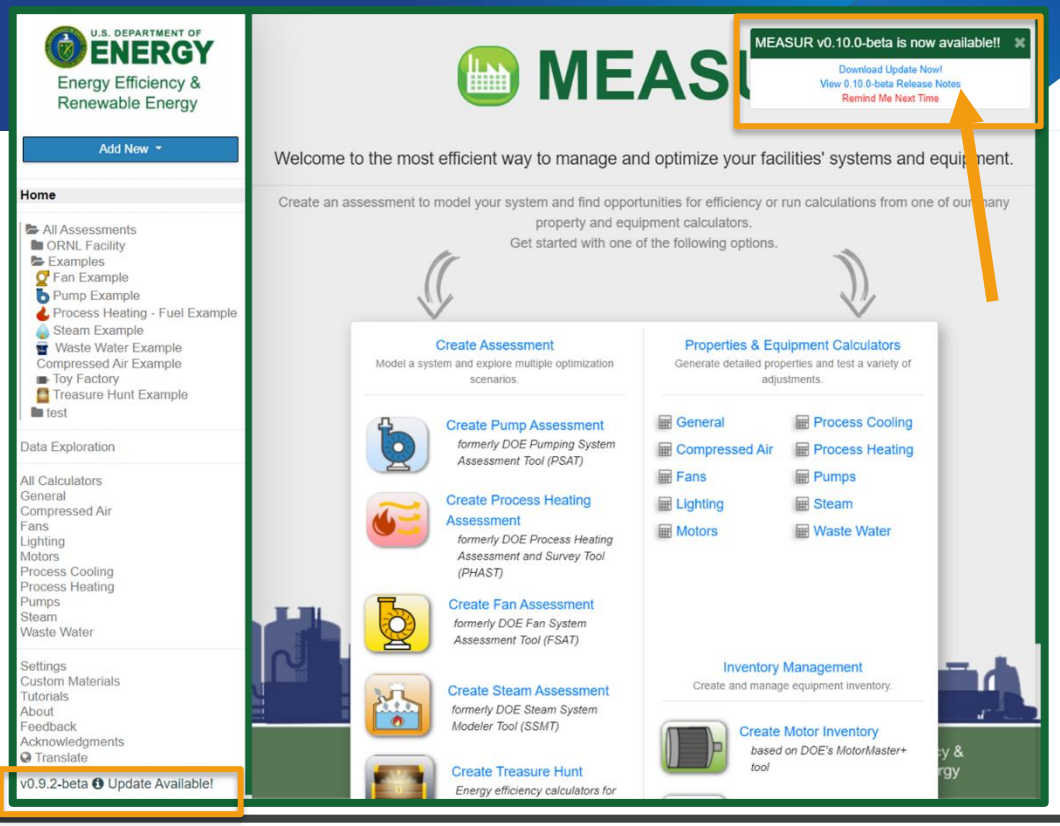
- FREE & Open source, cross-platform tool
- Technology and vender agnostic
  - Desktop/Mobile; Windows, Mac, Linux, Android
- Private data & Global useability
  - Data is stored on *YOUR* device
- Key User Features
  - Similar workflow for all assessment modules
  - Graphs, figures, accessible help text & examples
  - Regular updates




Find this tool at
https://measur.ornl.gov
https://industrialresources.ornl.gov

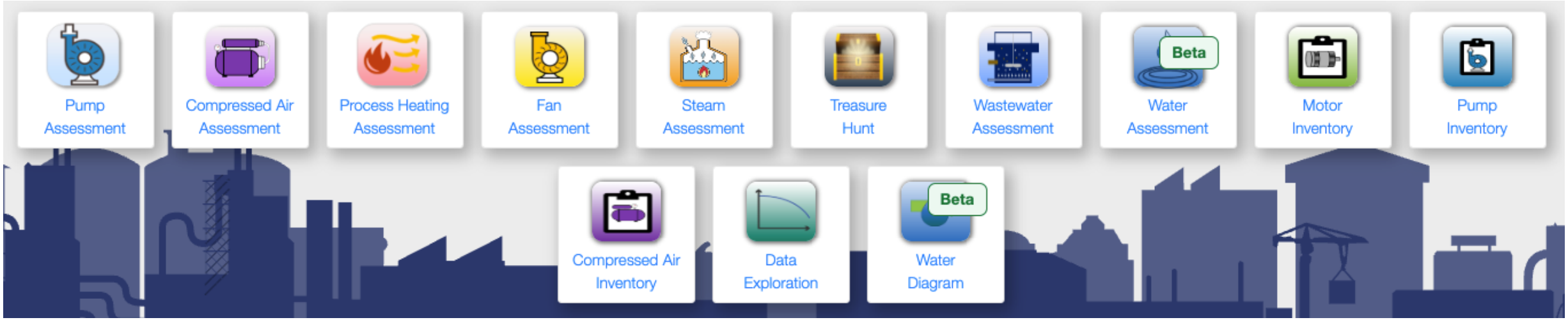
# Finding MEASUR

- Officially released March 2022
- Updates will occur often
  - Automatic notification of updates if connected to the internet
  - Please report bugs to measur-help@ornl.gov
- Download from DOE or GitHub
  - **Uninstalling will delete your assessments!**
- If using online –
  - **Clearing cache will delete your assessments!**



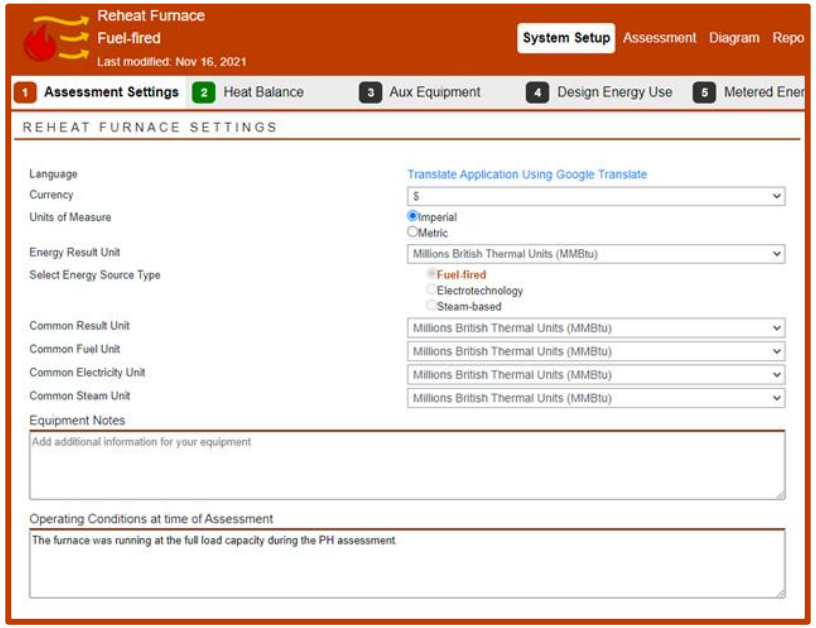

Download here:
https://industrialresources.ornl.gov
Or Google "MEASUR"
Web version: https://measur.ornl.gov/

# MEASUR's Modules

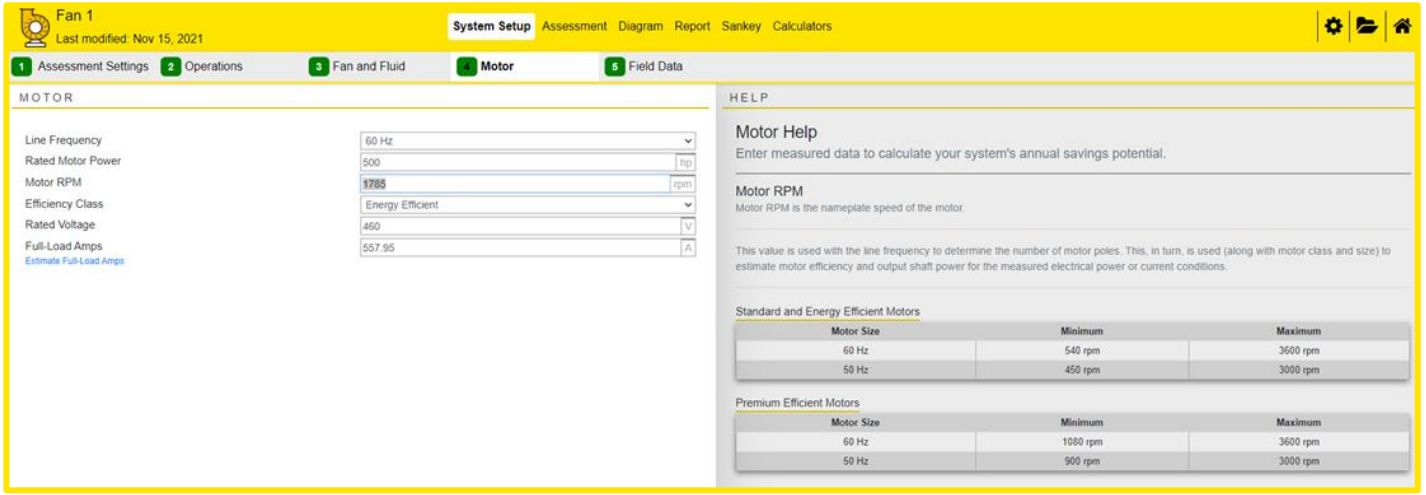



- 7 Assessment Modules
- 1 Diagram Module – Water
- 1 Data Exploration Module – Compressed Air
- 3 Inventorying Modules – Pump, Motor and Compressed Air
- Treasure Hunt Module
- 80 calculators

# System Setup



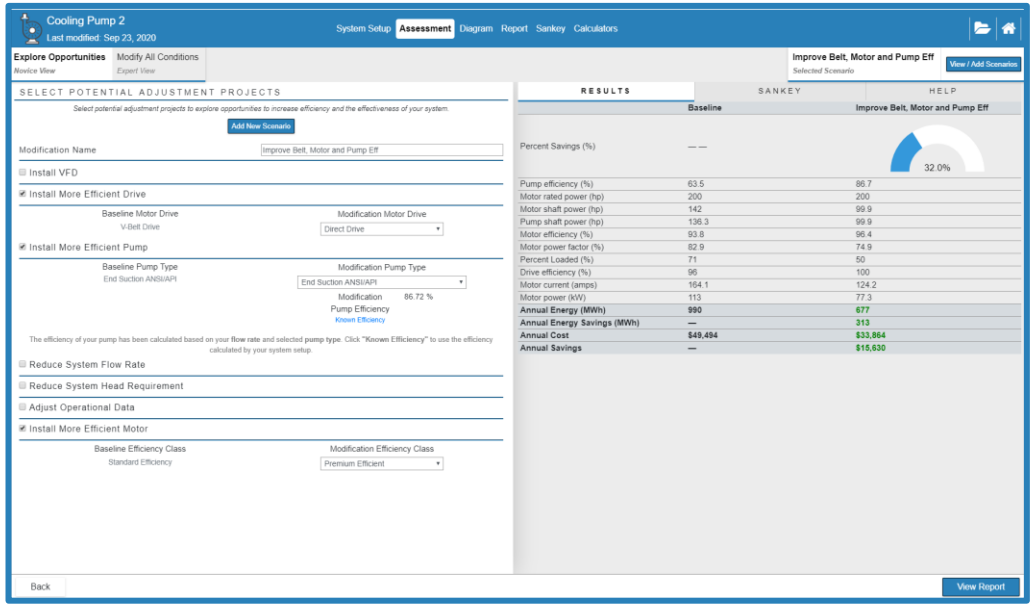

## Start with current equipment and operations - Baseline

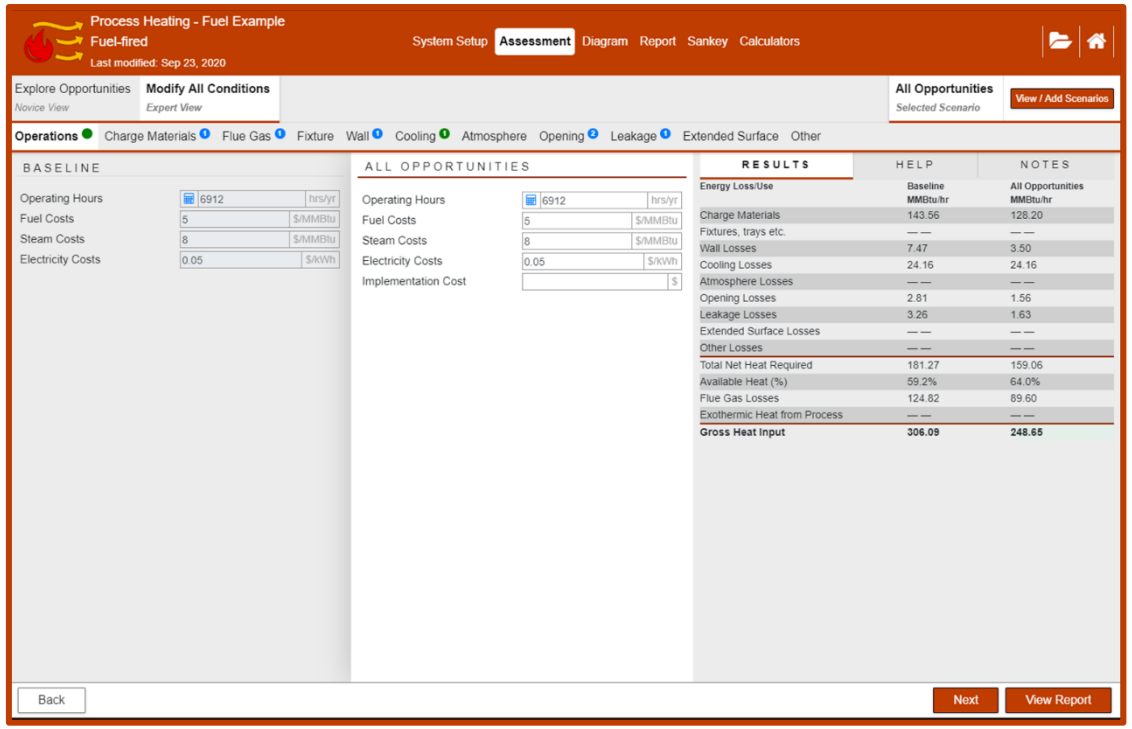



- Assessment Settings: Set units and basic assessment settings
- Assessment Specific Tabs
  - Data Entry for baseline assessment
  - Intermediate Results
  - Help text for each data entry field

# Assessments

## Explore energy savings opportunities

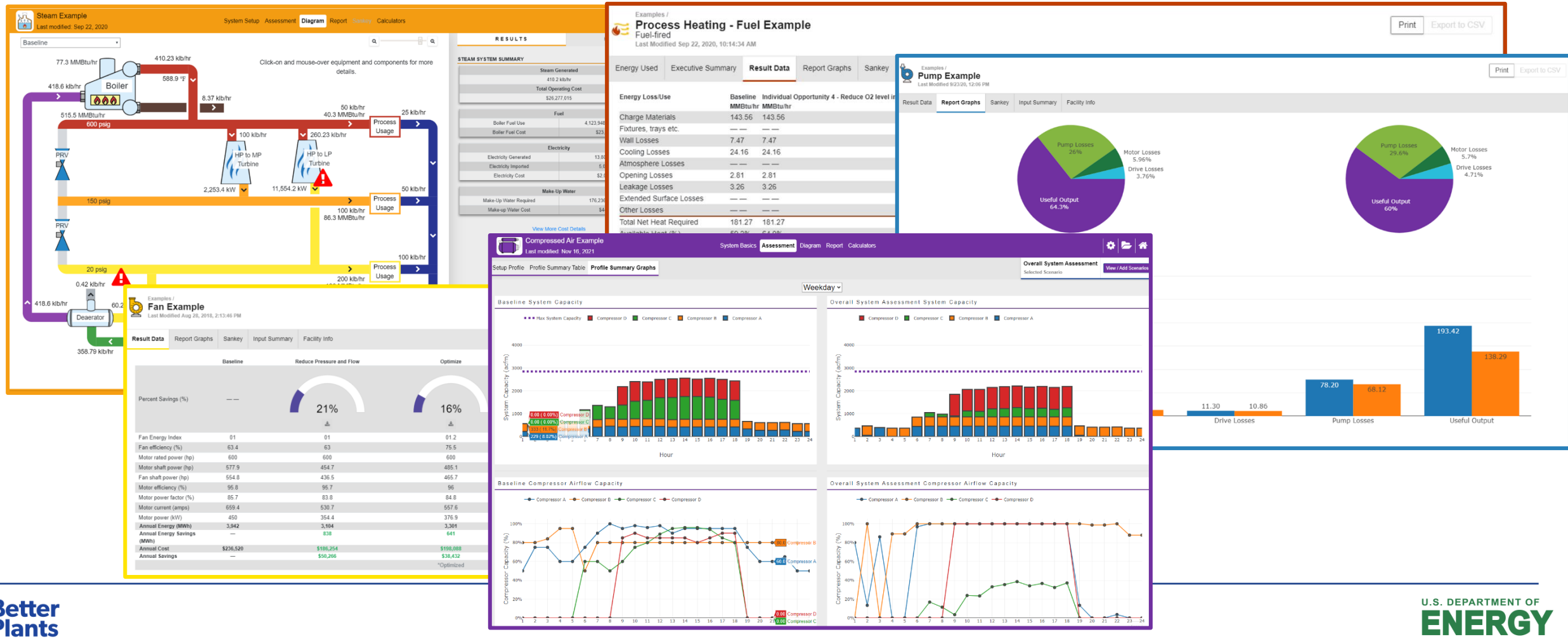



- Explore Opportunities: build scenarios from pre-established energy savings measures
- Modify All Conditions: build scenarios using same forms as baseline
  - Badges and field highlighting for visual cues

# Reports

## View side-by-side comparison of all scenarios and graphs for data visualization

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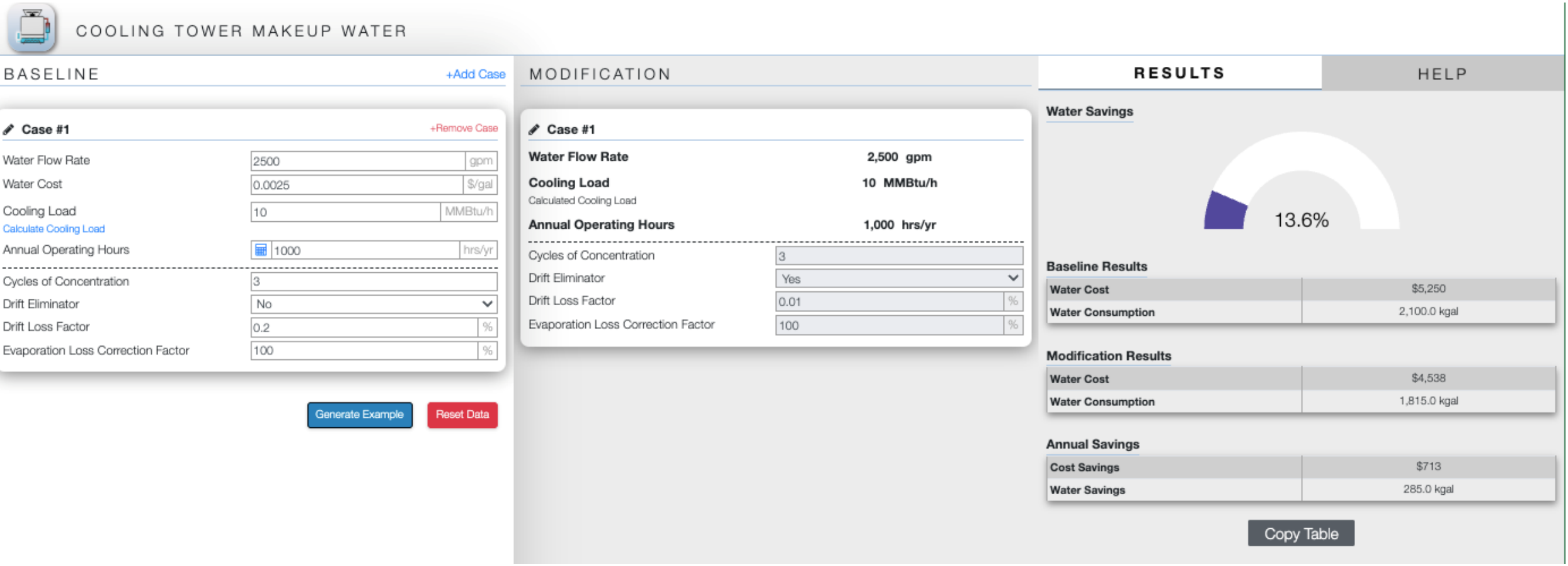
# Simple, easy-to-use Calculators

- 80 Stand alone Calculators
  - Motors
  - Pumps
  - Fans
  - Process Heating
  - Process Cooling
  - Steam
  - Compressed Air
  - Lighting
  - General
- Most have graphical results


COOLING TOWER MAKEUP WATER
BASELINE
+Add Case
Case #1
+Remove Case
Water Flow Rate
2500
gpm
Water Cost
0.0025
$/gal
Cooling Load
10
MMBtu/h
Calculate Cooling Load
Annual Operating Hours
1000
hrs/yr
Cycles of Concentration
3
Drift Eliminator
No
Drift Loss Factor
0.2
%
Evaporation Loss Correction Factor
100
%
Generate Example
Reset Data
MODIFICATION
Case #1
Water Flow Rate
2,500 gpm
Cooling Load
10 MMBtu/h
Calculated Cooling Load
Annual Operating Hours
1,000 hrs/yr
Cycles of Concentration
3
Drift Eliminator
Yes
Drift Loss Factor
0.01
%
Evaporation Loss Correction Factor
100
%
RESULTS
HELP
Water Savings
13.6%
Baseline Results
Water Cost
$5,250
Water Consumption
2,100.0 kgal
Modification Results
Water Cost
$4,538
Water Consumption
1,815.0 kgal
Annual Savings
Cost Savings
$713
Water Savings
285.0 kgal
Copy Table

# BOILER BLOWDOWN RATE

## BASELINE

### Conductivity Readings

| | | |
|---|---|---|
| Feedwater Conductivity | 400 | µS/cm |
| Blowdown Conductivity | 5500 | µS/cm |

### Boiler

| | | |
|---|---|---|
| Steam Flow | 100 | klb/hr |
| Steam Temperature | 500 | °F |
| Boiler Efficiency | 85 | % |

Calculate Efficiency

### Operations

| | | |
|---|---|---|
| Operating Hours | 8760 | hrs/yr |
| Fuel Cost | 3.99 | $/MMBtu |
| Water Cost | 0.0025 | $/gal |
| Makeup Water Temperature | 50 | °F |

Generate Example | Reset Data

## MODIFICATION

### Conductivity Readings

| | | |
|---|---|---|
| Feedwater Conductivity | 400 | µS/cm |
| Blowdown Conductivity | 6000 | µS/cm |

### Boiler

| | | |
|---|---|---|
| Steam Flow | 100 | klb/hr |
| Steam Temperature | 500 | °F |
| Boiler Efficiency | 85 | % |

Calculate Efficiency

### Operations

| | | |
|---|---|---|
| Operating Hours | 8760 | hrs/yr |
| Fuel Cost | 3.99 | $/MMBtu |
| Water Cost | 0.0025 | $/gal |
| Makeup Water Temperature | 50 | °F |

## RESULTS

HELP

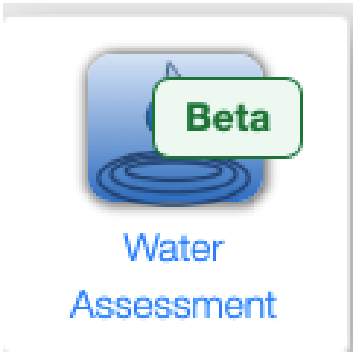
| | Baseline | Modification |
|---|---|---|
| Blowdown Rate (%) | 7.27 % | 6.67 % |
| Blowdown Rate (klb/hr) | 7.84 | 7.14 |
| Feedwater Rate (klb/hr) | 107.84 | 107.14 |
| Fuel Use | 35,211 MMBtu | 32,277 MMBtu |
| Makeup Water Use | 8,235 kgal | 7,500 kgal |
| Fuel Cost | $140,491 | $128,784 |
| Makeup Water Cost | $20,588 | $18,750 |
| Total Cost | $161,079 | $147,534 |
| **Fuel Savings** | **$11,708** | |
| **Makeup Water Savings** | **$1,838** | |
| **Total Savings** | **$13,546** | |

Copy Table

# MEASUR – Water Assessment Module

U.S. DEPARTMENT OF ENERGY

# Water Assessment Module





Baseline: Field Based Data Entry

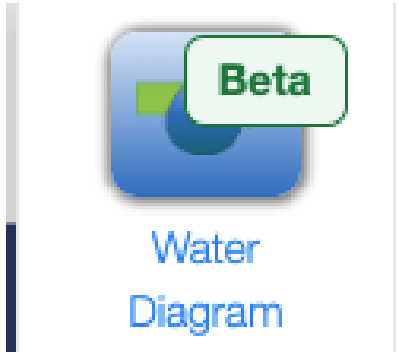
Assessment Water Savings Projects

Diagram: Visual Data Entry

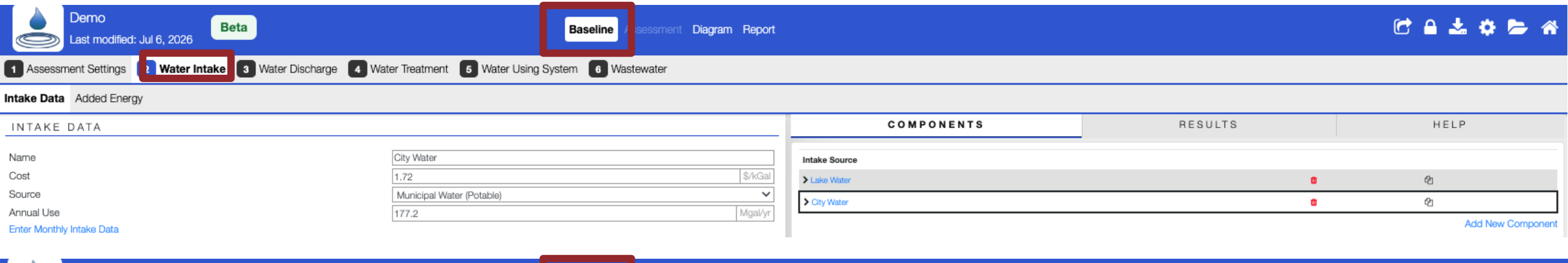
Reporting: Result tables and

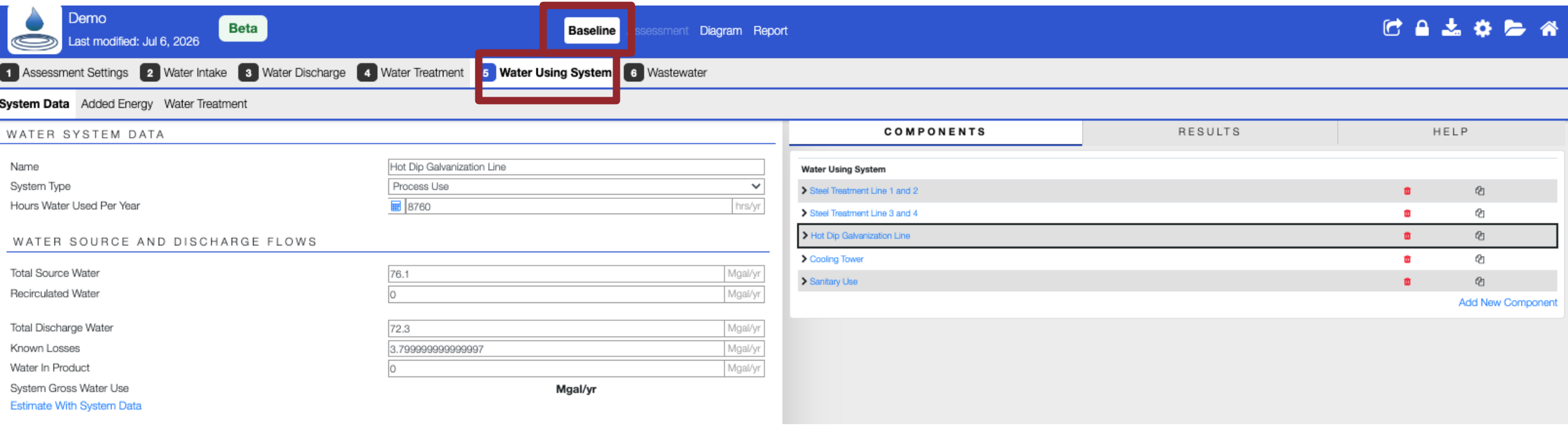
Visual Data Entry

- Input Water flow Components
- Define Components Relationships
- Input Flow and Cost data

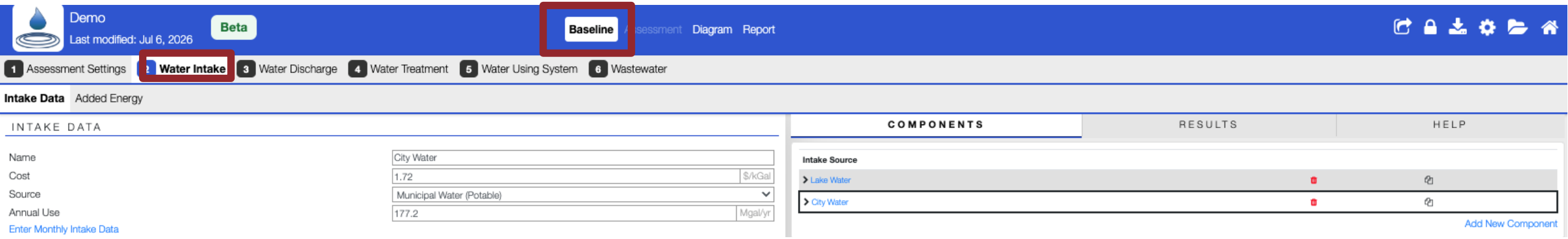


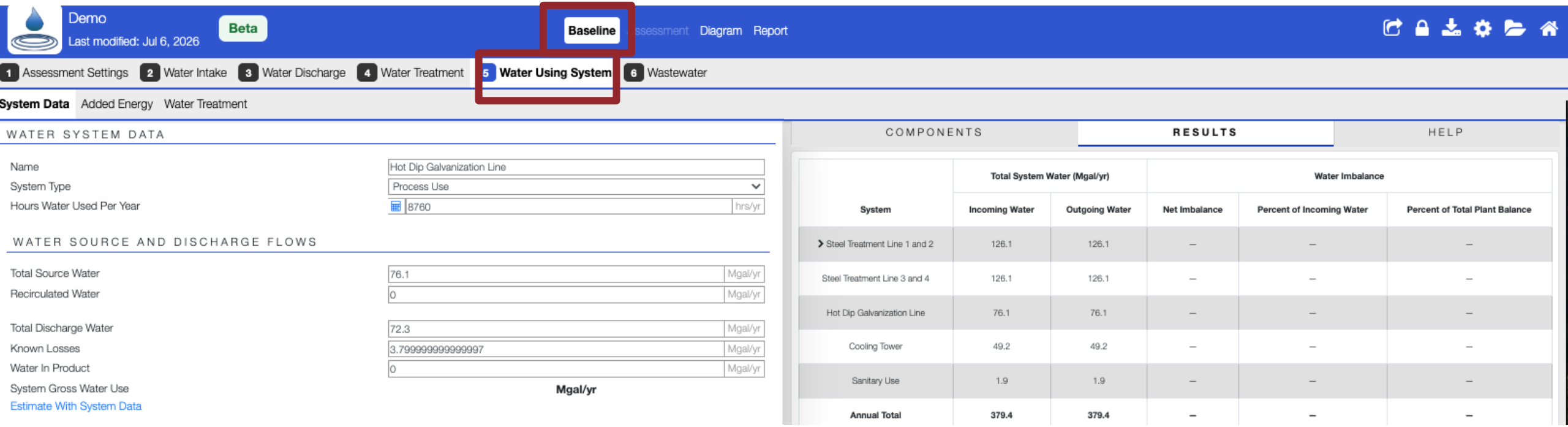
# Water Assessment Module - Baseline



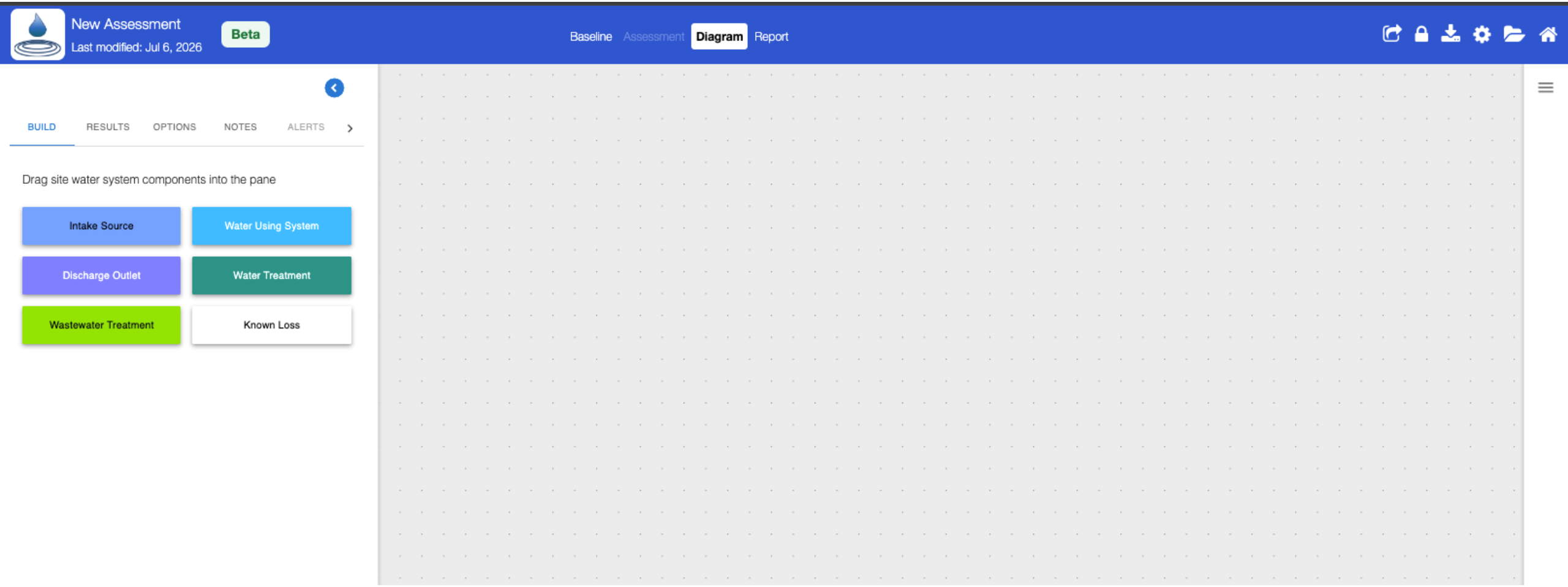



# Water Assessment Module - Baseline



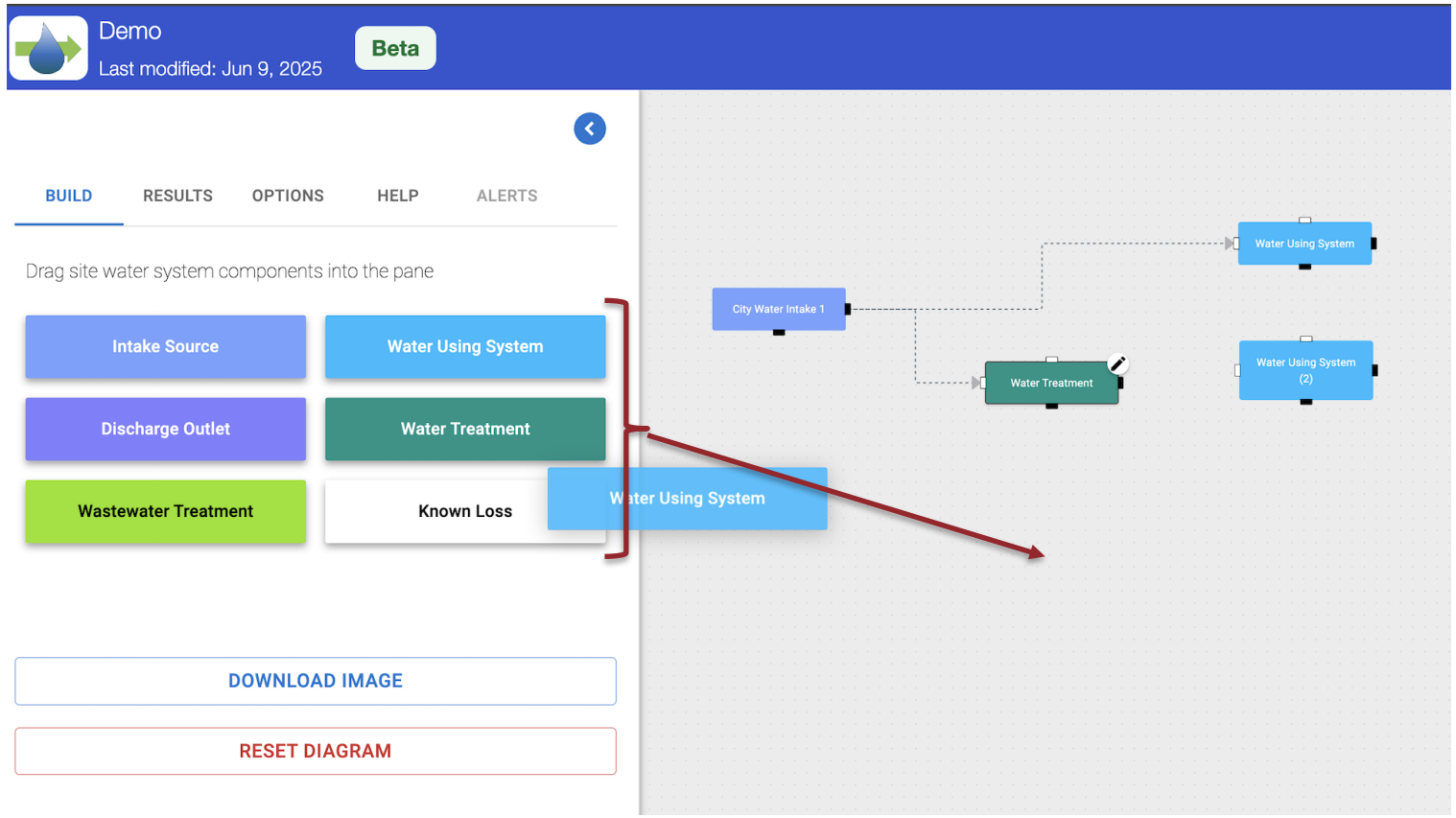



# Water Assessment Module - Diagram

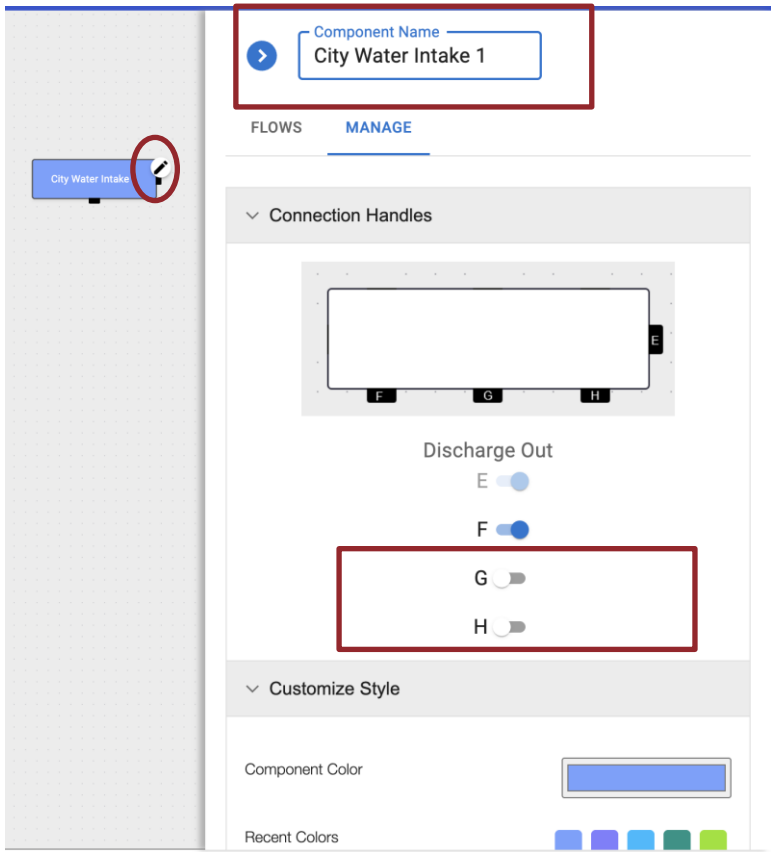


# Water Assessment Module - Diagram

- Drag, Drop and Connect Components as per water flows

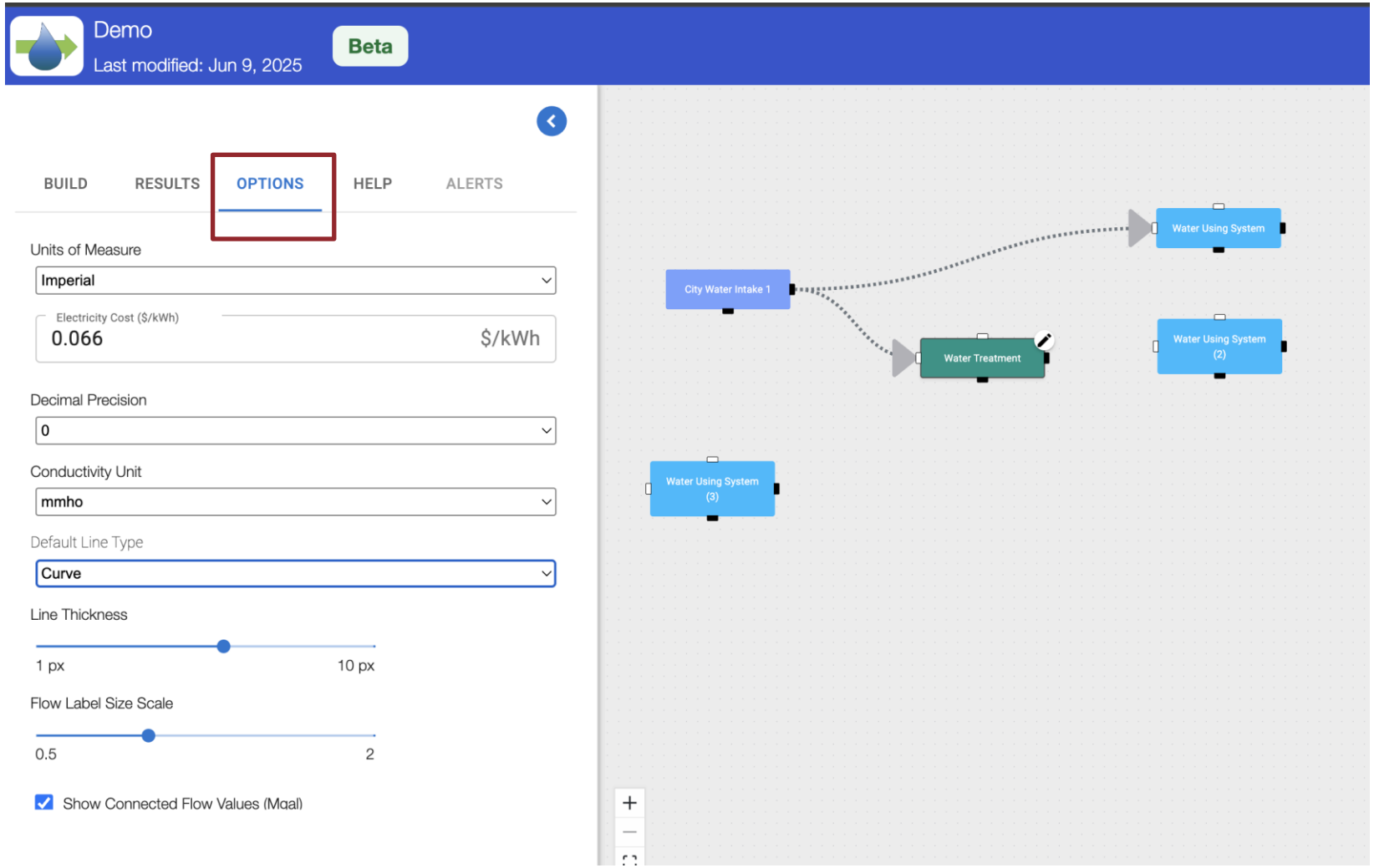



- Edit individual components using pencil icon

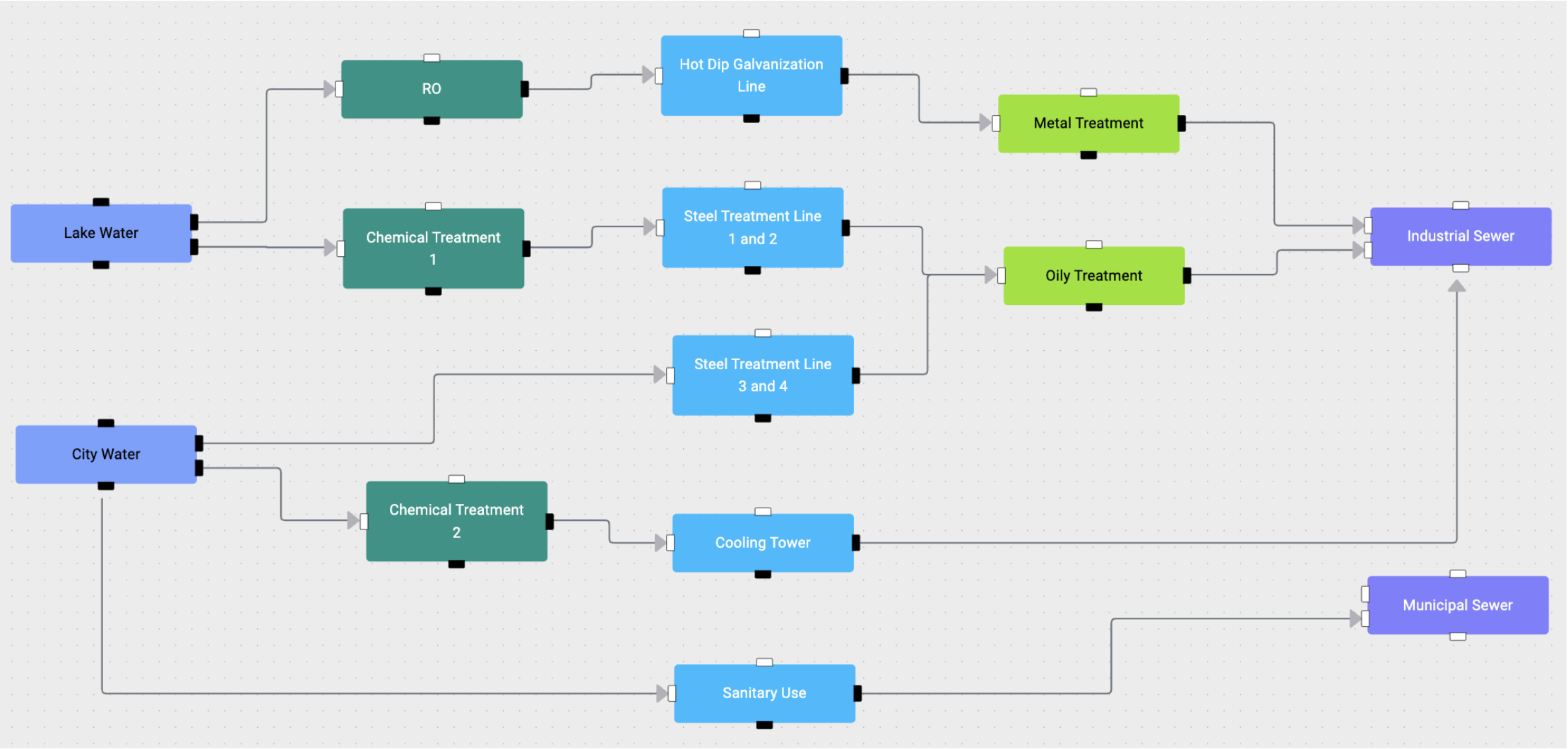


# Water Assessment Module - Diagram

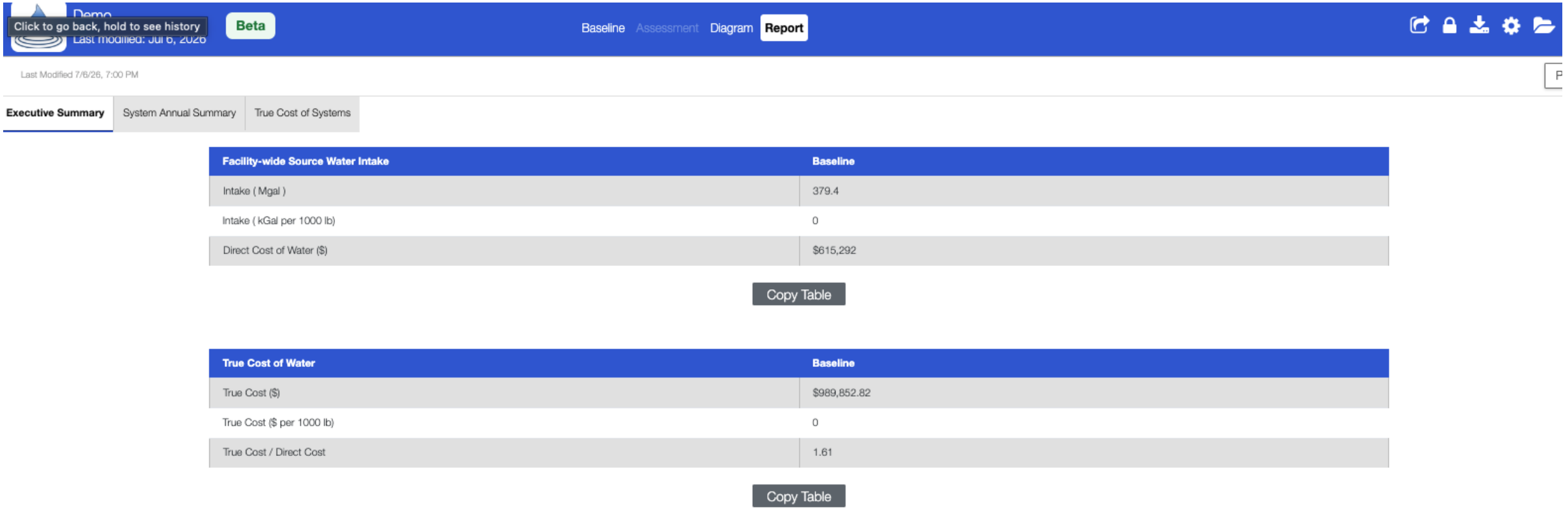
Use “Options” tab to customize flow diagram



# Water Assessment Module - Diagram



# Water Assessment Module - Report

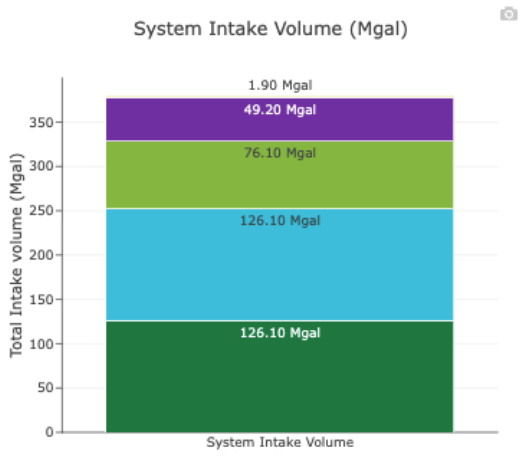


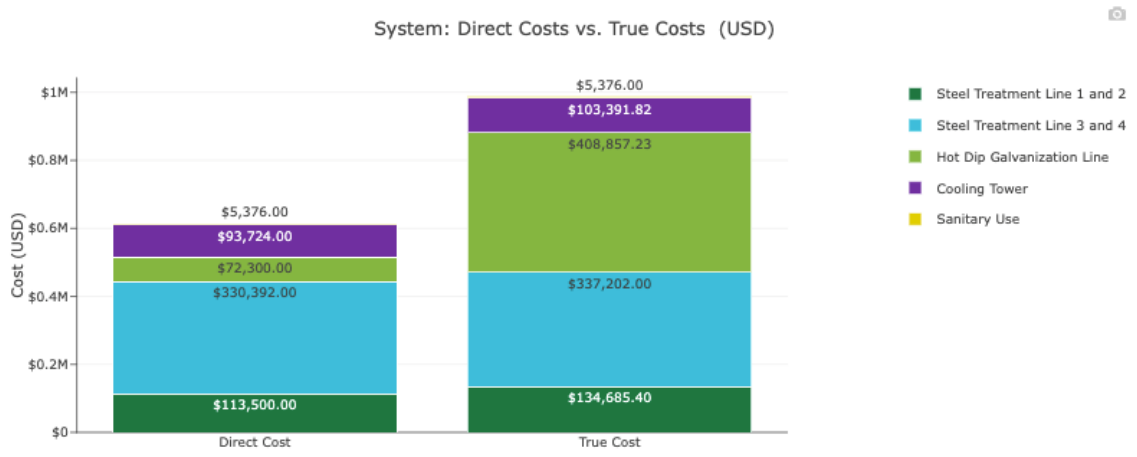
# Water Assessment Module - Report

Executive Summary | **System Annual Summary** | True Cost of Systems

| System | Source Water Intake Mgal/yr | Direct Costs $/yr | Direct Costs $/kGal | True Cost of Water $/yr | True Cost of Water $/kGal | True Cost/Direct Cost of Water |
|---|---|---|---|---|---|---|
| Steel Treatment Line 1 and 2 | 126.1 | $113,500 | $0.9001 | $134,685.4 | $1.0681 | 1.19 |
| Steel Treatment Line 3 and 4 | 126.1 | $330,392 | $2.6201 | $337,202 | $2.6741 | 1.02 |
| Hot Dip Galvanization Line | 76.1 | $72,300 | $0.9501 | $408,857.23 | $5.3726 | 5.66 |
| Cooling Tower | 49.2 | $93,724 | $1.905 | $103,391.82 | $2.1015 | 1.1 |
| Sanitary Use | 1.9 | $5,376 | $2.8295 | $5,376 | $2.8295 | 1 |
| **Plant** | **379.4** | **$615,292** | **$1.6218** | **$989,512.45** | **$2.6081** | **1.61** |

View Units/Cost | View Percent



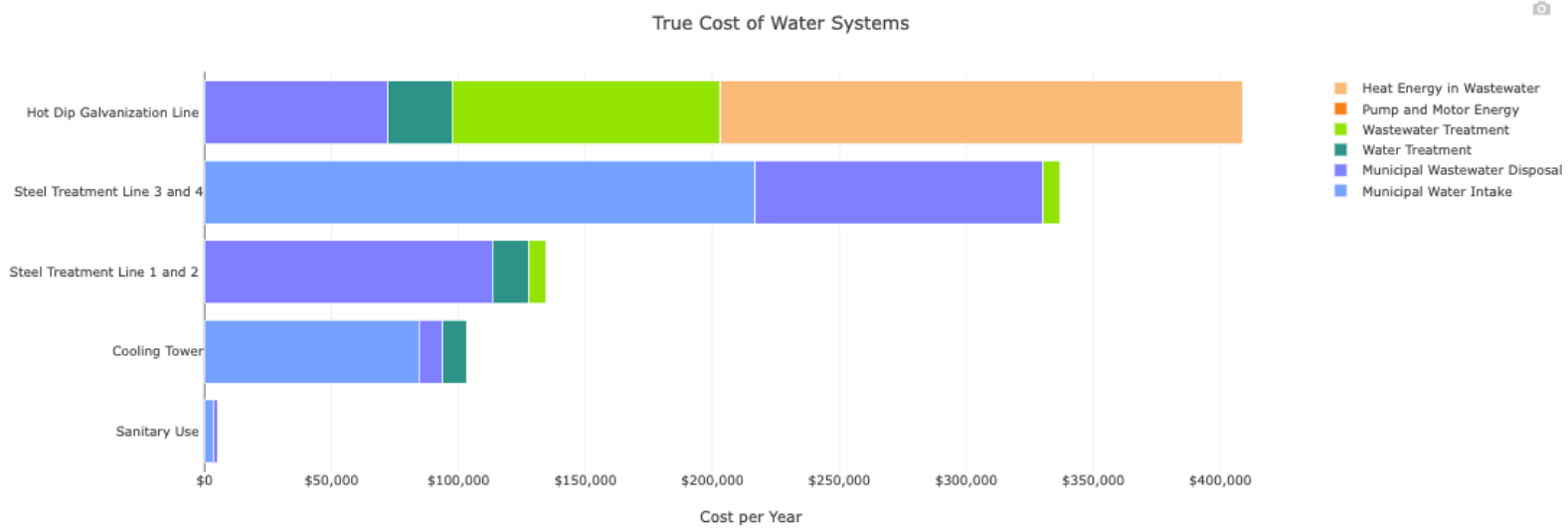
# Water Assessment Module - Report

Executive Summary | System Annual Summary | **True Cost of Systems**

| System | Municipal Water Intake | Municipal Wastewater Discharge | Third-party Disposal | Water Treatment | Wastewater Treatment | Pump and Motor Energy | Heat Energy | Total |
|---|---|---|---|---|---|---|---|---|
| Hot Dip Galvanization Line | 0 | $72,300 | 0 | $25,113 | $105,558 | 0 | $205,886.23 | $408,857.23 |
| Steel Treatment Line 3 and 4 | $216,892 | $113,500 | 0 | 0 | $6,810 | 0 | 0 | $337,202 |
| Steel Treatment Line 1 and 2 | 0 | $113,500 | 0 | $14,375.4 | $6,810 | 0 | 0 | $134,685.4 |
| Cooling Tower | $84,624 | $9,100 | 0 | $9,594 | 0 | $73.82 | 0 | $103,391.82 |
| Sanitary Use | $3,268 | $2,108 | 0 | 0 | 0 | 0 | 0 | $5,376 |

Adjusted Cost Attribution

Copy Table



# MEASUR Tool – Working Session

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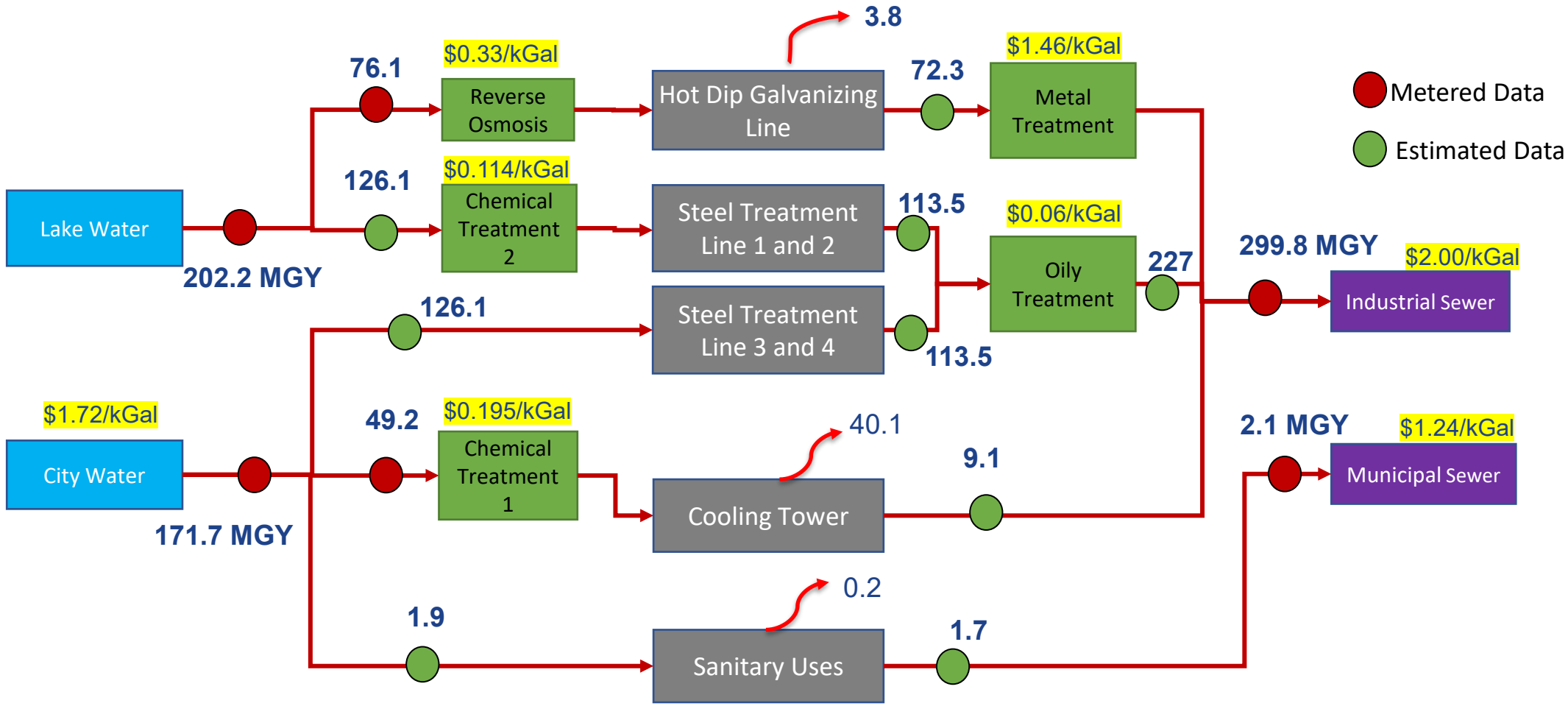
# Example Facility – With Data



# Pump and Heat Energy

## Pump Energy

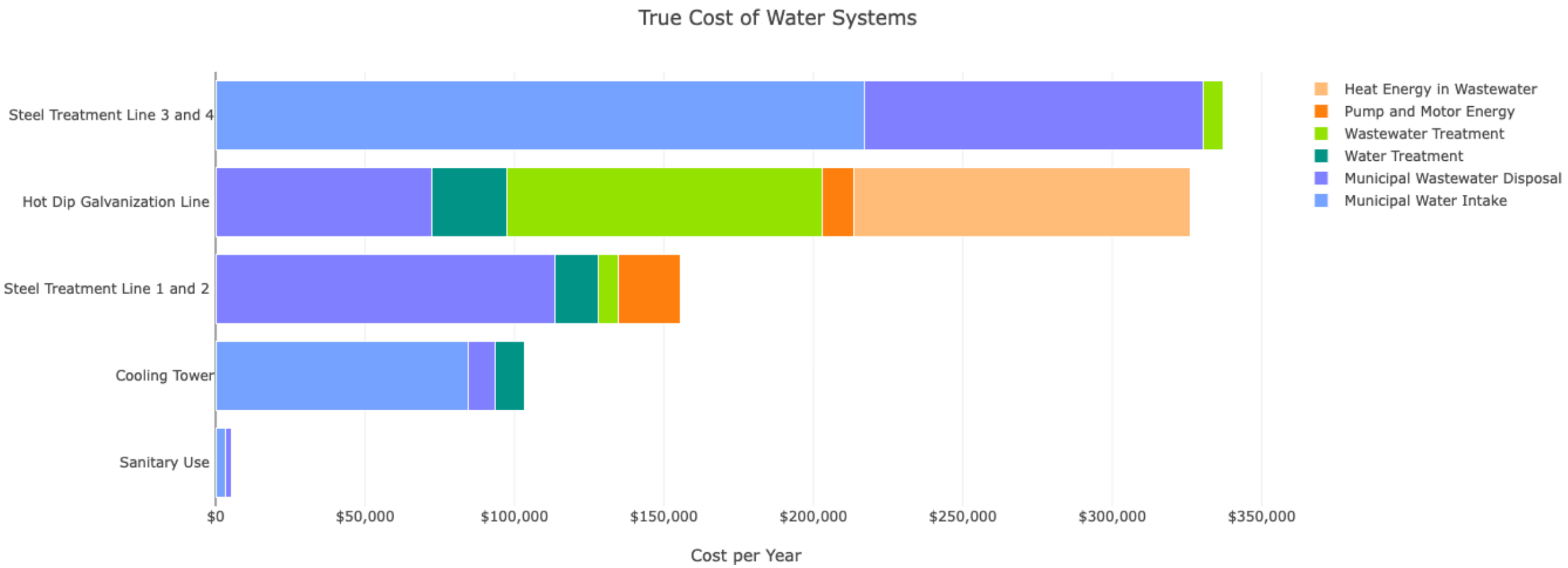
- Steel treatment line 1 and 2 being served by the lake have 2– 40hp pumps running 80% loaded (system efficiency 90% and operates 6000 hrs per year)

- HDGL line being served by the lake water has 1 – 40hp pumps running 80% loaded (system efficiency 90% and operates 6000 hrs per year)

## Heat Energy in Discharge

- Water used in HDGL line is also heated by a fuel fired heater (90% efficiency). Ambient water is a 60 F and discharges the line at 100F

# Results


True Cost of Water Systems
Steel Treatment Line 3 and 4
Hot Dip Galvanization Line
Steel Treatment Line 1 and 2
Cooling Tower
Sanitary Use
$0
$50,000
$100,000
$150,000
$200,000
$250,000
$300,000
$350,000
Cost per Year
Heat Energy in Wastewater
Pump and Motor Energy
Wastewater Treatment
Water Treatment
Municipal Wastewater Disposal
Municipal Water Intake

Thank You all for attending today's webinar.

See you all on next Thursday – July 14th, 2026 – 10 am ET

If you have specific questions, please stay online and we will try and answer them.

Alternately, you can email questions to me at thirumarank@ornl.gov

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