AABC Commissioning Group

AIA Provider Number 50111116

WATER AUDITS & WATER MANAGEMENT IN THE ENERGY PLANT AND BEYOND

Course Number: CXENERGY1912

DR. VALERIE A. SHOUP, PE

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WATER CONSERVATION

Course Description

April 2019

Why Should We Care About Water Conservation?

Approximately 71% of the earth is covered in water; only about 1% is drinkable. As the population continues to grow, water conservation water becomes increasingly important. All living organisms require water to survive, businesses depend on water for domestic use and occupant comfort. Loss of water in industrial operations can be a multibillion-dollar problem. Energy engineers and facilities managers often focus on electrical energy conservation overlooking vast opportunities in water management. This presentation provides an approach to water management and planning. Discussion will include how to benchmark, measure, document, and prioritize water management projects. The topics discussed are based on actual case studies, and concreate examples derived from experience and research.

CONTINUING EDUCATION AIA

Learning Objectives

At the end of the this course, participants will be able to:

1) Understand why engineers and facilities managers should care about water management

2) Understand little known facts about water rights

3) Understand the components of a water management program

4) Understand the basic approaches to water management including

benchmarking, measuring, and documenting water consumption

5) Understand the potential upside of a rigorous water conservation program

Heritage Institute of Sustainability LLC

Providing Sustainable Solutions to Today's Business Challenges

Presenter: Dr. Valerie A. S. Shoup
President of Heritage Institute of Sustainability LLC

Education:

- Oklahoma State University BSME
- University of Texas at Dallas MBA
- Walden University DBA

Licensure:

- Professional Engineer State of Texas, ICP Project Mgmt. & Quality Assessment, Certified Water Harvesting Practitioner

Organizations:

- ASHRAE 18-Years
- Fellow American College of Healthcare Executives
- President of North Texas Association of Energy Engineers
- Board Member of Helping Restore Ability

Awards:

- TCEQ: Innovative Operations, Best Business Operations
- D-Magazine: Healthcare Innovation
- STAR: Outstanding Sustainable Materials Management, Best Recycling Partnership

Water Management for All

WHY DO WE CARE ABOUT WATER?

LITTLE KNOWN FACTS ABOUT WATER

THE COMPONENTS OF A WATER MANAGEMENT PROGRAM

HOW TO BENCHMARK, MEASURE AND DOCUMENT WATER CONSUMPTION

APPROACHES FOR WATER MANAGEMENT

WATER CONSERVATION

- Approximately 71% of the earth is covered in water
- Only about 1% is drinkable.
- All living organisms require water so survive
- Businesses depend on water for domestic use and occupant comfort
- Loss of water in industrial operations can be a multibillion-dollar problem

More Little Known Facts about Water

- Some economists estimate industrial water consumption will double by 2050 in rapidly industrializing countries such as China
- Air cooled systems will save 75% of the water but the energy consumption may increase 4-5% with DX cooling

Reference: Power Engineering International 06/22/2016 Saving water in power plants
Research on the Status of Water conservation in the Thermal Power Industry in China Science Direct 3068-3074 , 2017

Integrated urban water management

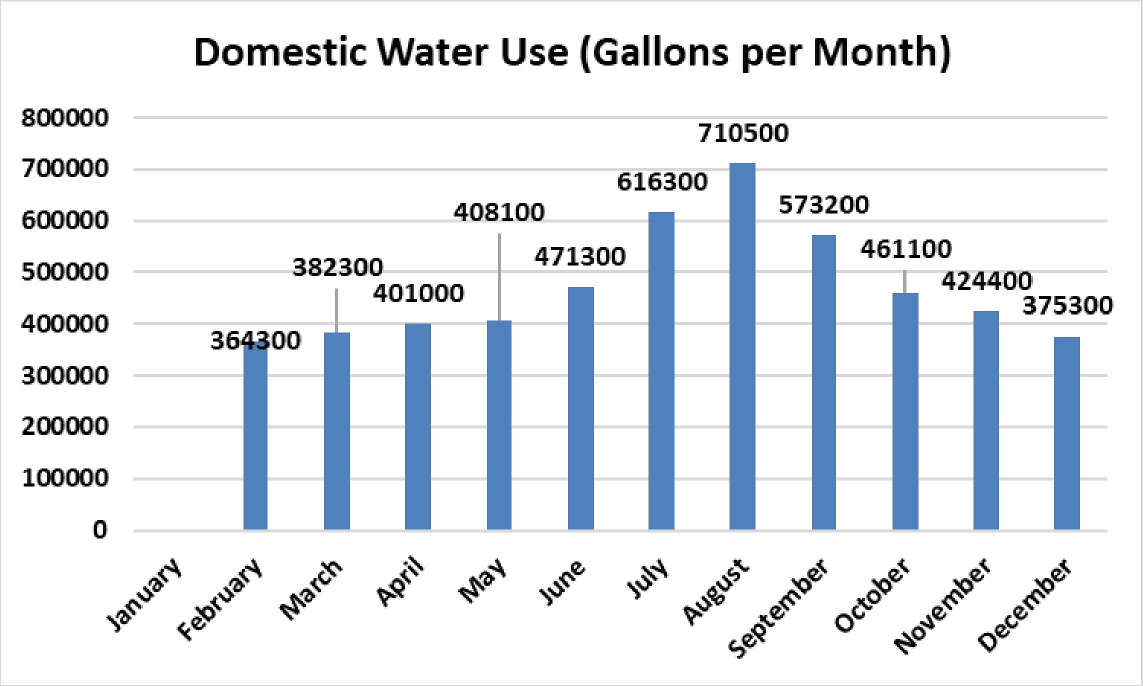
Contents

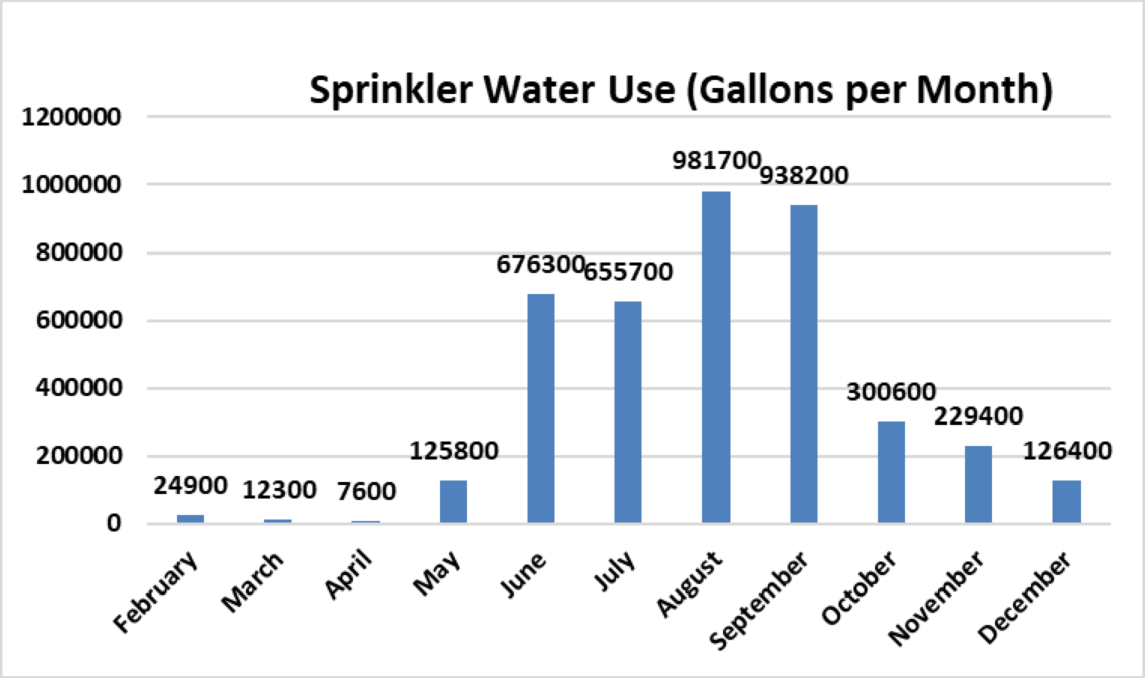
- Components of Water Management
- Approaches/Options for Water Management
- Examples
- Challenges

Components

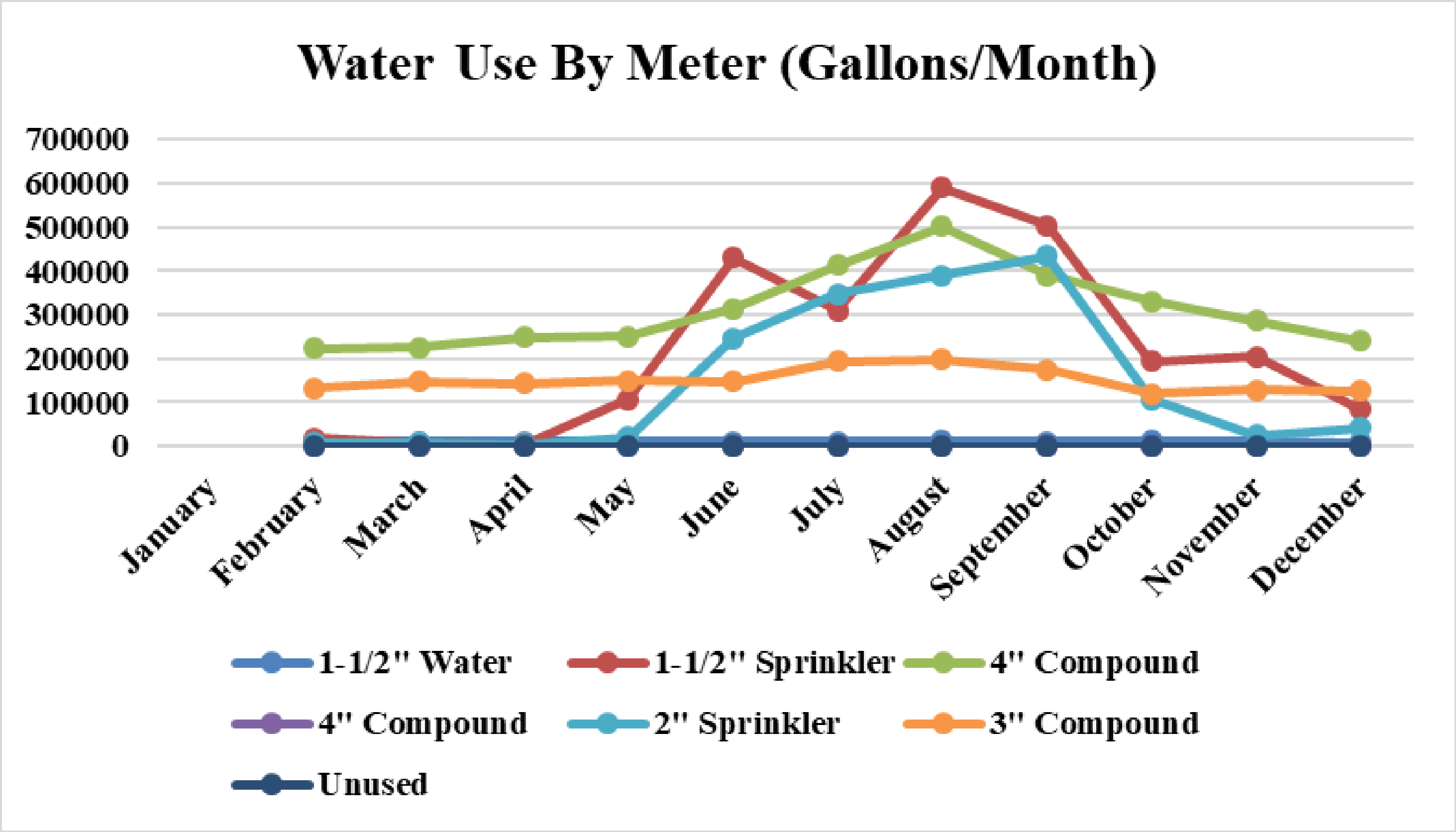
- Plan
- Gather Data
- Stakeholder Engagement
- Decide on an approach
- Retain Expert Advice
- Plan
- Implement
- Reassess

Know How You are Using Water





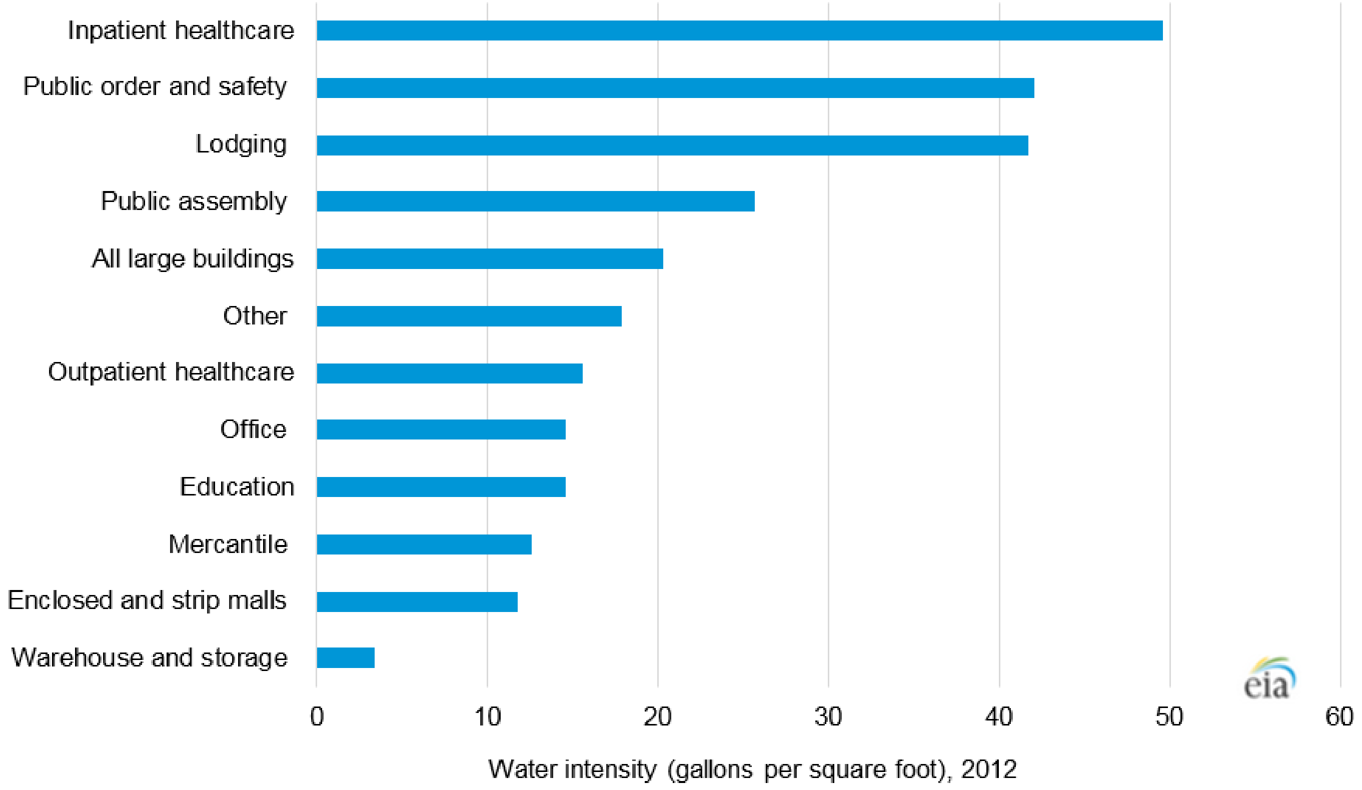
Know How Each Meter is Using Water



Benchmark

Water Intensity Use in Commercial Buildings

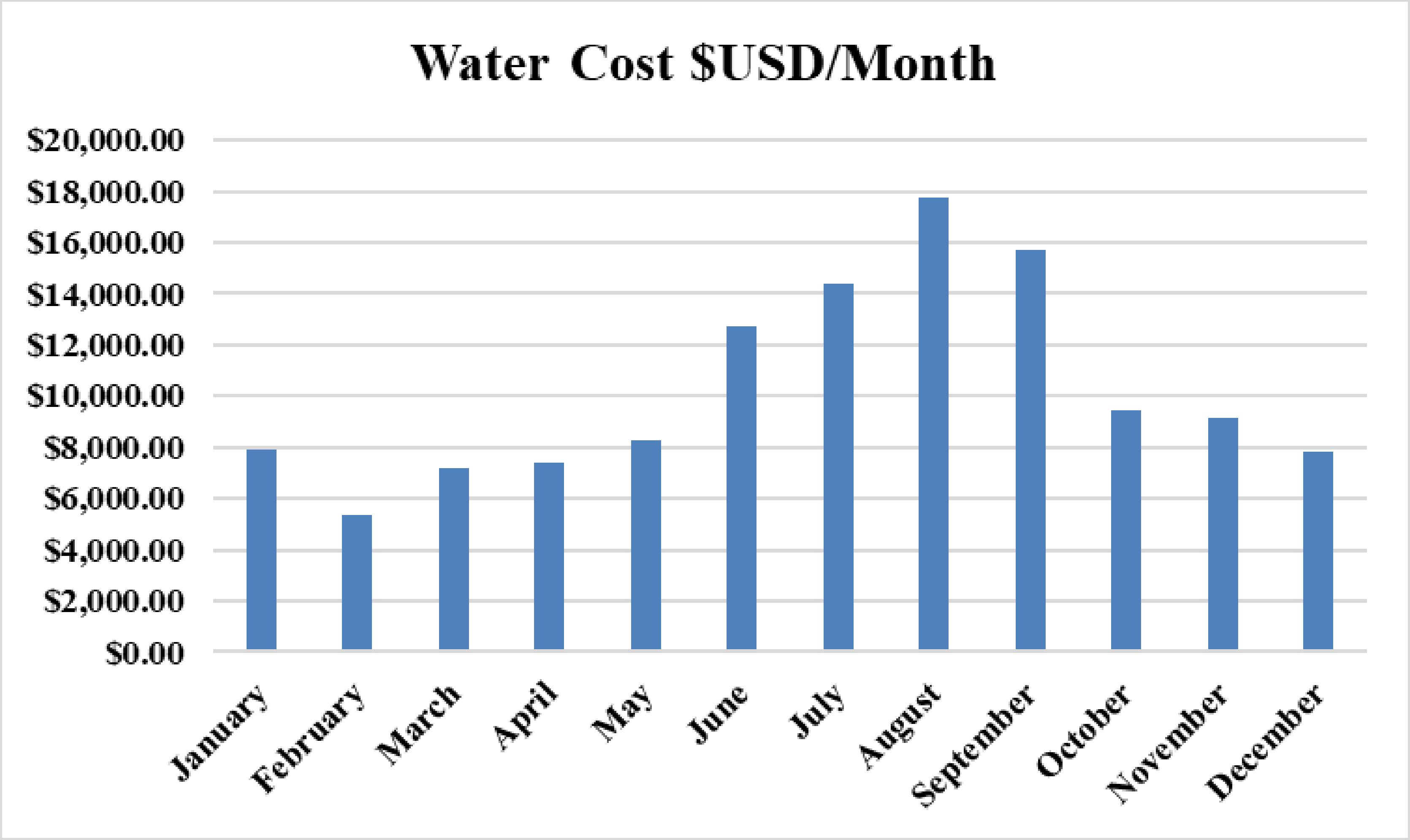
Figure 1. Inpatient healthcare buildings were the most intensive users of water among large commercial buildings in 2012



Gallons/Ft^2
Gallons/Employee
Gallons/Acre

https://www.eia.gov/consumption/commercial/reports/2012/water/

Know How Much You are Spending on Water



How Much Do Water Rates Really Change?

- **2017 Water 5.33 Sewer 4.78 Total 10.11**
- **2016 Water 5.25 Sewer 4.70 Total 9.96**
- **2014 Total 8.67**
- **2013 Total 6.06**

- **66% increase in 4 years!! So in 2021 it could potentially cost $16.86/1000 gallons!! (Already cities in south Texas charging $13 or more per 1000 gallons)** 1 (2013-2017)
- **USA Today Study of 29 localities saw doubling of rates over 12 years** 2 (2001-20012)
- **Circle of Blue Study Saw 41% rise in water costs over 5 years in 30 US Cities** (2010-2015)

References:
1) City of Dallas Water Utilities Division Water and Wastewater Rate Sheets 5/8th inch meter
2) https://www.usatoday.com/story/money/business/2012/09/27/rising-water-rates/
3) https://www.circleofblue.org

Approaches

- Conservation
- Earthworks
- Water Harvest
- Capture Grey Water Effluent

Example: Conservation

If you live in a City where you can get a free audit like Dallas or Fort Worth, engage the City and take advantage!

- Sprinkler Systems
- Kitchens
- Laboratories
- Domestic Fixtures
- Process Systems
- Cooling Towers

Know what you have, where you are using water, and create a use index. W/GSF, Water/Employee, Water/Acre, Water/Bed, Water/Population

What do you see here?

1.
2.
3

Cooling Tower Opportunities

- Cycles of Concentration/Blowdown Controls
- Level Controls
- Water Treatment
- Annual clean the cooling towers and maintain cooling tower inlet screens
- Drift eliminators on all towers
- Maintain the cooling tower system conductivity at or above the 1,600 μS/cm minimum standard.
- Calibrate the tower controller each month to maintain proper operating parameters
- Control biological growth and scale with proper chemical treatment
- Return AHU condensate to the cooling tower system or use condensate for irrigation
- The cooling towers should undergo routine structural inspection every five years to assess damage and mineral buildup. Yearly cleanup and minor maintenance are important to increase the longevity.
- Consider appropriateness of sidestream filtration.

Cycles of Concentration

CYCLES OF CONCENTRATION						
Chiller Tonnage (Nameplate)	**3**	**4**	**5**	**6**	**7**	**8**
100	5,480	4,930	4,660	4,380	4,380	4,110
200	10,960	9,860	9,320	8,770	8,490	8,490
400	21,920	19,730	18,360	17,530	17,260	16,710
500	27,400	24,380	23,010	21,920	21,370	21,100
600	33,150	29,320	27,400	26,580	25,750	25,210
800	44,110	39,180	36,710	35,340	34,250	33,700
1000	55,070	49,040	46,030	44,110	42,740	41,920
1500	82,740	73,420	68,770	66,030	64,380	63,010
2000	110,140	97,810	91,780	88,220	85,480	83,840
2500	137,810	122,470	114,790	110,140	107,120	104,930
3000	165,210	146,850	137,810	132,330	128,490	126,030
3500	192,880	171,510	160,550	154,250	149,860	146,850
4000	220,270	195,890	183,560	176,160	171,510	167,950
5000	275,340	245,480	229,590	220,270	214,250	209,860
https://www.energy.gov/eere/femp/estimating-methods-determining-end-use-water-consumption						

Make-Up = Evaporation + Blowdown + Drift

Increase Cycles, Reduce Blowdown

Do you know the IECC's?

- GPF Toilets: 1.28
- GPF Urinals: 0.5 gpf
- Sink Aerators: 0.5 gpm
- Cooling Towers: nlt 5 cycles
- Boilers: Conductivity controller, heat recovery
- Vacuum and Process systems: Must recycle water
- Sterilizers: Must recycle water
- Kitchens: Garbage disposers bad news! Compost food waste!
- Washing Machines: Energy star saves 30-60%/load (required by code)
- Pools are a huge waster if you do not have a cover to protect from evaporation
- Sprinkler Systems: Extensive standards on metering, and design

Ref: SECO: State Energy Conservation Design Standards 2017

Cost of Pumping Water

$C = 0.746\ Q\ h\ c\ /\ (3960\ \mu_p\ \mu_m)$ (1)

Definitions:

- C = cost per hour (USD)
- Q = volume flow (gpm)
- h = head (ft)
- c = cost rate per kWh ($/kWh)
- μ_p = pump efficiency (0 - 1)
- μ_m= motor efficiency (0 - 1)
- 3960 is 33000 (foot lbs./bhp) / 8.33 (weight of water)
- $.002=.746*10*10*.1/3960*.9*.9

Cost of Heating Water

Input=Output/EFF

Output=GPH*8.34*DT*Specific Heat

Definitions:

- GPH Gallons Per hour
- 8.34 pounds per gallon
- Delta T- Heating Water Temperature – Incoming Water temperature
- Specific Heat
- Eff=Efficiency of Heat Transfer
- 81,800=120*8.34*82*1
- 23.8kW * $.10= $2.38 assumes 100 % efficiency
- Take Output/Efficiency to get heat input
- Assume 85% efficiency $2.80 to heat the 120 gallons in the tank

Conservation

- Awareness
- Education
- Behavior Change

Water Management Group Tucson, AZ

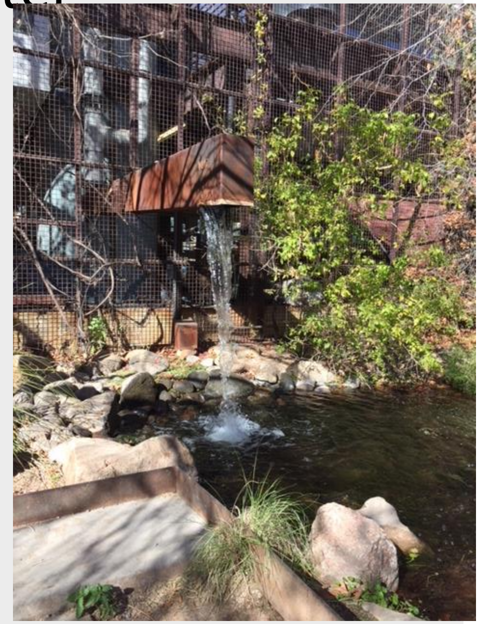
Example: Earthworks

- Before spend money on rainwater capture, consider making your property a living sponge.

- How is your landscape sloped?
- How is it mulched?
- Where does the water go when it rains?

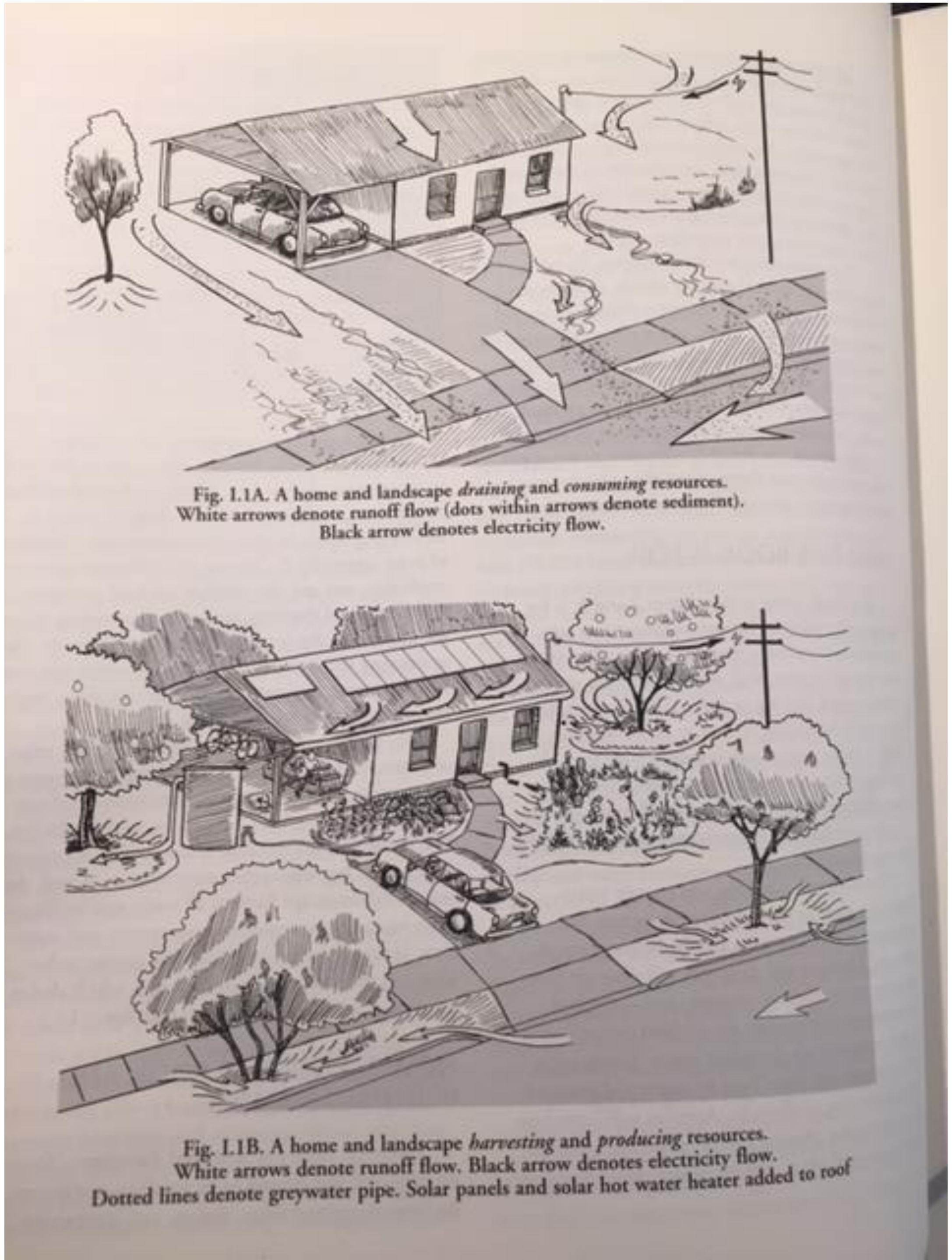
Example Earthworks

- Long and thoughtful observation
- Start at highest point of you watershed and work your way down
- Start small and simple
- Spread and infiltrate the flow of water
- Plan an overflow route
- Create a living sponge
- Stacking functions
- Feedback loop



Reference: Rainwater Harvesting for Drylands and Beyond Volume 2, Brad Lancaster

The Effect of Earthworks on Water Flow



Earthworks

Kemp Watershed

- Bridge Runoff
- Rainwater Capture
- Paths/Gardens
- Permeable Soils
- Butterfly Garden

WATER HARVESTING

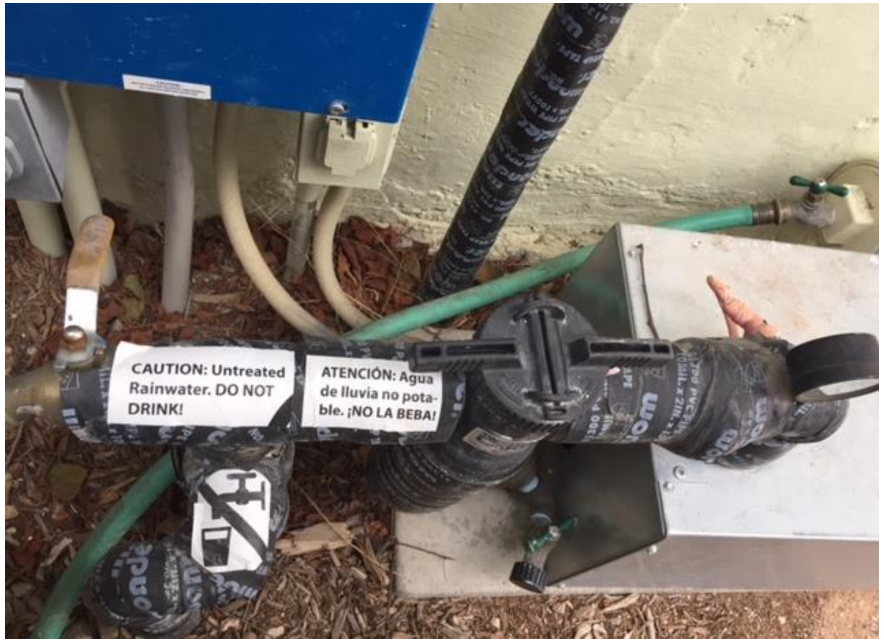
- FIRST YOU CONSERVED
- SECOND YOU IMPLEMENTED EARTHWORKS
- STILL NEED WATER

- CONDENSATE RECOVERY
- RAINWATER HARVESTING
- GREY WATER HARVESTING

Example Water Harvesting

- Roof square footage
- Driveways and hard surface runoff
- Runoff from adjacent properties
- Runoff from land
- Air handling unit condensate is clean and can be captured and returned through chw return lines or condensate return pumps

Water Harvesting: Small Volume Home



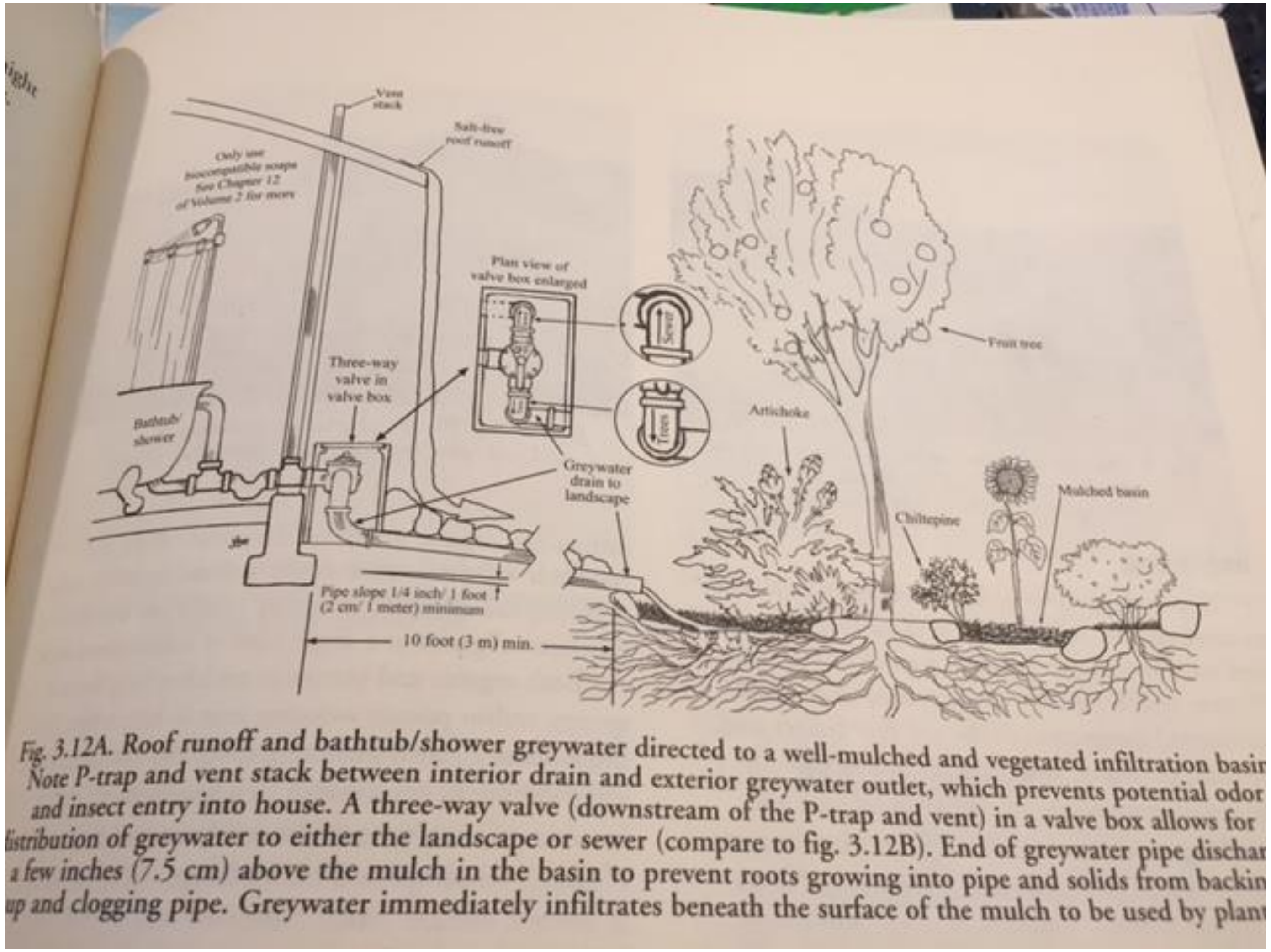
Harvesting Control System

Water Harvesting: Large Volume Commercial

Example Greywater Capture

- Washing Machines
- Bathroom Sinks
- Bathtubs/Showers

Greywater Plumbing



Greywater Capture

Infiltration Basin:

- Calc. Water Volume
- Perk Test Soil
- Design Basin

Challenges

- Knowing where to start
- Start small
- Knowing your constituents
- Resistance to change

Works cited

1) Texas Water Development Board 2017 State Water Plan
2) American Ground Water Trust https://agwr.org
3) City of Dallas Water Utilities Division Water and Wastewater Rate Sheets 5/8th inch meter
4) SECO: State Energy Conservation Design Standards 2017
5) Rainwater Harvesting for Drylands and Beyond Volume 1 2nd Edition, Brad Lancaster.
6) Rainwater Harvesting for Drylands and Beyond Volume 2, Brad Lancaster.
7) Create an Oasis with Greywater, 6th Edition, Art Ludwig

Questions???

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QUESTIONS ARE GUARANTEED, ANSWERS ARE NOT!

This concludes The American Institute of Architects Continuing Education Systems Course

Dr. Valerie A. Shoup

info@heritageios.com