Water Conservation City of Plymouth

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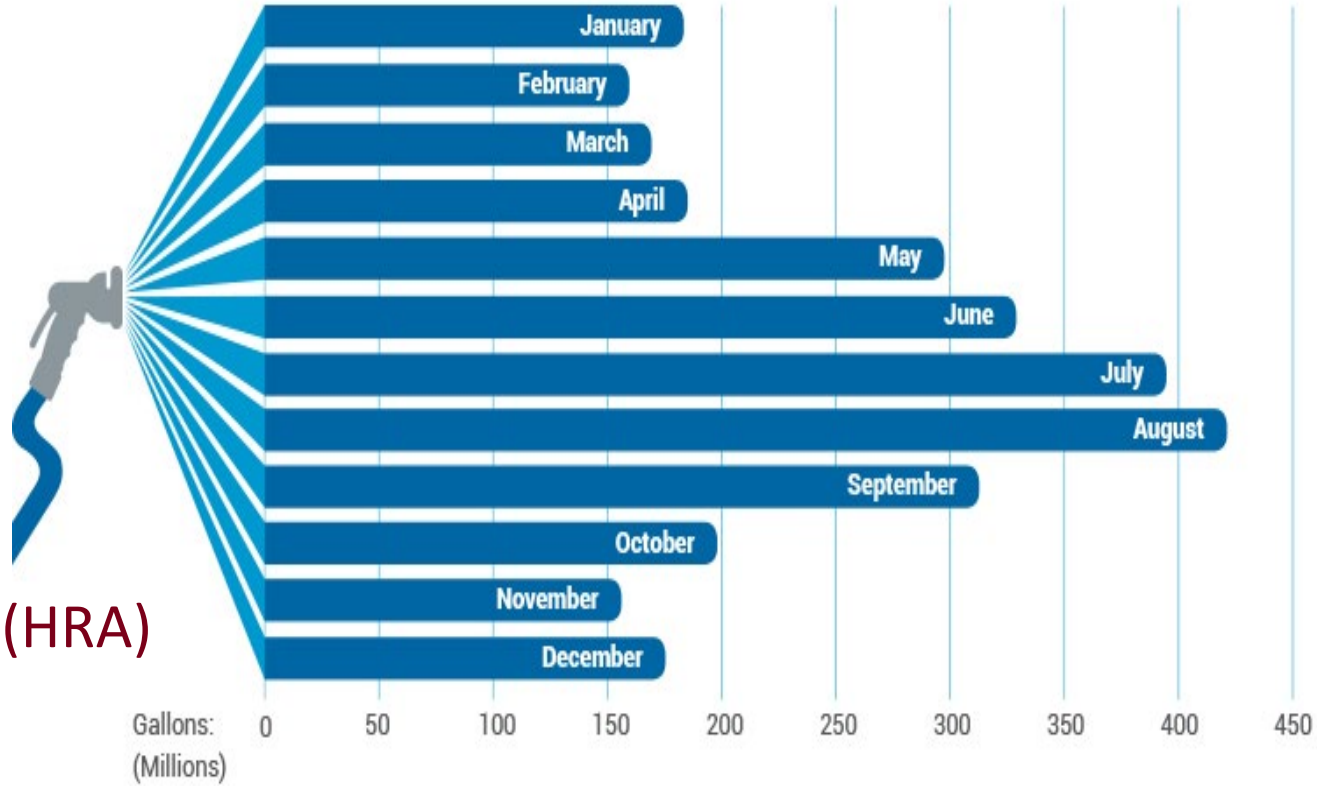
City Background

- Suburb 12 miles northwest of Minneapolis
- Population of 78,351 (7th Largest in MN)
- Eight lakes and more than 800 wetlands
- Water distribution to residents and businesses
  - Groundwater sources: three Aquifers
  - Two water treatment plants

Figure 1: One of Plymouth's Five Water Towers

Project Overview

- **Current Situation**
  - 3 billion gallons of water in 2018
  - 16.5 million gallons on city irrigation
- **Goals**
  - City-wide water audit with recommendations
  - Optimize city irrigation system
  - Housing & Redevelopment Authority (HRA) appliance and fixture efficiency study

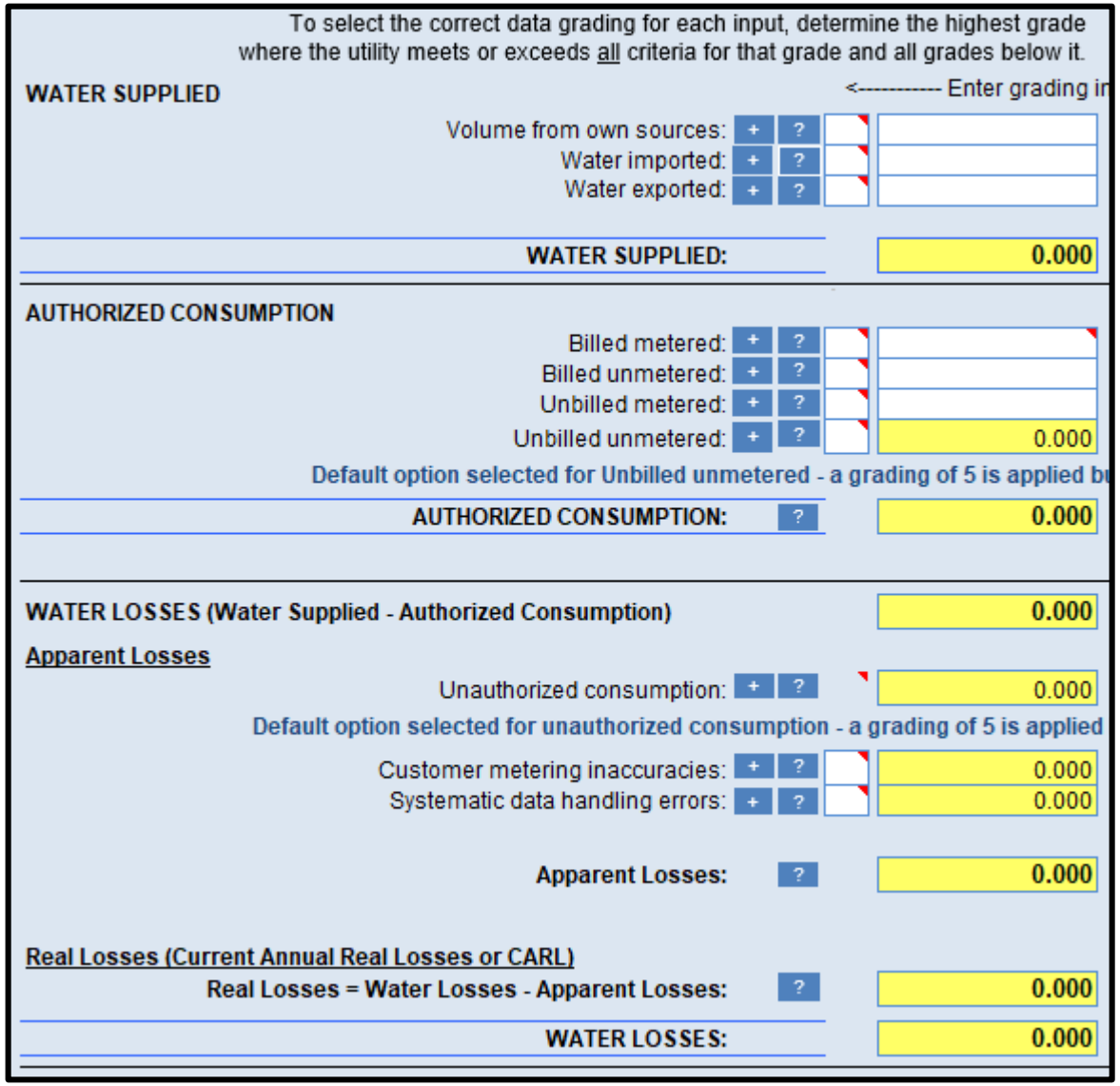


Water Audit – Purpose

- **Benchmarking**
  - Water resource management
- **Operational Efficiency**
  - Reliance on resources
  - Efficient water delivery
  - Costly: estimated cost of non-revenue water (NRW) = $322,000
- **Long Term Planning**
  - Better data
  - Proactive leakage control

Water Audit – Approach

- **Data collection**
  - AWWA Free Water Audit Software v5
  - 21 inputs
    - Finance
    - Public Works
    - Engineering & Water Resources
    - Geographic Information System (GIS)
- **Data scoring**
  - "Data validity score" 1-10
  - Guidance from software


To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below it.

WATER SUPPLIED <---------- Enter grading in

Volume from own sources: + ?
Water imported: + ?
Water exported: + ?

WATER SUPPLIED: 0.000

AUTHORIZED CONSUMPTION

Billed metered: + ?
Billed unmetered: + ?
Unbilled metered: + ?
Unbilled unmetered: + ? 0.000

Default option selected for Unbilled unmetered - a grading of 5 is applied b

AUTHORIZED CONSUMPTION: ? 0.000

WATER LOSSES (Water Supplied - Authorized Consumption) 0.000

Apparent Losses

Unauthorized consumption: + ? 0.000

Default option selected for unauthorized consumption - a grading of 5 is applied

Customer metering inaccuracies: + ? 0.000
Systematic data handling errors: + ? 0.000

Apparent Losses: ? 0.000

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: ? 0.000

WATER LOSSES: 0.000

Water Audit – Results

Water Balance Overview		

Water Audit – Results

- **Water Audit Data Validity Score: 72 out of 100 (Level IV - Goal is Level V)**
- **Current Annual Real Losses (CARL): 114 million gallons**
- **Unavoidable Annual Real Losses (UARL): 194 million gallons**
  - Calculated from system parameters (operating pressure, length of mains, etc.)
- **Infrastructure Leakage Index (ILI) = 0.58**
  - ILI < 1.0 indicates:
    - **World class leakage control**

      OR
    - **Non-conforming data**

$$ILI = \frac{CARL}{UARL}$$

Water Audit – Recommendations

1. **Conduct water audit annually**
   - Cost: ~ $750 per year
   - Benefits:
     - Benchmarking
     - More/better data needed for informed decision making

Water Audit – Recommendations

1. Conduct water audit annually
2. **Electronically calibrate and volumetrically test all source meters**
   - Cost: ~ $1,500 per year
   - Benefits:
     - Improve overall data integrity
     - Determine if meter maintenance / replacement necessary
     - Accurate supply and loss estimates

Water Audit – Recommendations

1. Conduct water audit annually
2. Electronically calibrate and volumetrically test all source meters
3. **Establish a customer meter testing policy**
   - Cost: ~ $12,000 per year
   - Benefits:
     - Improved data integrity resulting in more accurate apparent loss estimates
     - Gauge the accuracy of customer metering population
     - Maintenance/replacements of inaccurate meters as necessary

Irrigation Optimization - Approach

- **Evapotranspiration (ET) calculations for optimal run times**
  - Classify greenspace as playfield, recreational, or aesthetic
  - 4 test sites: incremental reductions

$$Water\ Requirement = \frac{Irrigation\ Factor\ \times Area}{Irrigation\ System\ Efficiency} \times Usage\ Multiplier$$

- **5 soil moisture sensors installed at Zachary Playfield (installed 6-26 and went operational 7-11)**
  - Upper and lower moisture thresholds
  - Moisture data & hydro reports used to determine savings

Figure 2: Toro® Turf Guard Moisture Sensor

Irrigation Optimization – ET Run Time Calculator

SUPPLEMENTAL WATER CALCULATOR (Turfgrass)

Area of Zone:	5,000	Square feet
Total Flow Rate:	22.0	GPM
Days of Watering Per Week:	3.5	Days per week
Efficiency of Irrigation System:	Medium	
Purpose of Greenspace:	Aesthetic	

CALCULATE

ZONE RUN TIME 12 Minutes

FLOW RATE CALCULATOR

Zone Operating Pressure: 45 PSI

Please select the number of heads within the zone and press calculate.

CALCULATE **Total Flow:** 137.8 **GPM**

Toro ® 640 Series

Nozzle Size	Quantity
40	6
41	2
42	2
43	4
44	0

Toro ® TR50XT Series

Nozzle Size	Quantity
1.0	0
1.5	0
2.0	0
3.0	0
4.5	0
6.0	0
7.5	0
9.0	0

Toro ® 570Z Series

Model	Quantity
570Z	0
570Z XF	0
570Z PR	0
570Z PRX	0

Toro ® S600 Series

Nozzle Size	Quantity
1.3	0
2.5	0
5.0	0

Toro ® S600S *or* S600C

Nozzle Size	Quantity
1.3	0
2.5	0
6.0	0
9.0	0

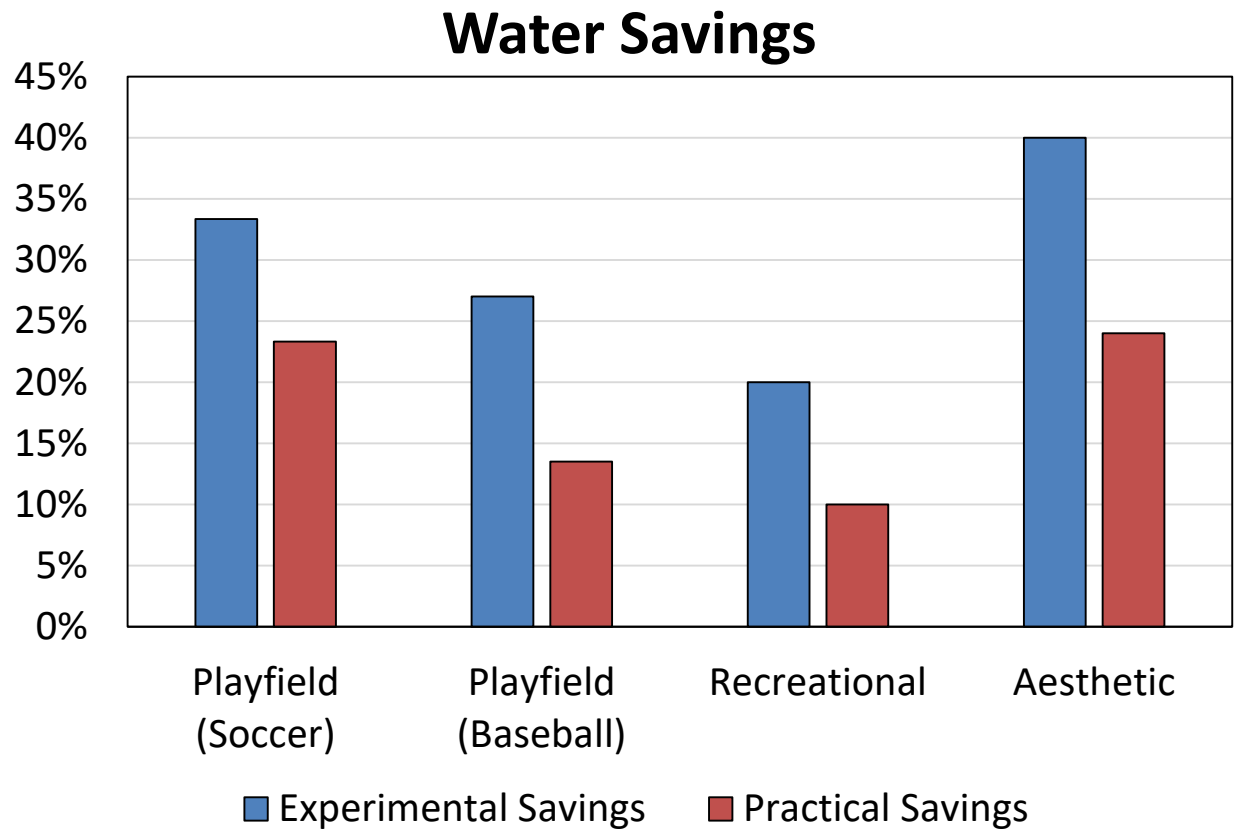
Toro ® S800 Series

Nozzle Size	Quantity
0.5	0
0.8	0
1.0	0
2.0	0
2.5	0
3.0	0
4.0	0
6.0	0
8.0	0

Press this button to clear all selections: CLEAR ALL

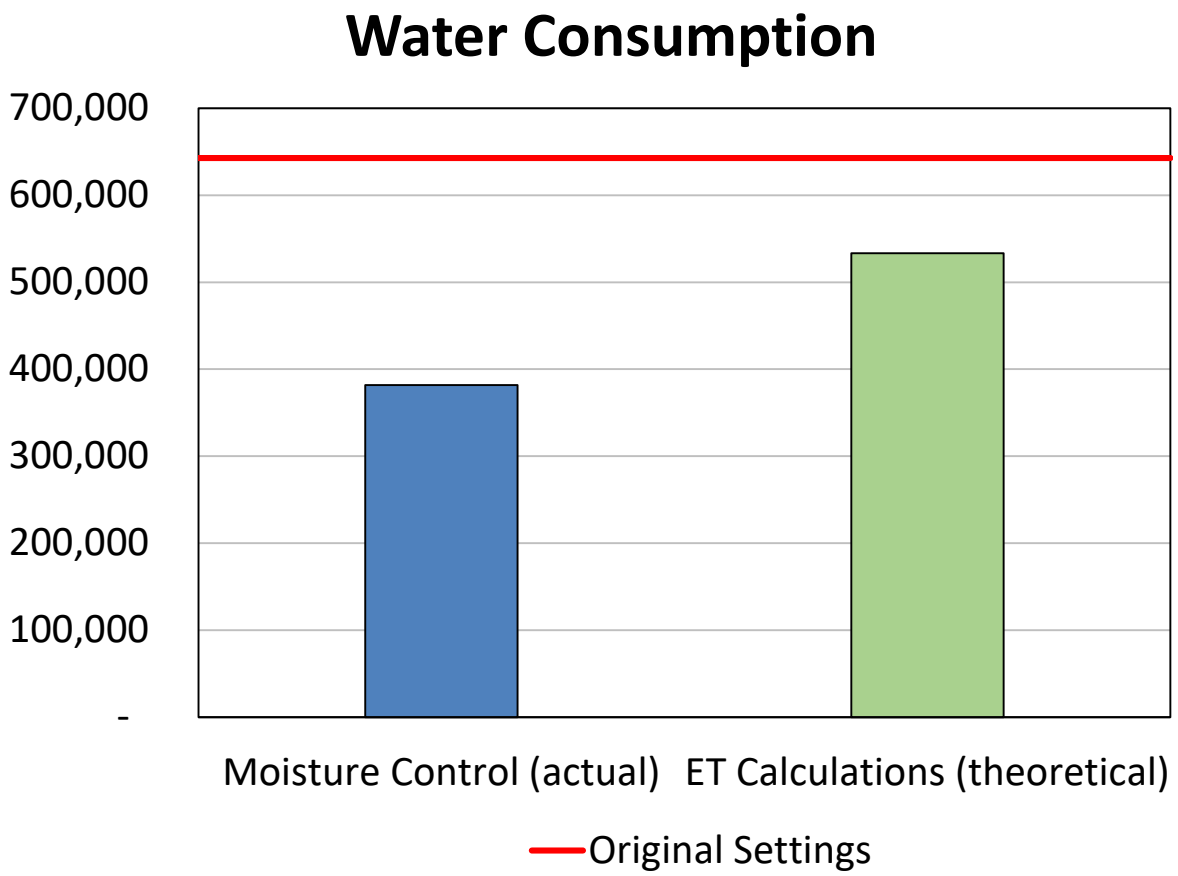
Irrigation Optimization – Results (ET calc.)

Greenspace Classification	Experimental Savings	Practical Savings
Playfield (Soccer)	33%	23%
Playfield (Baseball)	27%	14%
Recreational	20%	10%
Aesthetic	40%	24%



Irrigation Optimization – Results (Sensors)

- **Moisture sensor savings**
  - Compared to original settings: 41%
  - Compared to ET calculations: 29%
- **Rain-adjustments did not influence savings**



Irrigation Optimization – Recommendations

Recommendation	Implementation Cost	Annual Water Saved (gallons)	Annual Savings	Payback Period

Figure 3: Baseball field Irrigation System

Figure 4: Plymouth City Hall

HRA Water Efficiency – Approach

- **Housing & Redevelopment Authority (HRA) manages 2 assisted living facilities (Plymouth Towne Square & Vicksburg Crossing)**
- **Fixture Assessment of 27 units**
  - Flow rate recorded (bucket & stopwatch test)
  - Benchmark water use per unit

Figure 5: Plymouth Towne Square

Figure 6: Vicksburg Crossing

HRA Water Efficiency – Recommendations

Recommendation	Implementation Cost	Water/Energy Reductions Per Year	Annual Savings	Payback Period

Overall Yearly Savings Potential

Resource	Amount
Water	6,254,000 gallons
Natural Gas	5,280 therms
Electricity	720 kWh
Money	$17,730

Personal Benefits and Takeaways

- **Not every problem has a single "correct" solution**
  - May need to make assumptions
- **Importance of time management**
  - Large scale projects require careful planning
  - Multiple tasks with changing deadlines
- **Communication is key**
  - Different departments have different policies and goals
  - Engineering & Water Resources, Public Works, Finance, etc.