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Water Resources Shaping Ohio's Future: Water Efficiency Manual for Industrial, Commercial, and Institutional Facilities (Presentation)

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2014

Prepared for:
Ohio Lake Erie Commission
Ohio Department of Natural Resources (ODNR)

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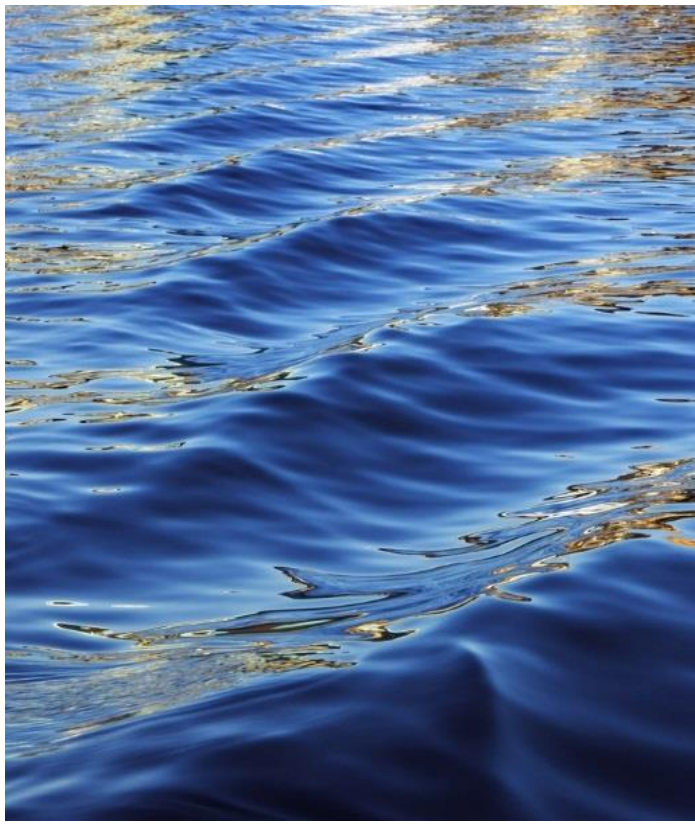
Center for Economic Development

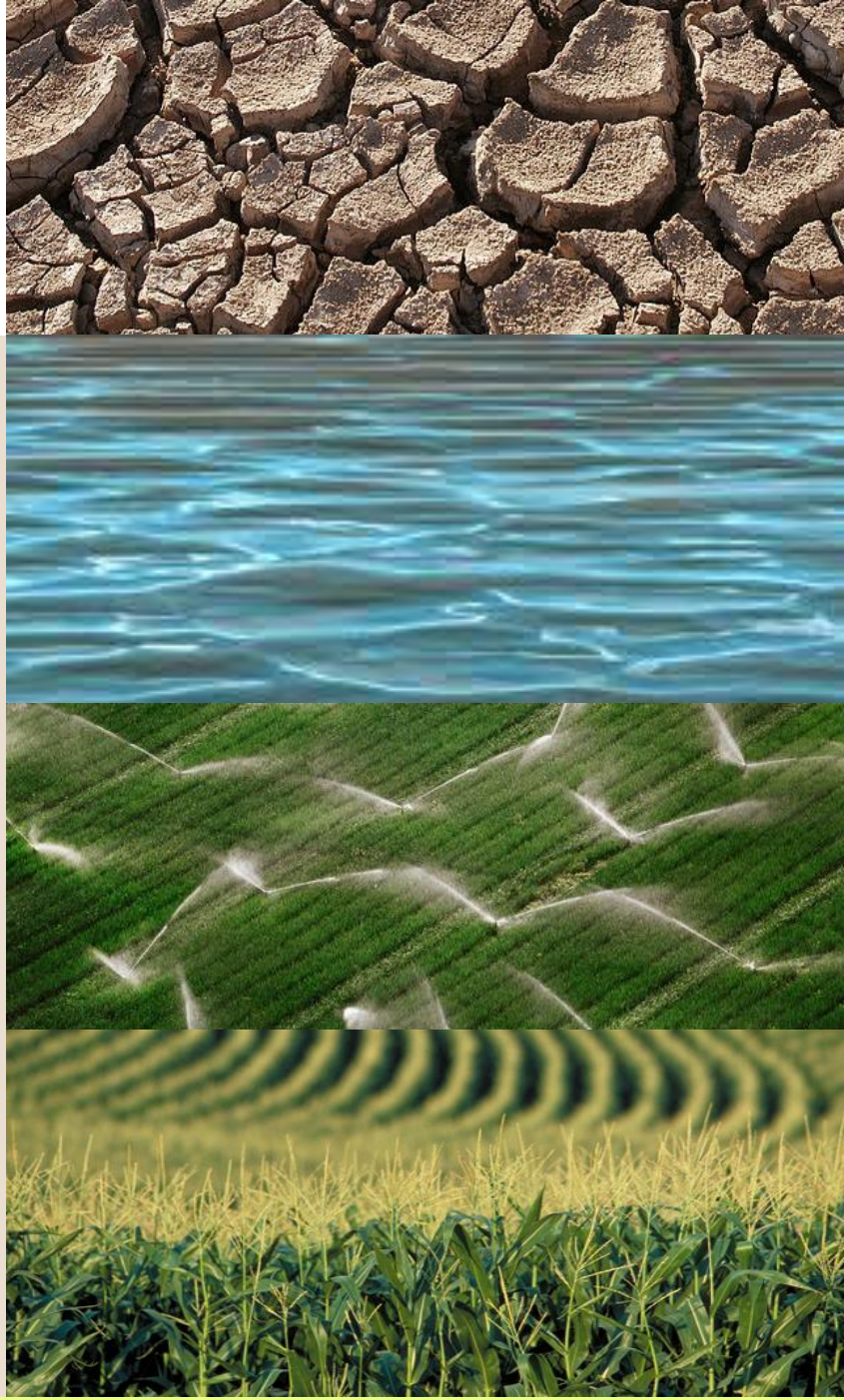
Water Resources Shaping Ohio's Future:

Water Efficiency Manual for Industrial, Commercial, and Institutional Facilities

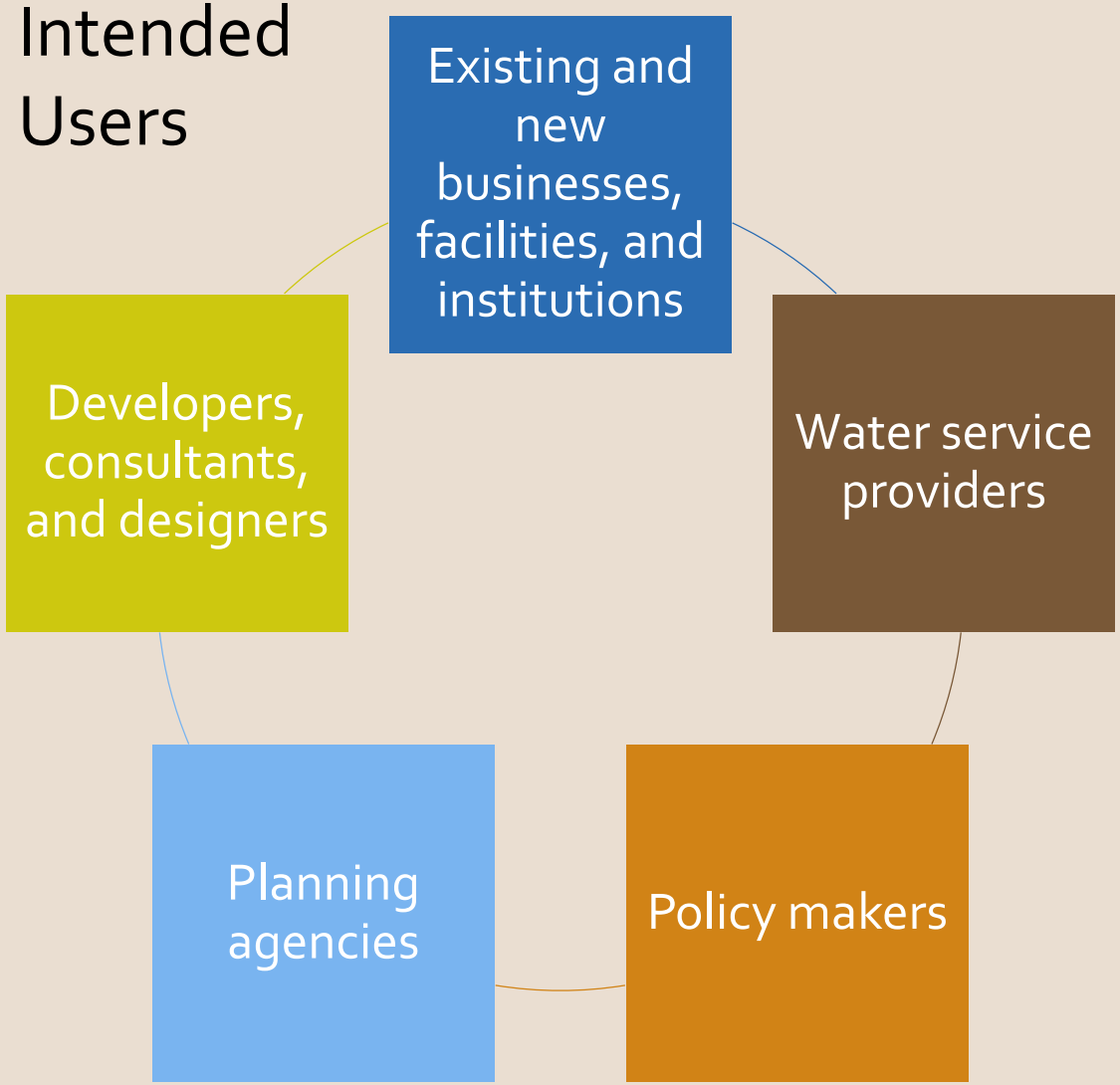


Highlights of Literature Review

- Scope and size of literature are vast.
- Broad geographical differences:
  - Europe, United States, Great Lakes, Ohio
- Water-rich vs. water-stressed
- Levels of planning and oversight vary widely.
- Sector differences
  - Data outdated or not gathered
- Great Lakes context: How is water valued?



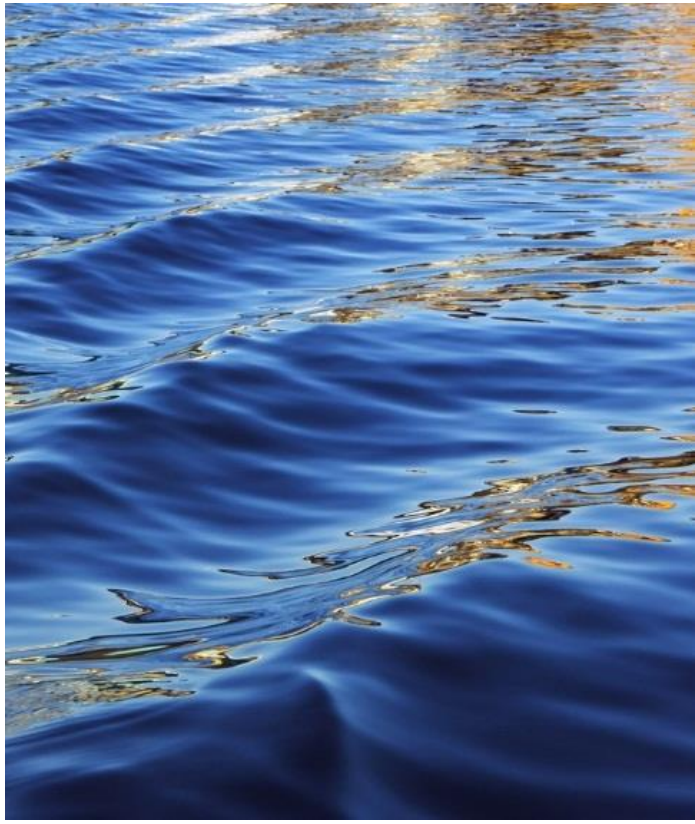
Intended Users



When to Use This Guide

Now	• to determine what you can do to use water efficiently, save money in your facility, and help protect Ohio's water resources.
As you apply for a water withdrawal permit	• to learn about opportunities to achieve significant energy and environmental benefits through water efficiency practices.
As you plan and budget for next year	• to identify essential programs, equipment and employee participation tools for water efficiency.
When considering to purchase	• any new cooling, heating, processing, landscaping, sanitary fixtures, facility support equipment and service contracts.
Before you seek support and engagement	• from your management, maintenance and production personnel.
Before any facility upgrade and expansions	• that can impact your water processes.
In the case of any unforeseeable water crisis	• such as drought or intensified competition for water withdrawals.

GENERAL PRINCIPLES AND PRACTICES FOR SUSTAINABLE WATER MANAGEMENT



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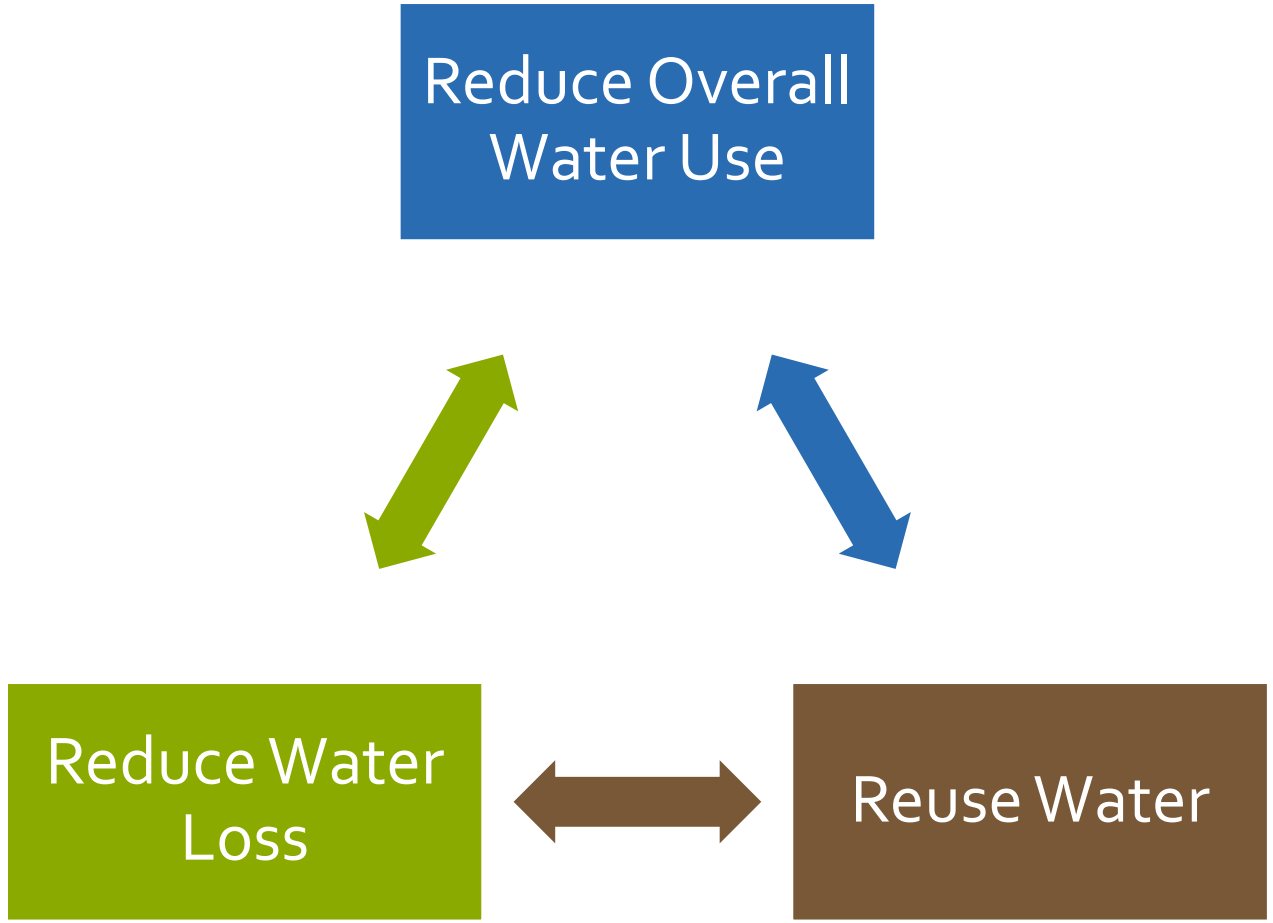
First-Mover Competitive Advantage

Start using water efficiently today and your firm will have a competitive advantage over companies that choose to wait. For a holistic approach, include water efficiency measures in your business strategic plan. Prioritize needs, set ambitious yet achievable goals, establish present performance minimums, and carefully plan for taking action.

Water Efficiency Categories



Water Audit

- List all water-consuming equipment
- Check plumbing diagrams
- Measure water flow rates and usage
- Define water quality needs for each process
- Assess existing water-efficiency measures
- Observe shift clean-ups and process change-overs
- Identify all water losses (e.g. evaporation, leaks, etc.)
- Identify water-efficiency opportunities for each operation
- Determine the true cost of water use

Steps for a Successful Water Efficiency Program

1. Set Commitment & Goals
2. Assemble Support & Resources
3. Conduct a Water Audit
4. Identify Best Water Management Practices
5. Prepare a Plan & Implementation Schedule
6. Monitor Results & Publicize Success

Technical and Financial Feasibility for Best Management Practices: Cost Analyses

The Unit Cost of Water

Payback Period

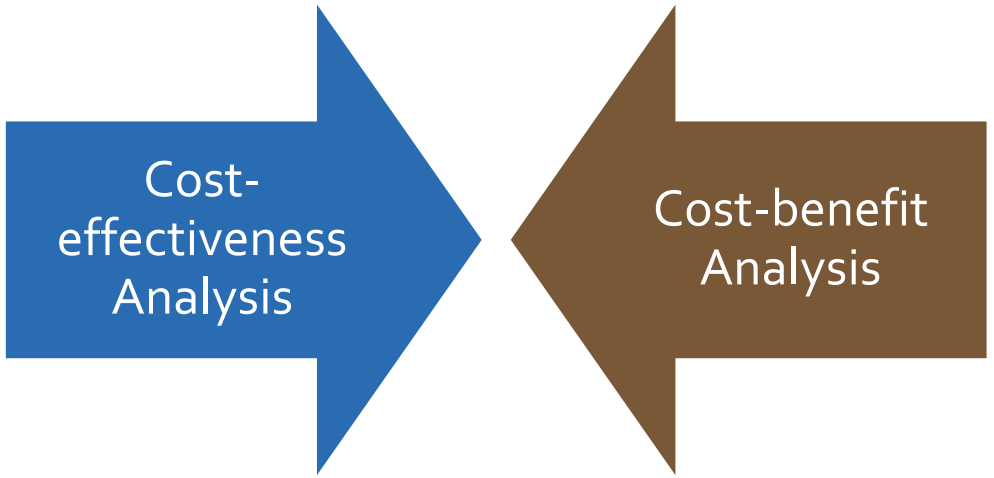
Return on Investment (ROI)

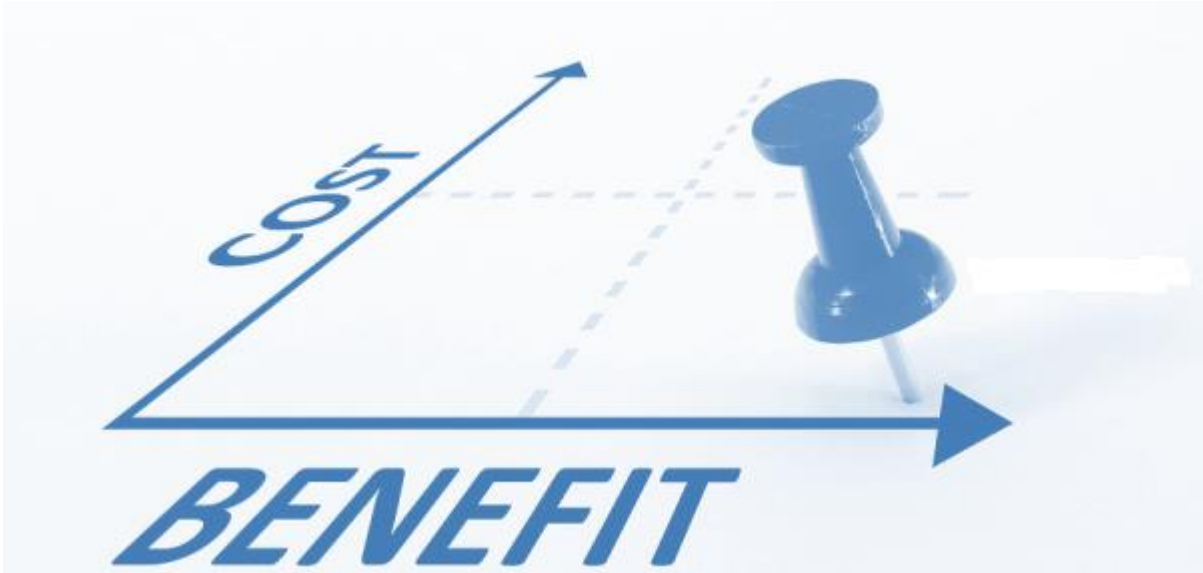
Internal Rate of Return (IRR)

Net Present Value (NPV)

Financial and Economic Analyses

- The recommended economic screening measure is ***Cost-effectiveness Analysis.***
- In contrast to cost-benefit analysis, cost-effectiveness accounts for the outputs produced by a project, which are not measured in monetary terms.
- Examples: lives saved, illnesses prevented or years of life gained as an output for a healthcare intervention.
- Ensures that the greatest water savings is achieved for a given expenditure.



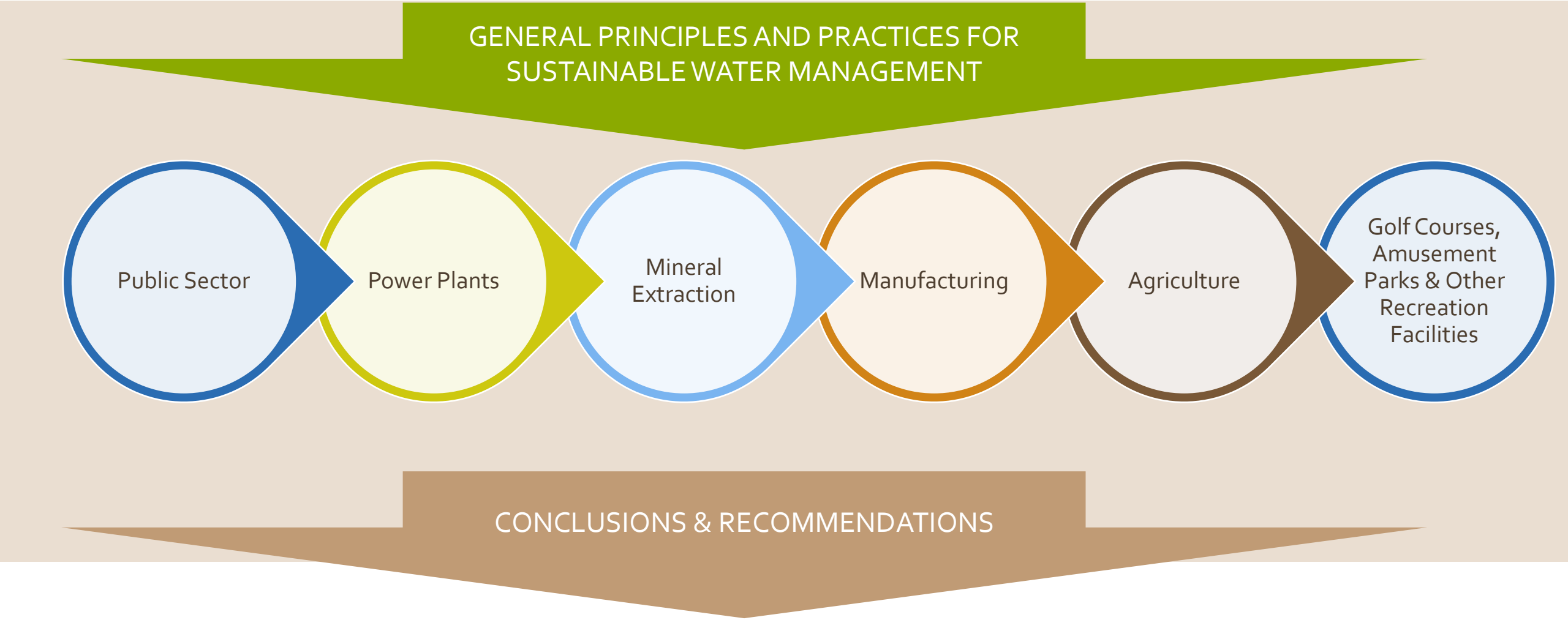


Long Term Considerations for Financial and Economic Analyses

Consider

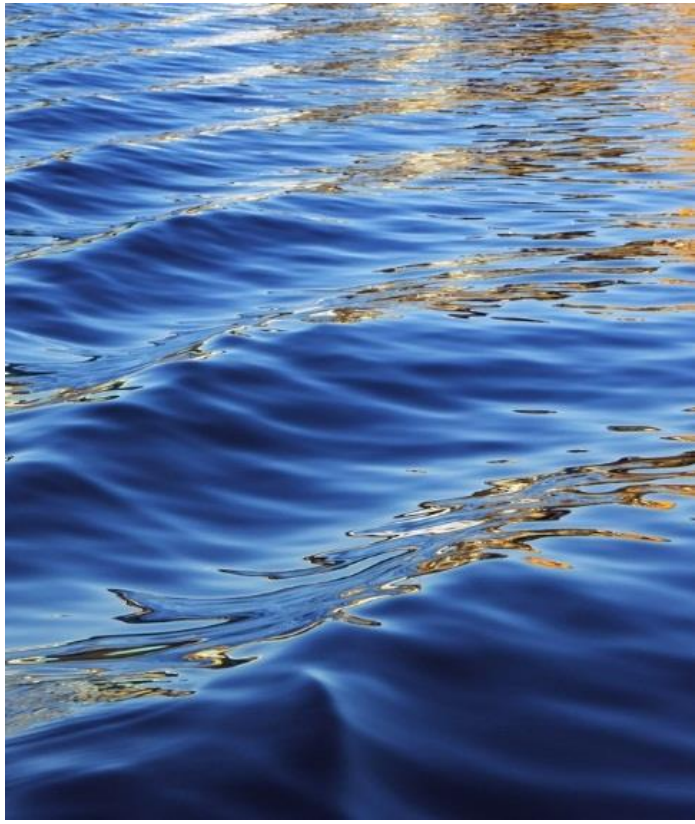
- Increased Water and Wastewater Rates
- Increased Energy Rates
- Co-benefits of Water Efficiency
- Reliability of Water Supply Risks
- Reputational Risks and Benefits

Selected Sectors & Organization of the Report



Public Sector

Best Management Practices



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Public Sector Water Use In Ohio

- Public entities withdraw over 500 billion gallons from surface and ground water resources in Ohio each year.
- Primary use is for treatment for drinking water at over 600 facilities in the state and for supplement to waste water treatment processes.

WATER & WASTE WATER

Regulation of Public Water

- Ohio Environmental Protection Agency regulates construction and operation of public water supply, treatment, and distribution systems.
- The state completed water plans in the 1970s and 1980s.
  - Emphasized development of supply, not conservation.

SUPPLY VS. CONSERVATION

Best Administrative Practices

- Overall shift to integrated, systems-based, ecosystem approach to water management:
  - USEPA: sustainable water infrastructure program
    - Climate ready water utilities
  - USEPA integration of sustainability approach to water
    - Integrates systems approach with risk-based assessment models from past regulatory framework
    - Triple value framework

SUSTAINABILITY & WATER MANAGEMENT

Urban Public Water Systems

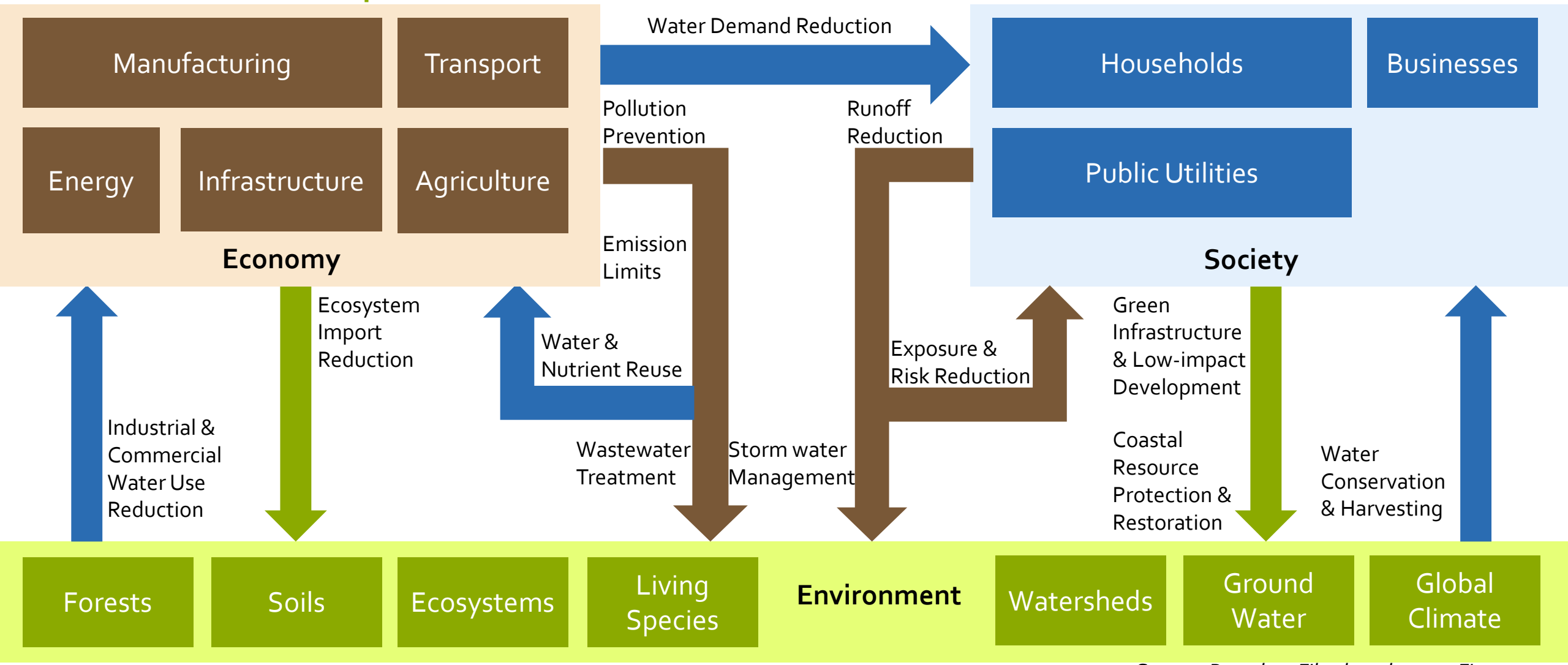
- New frameworks:
  - Sustainable urban water management
  - Integrated urban water management
  - Water sensitive cities
- Integrative approach includes:
  - Source protection, water recycling, demand reduction, waster harvesting, pollution prevention, resilience to hazards

NEW WATER MANAGEMENT FRAMEWORKS

Best Management Practices

Triple Value Framework and Water Resources

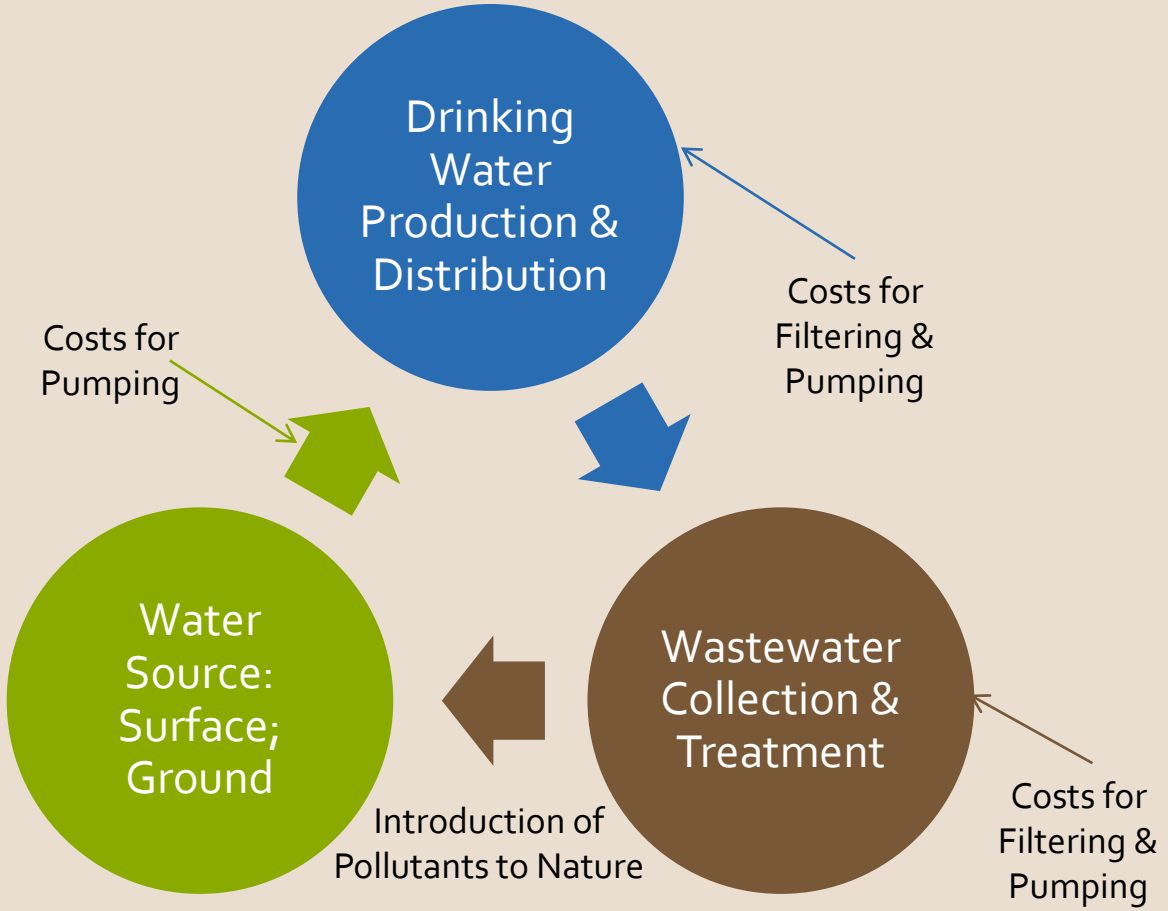
Innovative Technologies



Source: Based on Fiksel et al. 2013, Figure 4.

Shift in Urban Water Management

20th Century Urban Water Management Cycle



21st Century Integrated Urban Water Management Cycle

Step 1 Prevention and Minimization

Key Question: to use or not to use?

- Reduce water use
- Water saving technologies in industry and household
- Reuse grey water
- Ban undesirable compounds
- Apply low water use or dry sanitation
- Apply rainwater harvesting

Step 2 Treatment for Reuse

- Convert waste to something for reuse (e.g. biogas, fertilizer, protein)
- Select treatment processes that make best use of possible side products
- Optimize effluent reuse

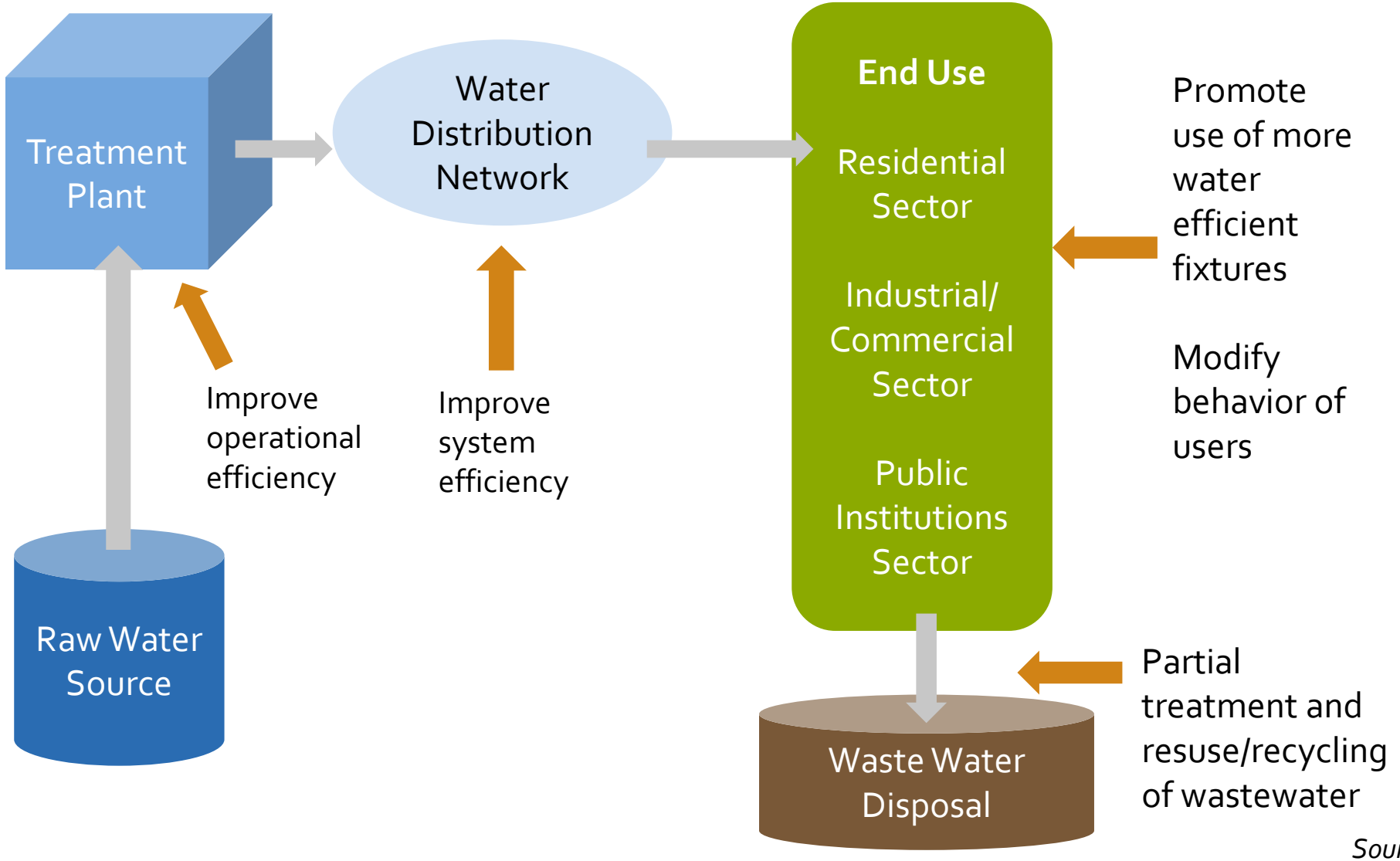
Step 3 Stimulate natural self purification

- Discharge into intermediary for natural purification

Water Resources

Source: Based on Nhapi and Gijzen 2005 in van der Steen 2008

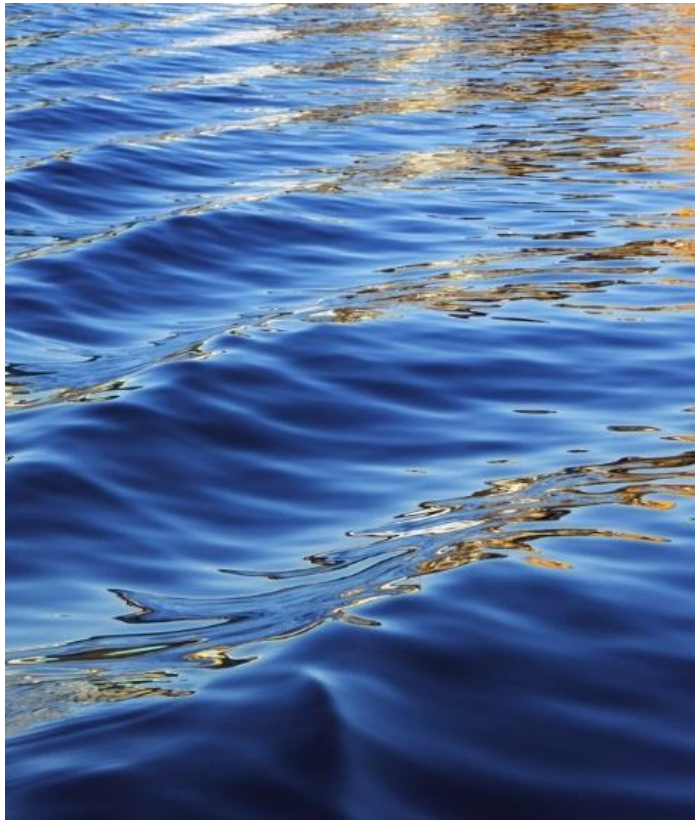
Water Demand Management Intervention Points



Source: after Kayaga and Smout, 2011

Power Plants

Best Management Practices



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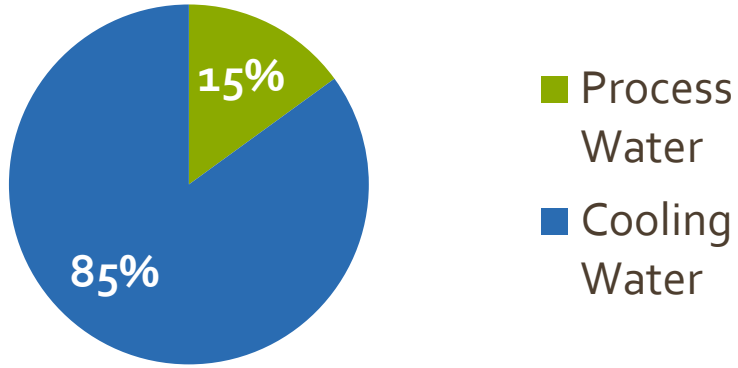
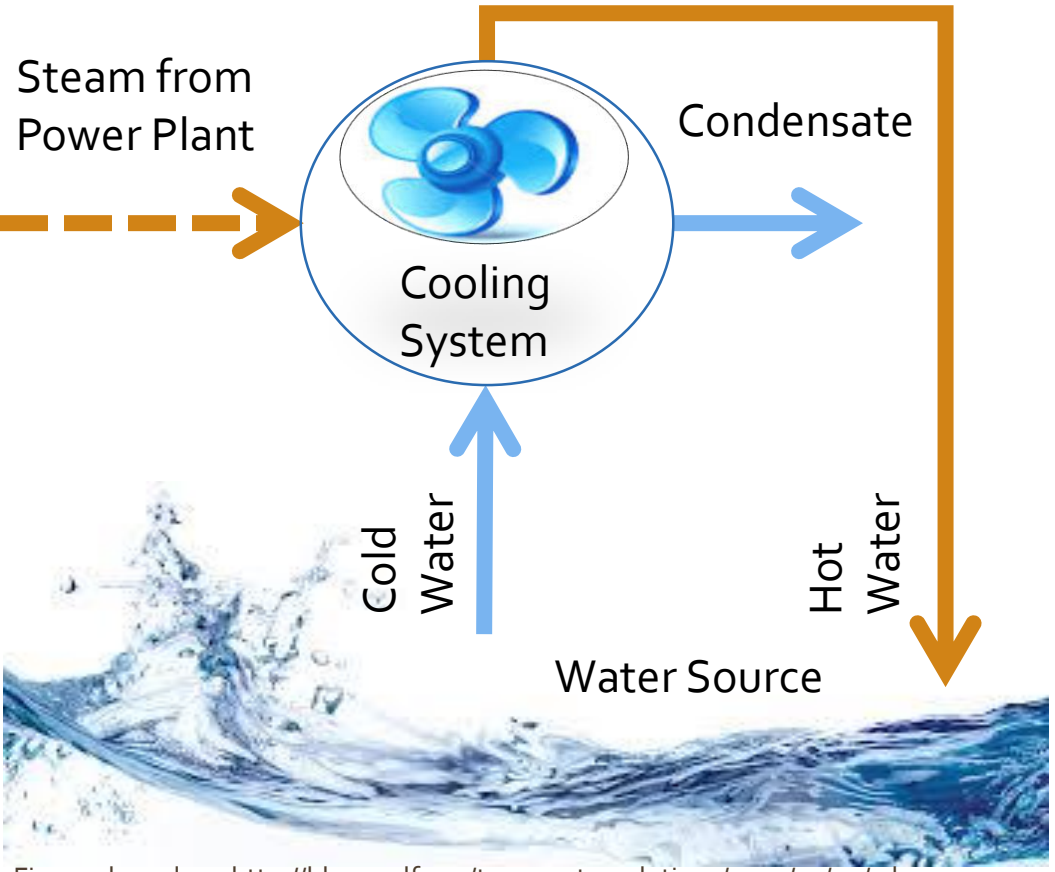
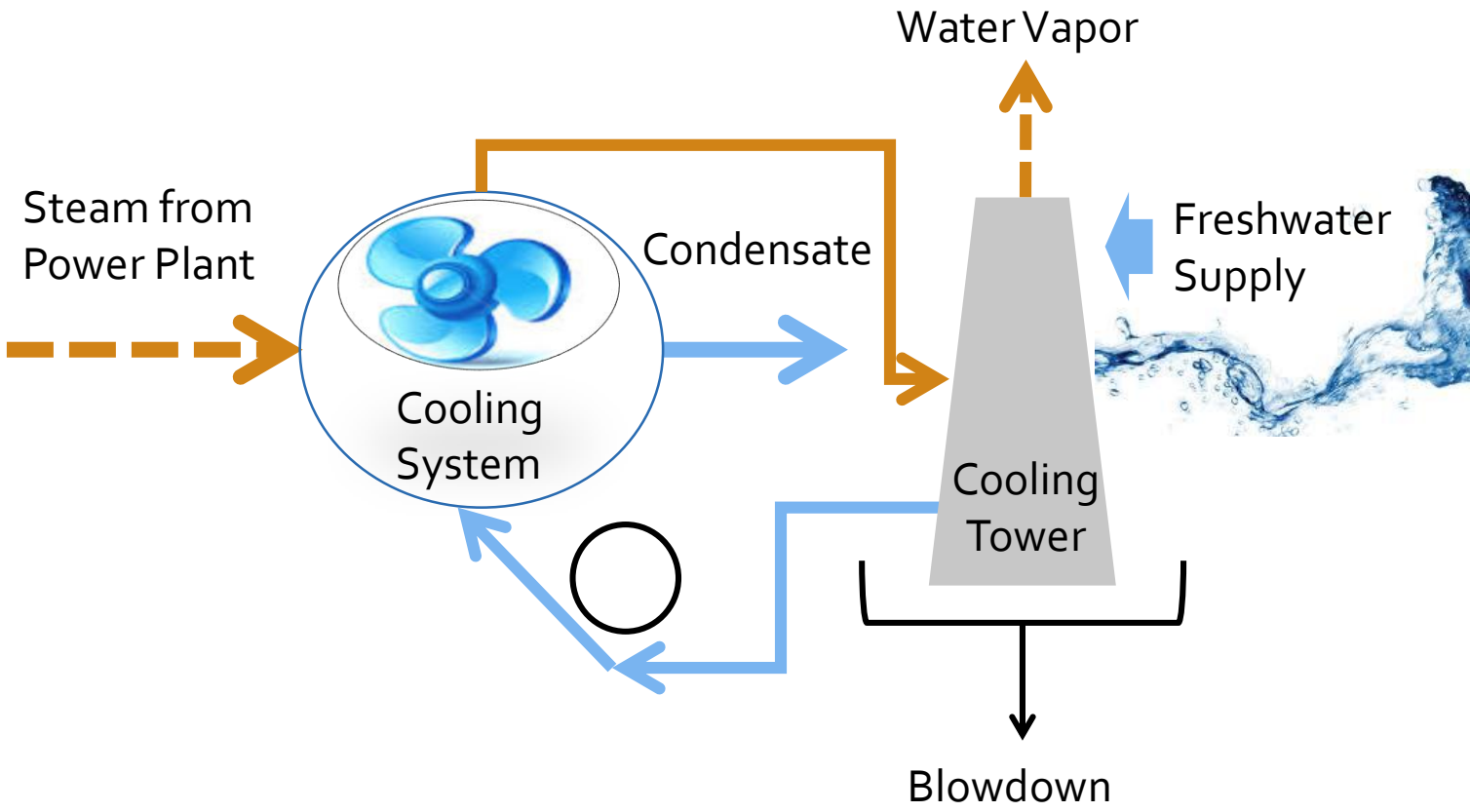
Use of Water in Power Plants



Open-loop Cooling



Closed-loop Cooling



Figures based on: http://blogs.edf.org/texaswatersolutions/2010/03/29/why-power-plants-use-so-much-water-and-what-to-do-about-it/

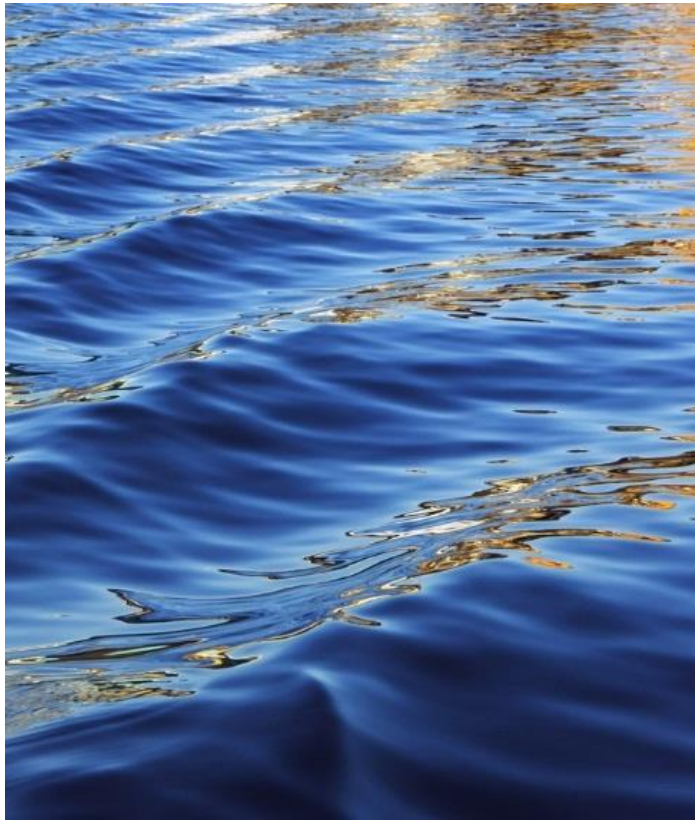
BMPs for Power Plants

1	Return once-through water to reservoir for reuse in order to minimize the actual amount of water consumed in the system.
2	Maximize the use of wastewater from one process as source water for another process that requires lower quality water.
3	Repair and maintain all equipment routinely to minimize water loss.
4	Collect and utilize storm water run-off where feasible.
5	Arrange a task force team to monitor and optimize water usage at all times.
6	Boost your awareness of best management practices by participating in water conservation technical organizations.
7	Assess water-efficient processes when considering capital investments.
8	Evaluate standard operating procedures to ensure water usage optimization, and regularly incorporate best practices and lessons learned.
9	Minimize cooling water consumption by using computer controlled systems to adjust for certain climatic conditions.
10	Employ dust suppression chemistry where appropriate to minimize water usage.
11	Engage employees in water conservation and drought mitigation efforts.

http://www.daytondailynews.com/news/news/local/ohio-power-plants-likely-to-see-costly-epa-fines/nMxf4/

Mineral Extraction

Best Management Practices



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Hydraulic Fracturing Best Management Practices

- Minimize Freshwater Use
- Identify Alternative Sources of Water
- Develop Conservation Practices
- Engage and Collaborate with the Local Industry and Community

Minimize Freshwater Use: Recycling

- **Treat and reuse both flow-back and produced waters**
  - goal should be to recycle 100% of returned or produced water from the well bore
- **Determine feasibility of capture and assess content of flow-back water.**
- **Combine thermal processing with membrane processing.**
  - Combined technologies increase efficiencies.
- **Assess new membrane technology.**
  - New technologies are being developed rapidly in response to recycling needs.
- **Conduct a lifecycle water analysis.**
  - Water volume and makeup produced during different stages of the life of the well are likely to vary.
  - Each stage will require different strategies for recycling, suggesting the need for life cycle planning for each period throughout the lifetime of the well.

Minimize Freshwater Use: Identify Alternative Sources of Water

- **Hydraulic Fracturing Does Not Require Potable Water.**
  - Underground freshwater aquifers should be considered as the source of "last resort."
- **Use Wastewater.**
  - Operator can acquire third party waste water, most commonly from municipal wastewater treatment plants or industries.
  - Acid Mine runoff may also be suitable.
- **Use Brackish water.**
  - Brackish groundwater is found beneath the freshwater table, but can be produced in much the same manner that fresh groundwater is produced.
  - Establish that the brackish water reservoir is not interconnected with the freshwater reservoir

Minimize Freshwater Use: Conservation

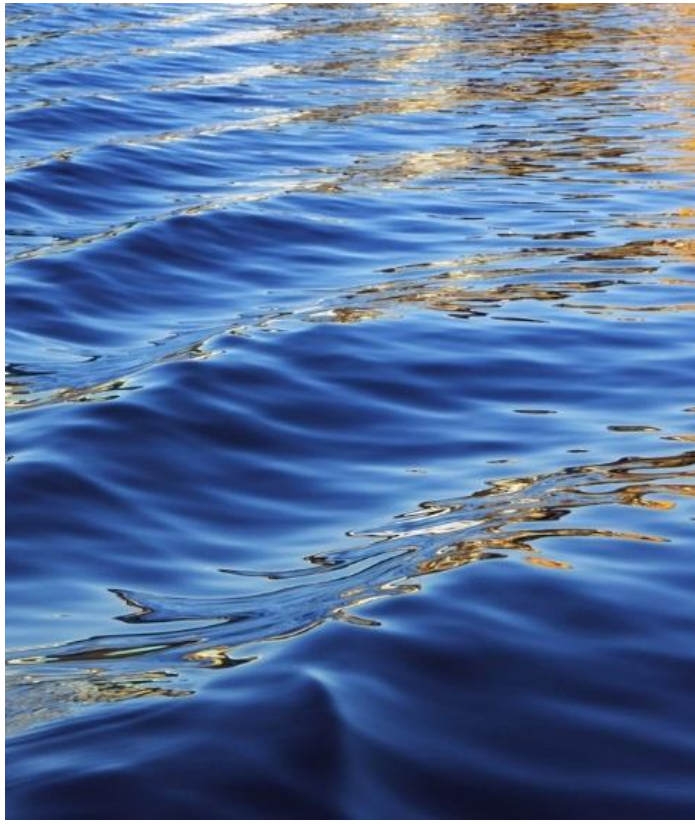
- **Embed Water Conservation Strategies into the Company Culture at All Levels.**
  - Management and Board level supervision.
  - Require contractors to deploy comparable strategies.
- **Use Best Available Technologies.**
  - Quality pipes, pumps; keep pipelines above ground to check for leaks.
  - Use evaporation covers when appropriate.
- **Use Shadow Pricing.**
  - Including externalities in water pricing can enable economic justification of more conservation measures.

Collaboration

- **Industry Collaboration**
  - **Private Investment into Water Infrastructure.**
    - Joint investment into the infrastructure enables parties to risk longer term cost recovery.
  - **Centralize pipeline networks and storage facilities**.
  - Shared infrastructure and centralized storage may be critical to the cost effectiveness of recycling. Large operators should take the lead here as well.
  - **Create database for wells and pipeline locations**.
- **Community Collaboration.**
  - **Agriculture and Industry**. Work cooperatively with agriculture and other industries to minimize stream impacts and ensure sufficient water for irrigation.
  - **Community Groups and Government Agencies**.
    - Work cooperatively with agriculture and other industries to minimize stream impacts and ensure sufficient water for irrigation.
    - Communicate with local communities to identify important uses and critical value of local water sources

Manufacturing

Best Management Practices



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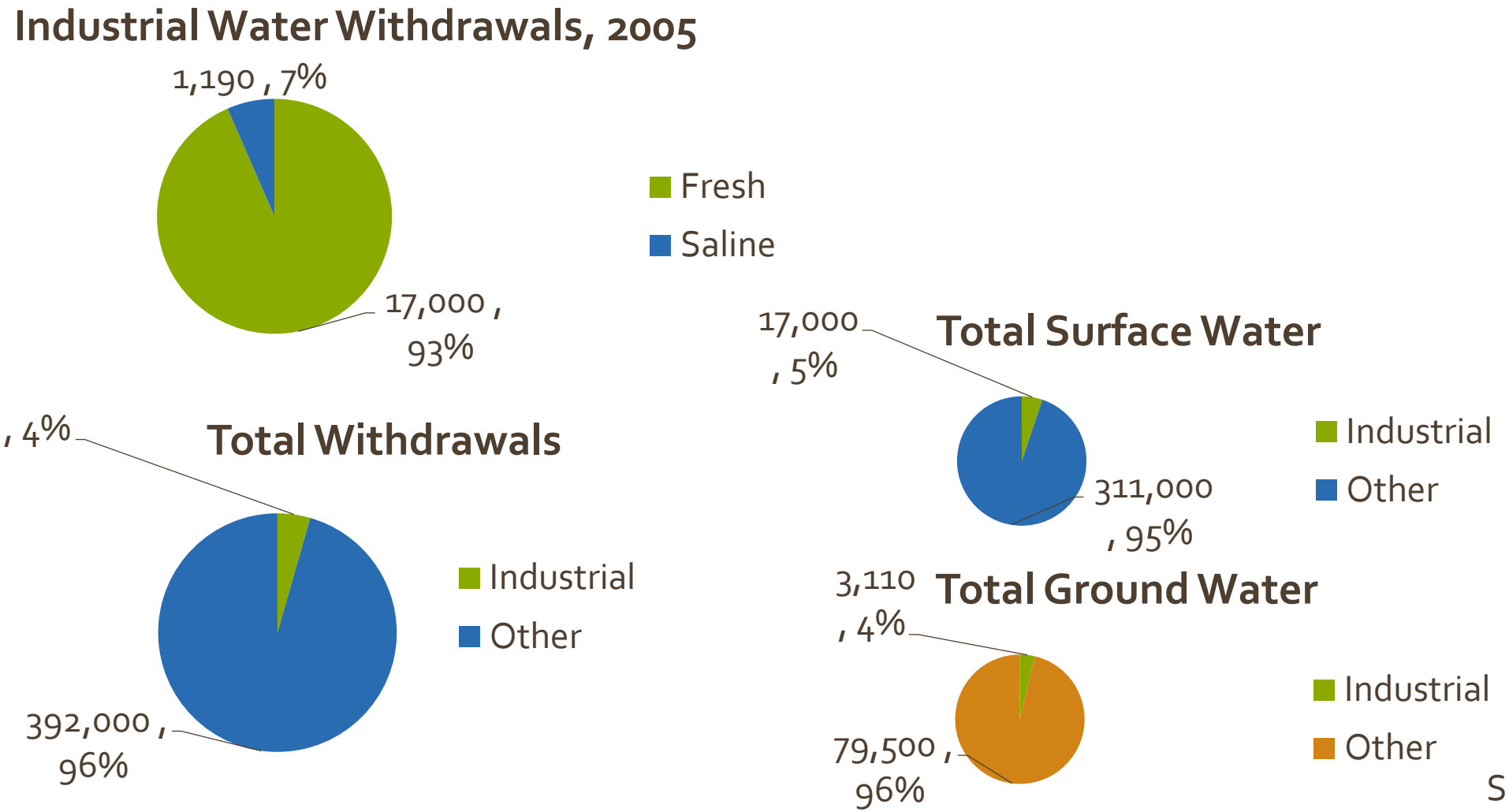
Total and Industrial Water Withdrawals, 2005



Source: USGS

Use of Water in Manufacturing Processes

- Cleaning and rinsing products, parts and vessels
- Transporting parts or ingredients
- As a lubricant
- As a solvent or reactant in a chemical reaction
- Forming a water seal to block out contact with air
- Pollution control
- Inclusion in the product such as in beverage manufacturing.

1) Adjusting the flow of water
2) Modifying the equipment or installing water saving devices
3) Replacing existing equipment with more water-efficient equipment
4) Water treatment, recycling, and reuse
5) Changing to a waterless process

Process Water

Cooling Water

Steam Generation & Boilers

Sanitation, Irrigation, Food Service & Housekeeping

Water Use in Iron & Steel Industry

Material Conditioning

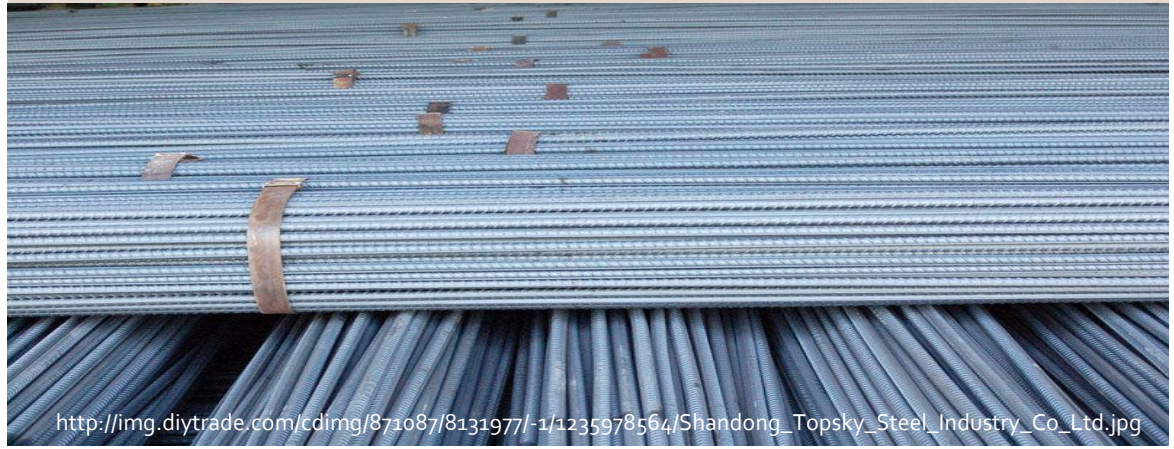
Air Pollution Control

Heat Transfer

(approximately 75% of all water used in steel production)

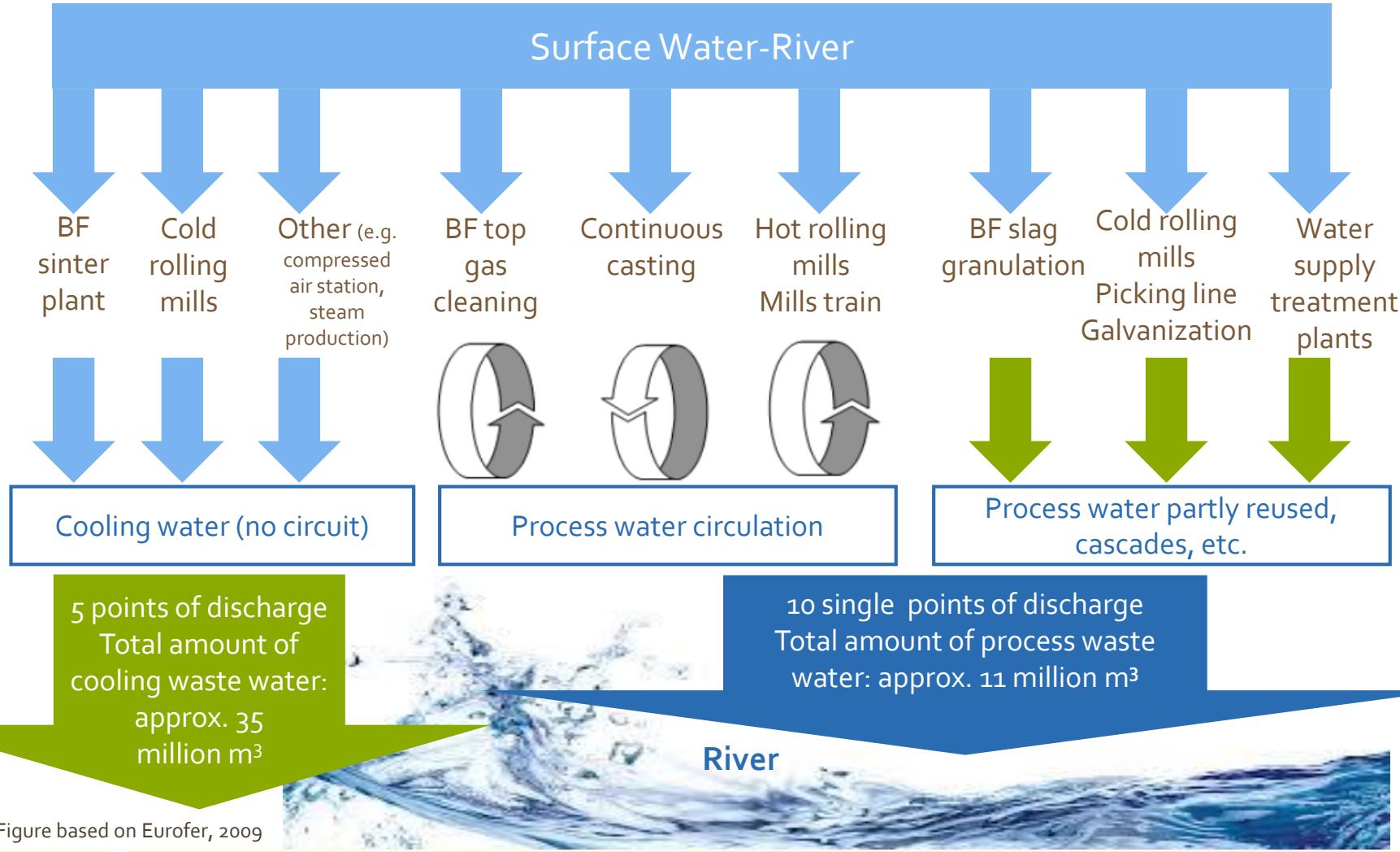
Three examples where semi-closed systems are used:

- in cooling towers for decreasing the water temperature.
- for the recycling of waste water after treatment for further uses not requiring such high quality water as for the first use.
- for process water which can be led into a close cycle.



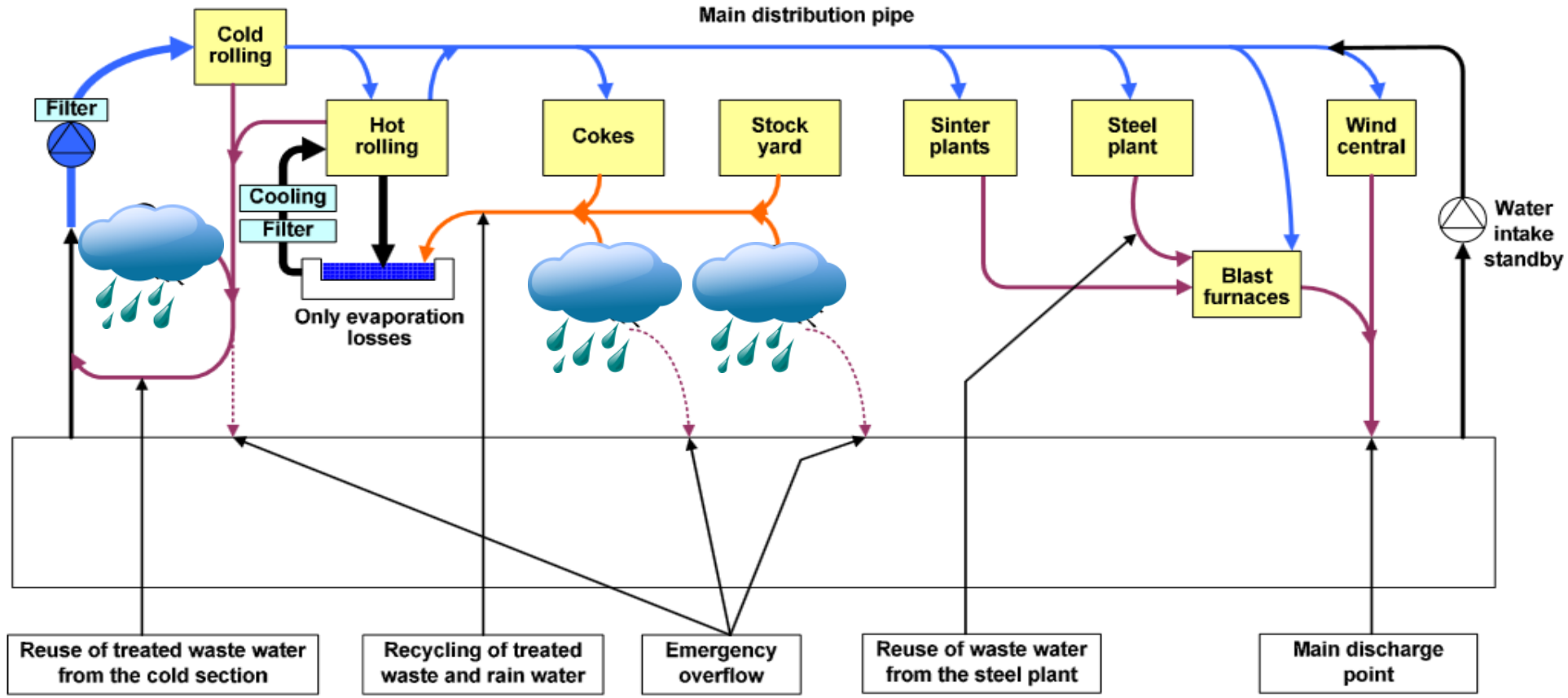
http://img.diytrade.com/cdimg/871087/8131977/-1/1235978564/Shandong_Topsky_Steel_Industry_Co_Ltd.jpg

Example for the Water Management of an Integrated Steelworks with Separate Circuits



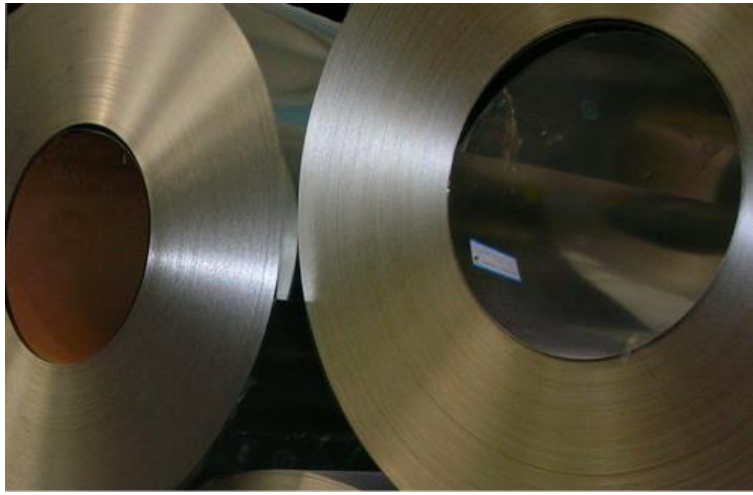
Source: Figure based on Eurofer, 2009

Example for the Water Management of an Integrated Steelworks Using a Cascade System



Source: [316, Eurofer 2009]

Techniques to Reduce Water Intake and Minimize the Amount of Discharge Waste Water



- Avoiding the use of potable water for production lines
- Increasing the number and/or capacity of water circulating systems when building new
- Plants or modernizing/revamping existing plants
- Centralizing the distribution of incoming fresh water
- Using the water in cascades until single parameters reach their legal or technical limits
- Using the water in other plants if only single parameters of the water are affected and further usage is possible
- Keeping treated and untreated wastewater separated - making it possible to dispose of waste water in different ways at a reasonable cost
- Using rainwater whenever possible

Chemical Industry

1. Basic or commodity chemicals
2. Specialty chemicals derived from basic chemicals (adhesives and sealants, catalysts, coatings, electronic chemicals, plastic additives, *etc.*)
3. Products derived from life sciences (pharmaceuticals, pesticides and products of modern biotechnology)
4. Consumer care products (soap, detergents, bleaches, hair and skin care products, fragrances, *etc.*)

- **Most of the water used by the chemical industry is for return-low applications.** The largest share is used as non-contact cooling water (about 95% of all water used by this sector).
- Only about 5% of water is used for consumptive uses, such as water in products and evaporative losses.

General Best Management Practices for Water Reuse and Conservation – Chemical Industry

1. Institute a rigorous system of water use measurement.
2. Quantify the energy losses from the use of cooling water.
3. Reduce the practice of once-through cooling water.
4. Educate employees and the public on water conservation.
5. Eliminate leaks and other inefficiencies.
6. Identify water reuse opportunities that also reduce energy consumption.
7. Continue research and development efforts focused at low energy, low water processes.

Specific Best Management Practices for Water Reuse and Conservation – Chemical Industry

1. Reduce water usage by installing multiple heat exchangers.
2. Reuse of municipal household water wastewater for use in manufacturing.
3. Adapt advanced technologies in water cleaning for more efficient water reuse.
4. Adopt Zero Liquid Discharge (ZLD).
5. Mass Integration Approach (MI).

Petroleum Refining Industry

- The processing of refining crude oil into petroleum requires the withdrawal and consumption of large amount of water.
- Water is primarily used in the production of steam and for cooling, with some water also used to remove inorganic compounds during processing.
- 12.5 gallons of water for every gallon of crude refined (King, & Webber, 2008).
- A typical refinery, according to the Department of Energy, withdraws water at a rate of 3-4 million gallons per day.

BMPs for Water Conservation -- General Practices for Companies Engaged in Petroleum Refining

1. Develop a stepwise, systematic approach to water management at facilities, and corporation-wide.
2. Think holistically about a facility, or even beyond the facility, to include the entire watershed.
3. Institute a rigorous system of water use measurement.
4. Quantify the energy losses from the use of cooling water.
5. Reduce the practice of once-through cooling water.
6. Educate employees and the public on the importance of water conservation
7. Eliminate leaks and other inefficiencies.
8. Identify water reuse opportunities that also reduce energy consumption
9. Continue research and development efforts focused at low energy, low water processes.

BMPs for Water Conservation during Petroleum Refining

1. Utilize Pinch Analysis to Determine Potential Sources of Efficiency Gains.

2. Internal Treatment and Reuse of Wastewater

3. Treatment of Cooling Water Makeup or Sidestream to Minimize the Amount of Blowdown Required

4. Design Cooling Towers to Increase Sensible Heat Transfer and Reduce Evaporative Losses.

5. Increased Use of Wastewater from External Sources for Water Supply

6. Capture and Reuse of Onsite Stormwater

http://ir.marathonpetroleum.com

Food Processing

- Water is used for the transporting, cleaning, processing, and formulating of products.
- Oftentimes water is explicitly used to meet federal sanitary requirements, limiting the prospects for process reuse and the recycling of municipal wastewater.
- It is estimated that industry-wide, the average water use is approximately 8.6 gallons of water per unit of output (Ellis, Dillich, & Margolis, 2001).
- Cost savings from water use reduction of 15-30% can be achieved, with attractive returns on investment.

http://www.marketresearchreports.com

General BMPs for Water Conservation during Food Processing

1. Reducing the Driving Force for Mass Transfer
2. Local Recycling
3. Non-water-based operations
4. Better Process Control and Optimization
5. Avoiding the Once-through Use of Utilities
6. Better Production Scheduling
7. Better or Different Equipment Design
8. Monitoring
9. Imptrving Energy efficiency

http://www.clientsfirst-us.com/food-processing.php

Specific Best Management Practices for the Food Industry

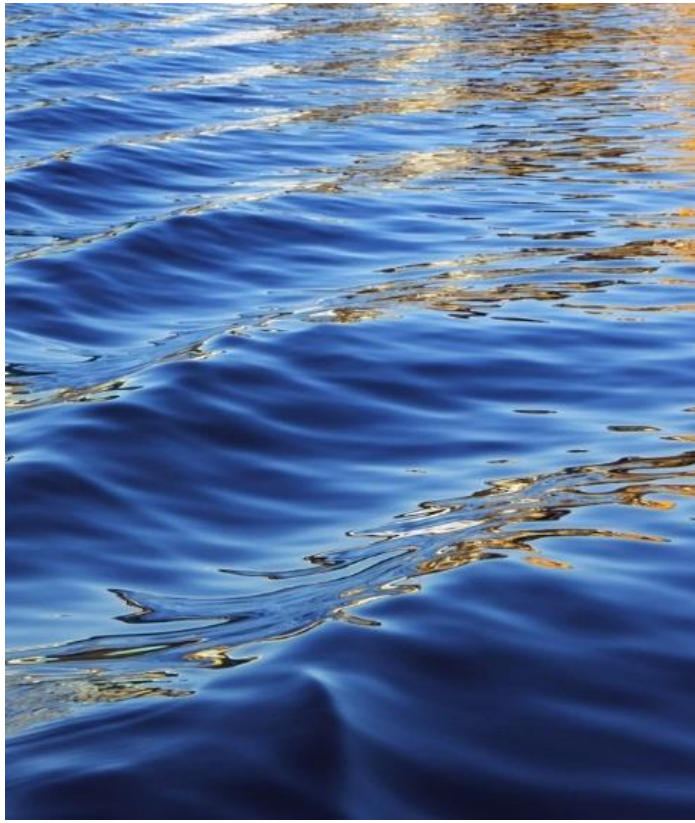
- Where feasible, re-chlorinate and recycle transport water.
- For product transport use conveyor belts. Preferably, use "rabbit-ear" or V-shaped roller supports that are easier to clean.
- Where feasible, use pneumatic conveying systems.
- Instead of flat bottom troughs, use flumes with parabolic cross-sections.
- Optimize depth of product on conveyors for maximizing wash water efficiency.
- Establish optimal nozzle size and pressure.
- Replace eroded and non-functional nozzles.
- Split spray wash units into two or more sections, and establish a counter-flow reuse system.
- Control belt sprays with a timer to allow for intermittent application of chlorinated water.
- Consider installation of soaking units where indicated.

Investigate the use of these alternatives in water-intensive units:

1) rubber-disc scrubbing units instead of raw product cleaning and peeling
2) steam vs. water blanchers
3) evaporative coolers instead of water-cooled systems.

Agriculture

Crop per Drop



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Introduction

- Crop per Drop - Water productivity (WP) for agricultural operations equates to the net return of food for a unit of water used.

EVERY DROP MATTERS

Regulatory Programs - Federal

- United Stated Department of Agriculture - National Resource Conservation Service (NRCS)
  - considered by many as the leading Federal agency for assisting in restoring watershed health
- USEPA is mostly concerned with protecting water resources from contamination and discharge
  - Animal Feeding Operations
  - Aquaculture Projects
  - Concentrated Aquatic Animal Production Facilities
  - Biosolids and Agriculture
  - Nonpoint Source Pollution and Agriculture
  - Estuaries and Agriculture
  - National Coastal Water Program and Agriculture
  - Oil Spill Prevention, Control and Countermeasures (SPCC) Plan and Agriculture
  - TMDLs and Agriculture
  - Wetlands and Agriculture
- The Food and Drug Administration is primarily concerned with water within the area of food safety and hygiene.

Regulatory Programs - State

- Ohio Department of Natural Resources (ODNR)
  - the lead state agency regarding water withdrawal notifications for agricultural operations.
- Ohio EPA
  - Like the Federal EPA the Ohio EPA is also active with water management approaches for agricultural operations.
- The Great Lakes Compact
- The Ohio Farm Bureau

Best Management Plans: Approaches, Tools & Technology

Laser Leveling

- Many growers are leveling their fields to improve irrigation efficiency and reduce soil erosion by controlling the velocity of the irrigation water they apply. By making the field uniform in slope, the grower will know when to cut off irrigation water and have no tail water exit the field.

Tail Water Returns

- Some growers with large integrated operations collect their tail water for reuse on the next field in line. All the water is eventually recirculated, and they enjoy very high irrigation efficiency.

Conversion to High Efficiency Systems

- Many growers have or are in the process of converting to drip or micro sprayer irrigation systems, which run according to the crop cover usage. These systems deliver water directly to each plant and have minimal risk of runoff issues.

Irrigation Scheduling

- With water being a major cost to growers, the application of water exactly when the crop needs it and in the amount needed is becoming more important. In addition, water stress is a great management tool for certain crops to spur plant growth in certain directions (more reproductive growth, less vegetative). Many growers take advantage of irrigation practice review services that give irrigation uniformity evaluations and tips for better management.

General BMPs

- Best Management water withdrawal and use practices for agricultural operations are wide ranging and difficult to bound.
- On-Farm and Water District Delivery Systems (withdrawal and staging), Cropping Practices, Animal feeding operations, and Land Management.

Watercourse Improvement

LASER Land Leveling

Drip Irrigation

General BMPs (cont.)

- On-Farm Water Delivery Systems BMPs:
  - lining of on-farm irrigation ditches and replacement of on-farm irrigation ditches with pipeline
  - Low Pressure Center Pivot Sprinkler Irrigation Systems for irrigation of land with flat to modest slopes
  - Drip-Micro Irrigation Systems for more efficient irrigation
  - Gated and Flexible Pipe for field water distribution
  - Surge Flow Irrigation to apply irrigation water to furrows to aid in reduction of deep percolation
  - Linear Move Sprinkler Systems for more efficient irrigation of certain shaped field and/or fields with elevation changes.





General BMPs (cont.)

- Land Management Systems BMPs:
  - Furrow Dikes to reduce water runoff from agricultural row crops
  - Land Leveling to increase the uniformity with which water is applied to an irrigated field
  - Conversion of Supplemental Irrigated Farmland to Dry-Land Farmland which uses rainfall to irrigate agricultural lands
  - Brush Control/Management to reduce evapotranspiration in order to improve water quality and water yield.

- In Water District Delivery Systems:
  - Lining or replacement of the irrigation canals with pipeline improves efficiency and reduces or eliminates seepage
  - Facilitating conveyance of water to a group of users.
  - Tailwater Recovery and Reuse Systems, which make use of the irrigation water that runs off the end of an irrigated field

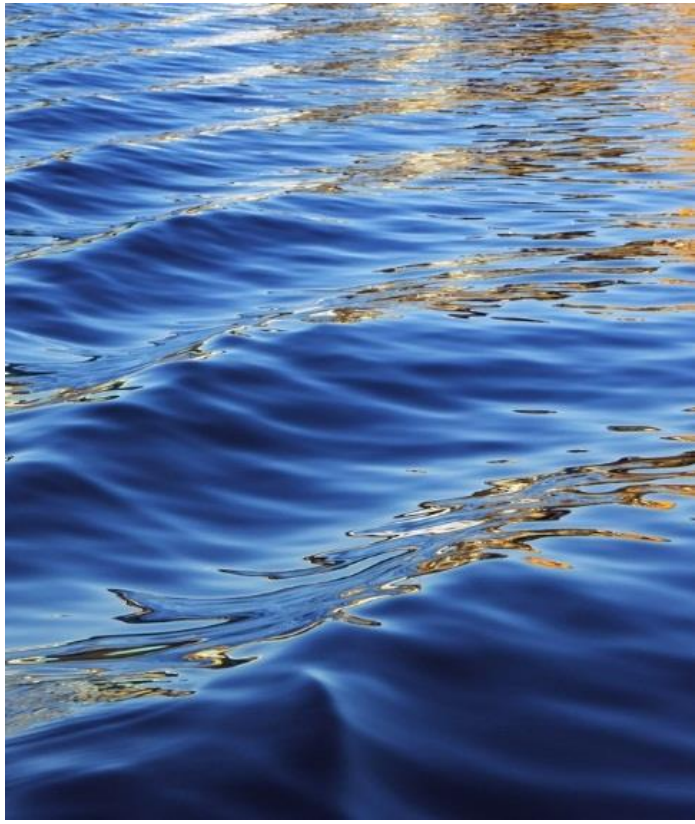
Location Specific Approaches

- USDA – National Resource Conservation Service delivers conservation technical assistance through its voluntary Conservation Technical Assistance Program (CTA).

  - Reduce soil loss from erosion
  - Solve soil, water quality, water conservation, air quality, and agricultural waste management problems
  - Reduce potential damage caused by excess water and sedimentation or drought
  - Enhance the quality of fish and wildlife habitat
  - Improve the long term sustainability of all lands, including cropland, forestland, grazing lands, coastal lands, and developed and/or developing lands
  - Assist others in facilitating changes in land use as needed for natural resource protection and sustainability

Golf Courses, Amusement Parks and Other Recreation Facilities

Best Management Practices



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Golf Course Water Use

- Average US golf course uses 312,000 gallons of water PER DAY for irrigation in temperate climates
  - 1 million+ gallons per day in arid climates
  - Each day, uses water supply for a family of four for four years
- In US, 2 billion gallons of water PER DAY used to irrigate turf grass on courses

http://parks.ohiodnr.gov/things-to-do/golf/salt-fork-golf-course

Regulations for Golf Courses

- Subject to water quality and storm water requirements under Clean Water Act
- Some states add requirements, particularly those in arid climates
  - Some require use of lowest quality water or recycled/treated water for irrigation

http://controlledpumpservices.com/golf-course-irrigation/

http://www.purewatergazette.net

Golf Course BMPs

- Integrated approach that emphasizes working with nature
- Includes strategies:
  - Design of course to retain rain water or reduce amount of turf grass to reduce irrigation
  - New grasses bred to require less water
  - Reduced use of chemical pesticides and herbicides reduces use of water
  - Weather monitoring and computerized irrigation systems reduce over-watering


http://themeconstruction.net/golf-course-water-conservation/

Water Source Management on Golf Courses

- Majority of water from on site from lakes and irrigation ponds or wells
- 37% of courses in southwest use recycled/reclaimed/effluent water
  - Grey water most dominant
  - Effluent from public wastewater treatment plants can be used on courses for irrigation with careful management

http://www.usga.org/Course-Care/Golf-and-the-Environment/Water/Golfs-Use-Of-Water//

Water Theme and Amusement Parks

- Ohio's 150+ theme parks withdrew more than 62 million gallons from surface and groundwater in 2012
- Water theme parks are basically large "swimming" pools
- BMPs operate systems to retain 98% of the water, with only 2% leaving the system due to evaporation or discharge

New Strategies

- State of the art practice is to reduce the use of chlorine for treatment of water that cycles through the water park system.
  - Micron filtration, carbon filtering, moss filtration
  - Alternative techniques reduces need for flushing systems or discharging splashback, saving water
  - Key aspect of BMPs when water is purchased from public water systems

BMP "Gaps"

Management Framework

New concepts

-Resilience

-Valuation/pricing

-Efficiency

-Integration/Linking

Administrative Needs

1. **Data/Monitoring**
2. **Regulations/Guidelines**
3. **Planning Activities**
   - -Basin
   - -State
   - -Regional
   - -Municipal
   - -Economic Sectors

SUMMARY & RECOMMENDATIONS FOR NEXT STEPS

Water Withdrawal Regulations

- Adjust withdrawal thresholds to meet recommendations of advisory board and bring Ohio into alignment with other GL states
- Use science-based approach to set withdrawal thresholds to ensure no cumulative adverse impacts to ensure "environmentally sound" water conservation measures.

State Level Water Planning

- Need to be updated and based on demand management model rather than increasing access/supply

Local/Regional Water Planning

- Encourage integrated approach to water management across all sources and uses of water; on a watershed basis; e.g. balanced growth program, Chagrin River
- Encourage/require regional water management plans, tie into local land use planning


http://news.yourolivebranch.org

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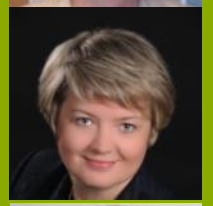
Questions or Comments

Photo Source: http://www.surfexcel.in/kids-activities/how-to-help-tackle-indias-water-pollution-problem-at-home/attachment/grass_with_water_drop_10669171/

Prepared for:
Ohio Lake Erie Commission

Ohio Department of Natural Resources (ODNR)



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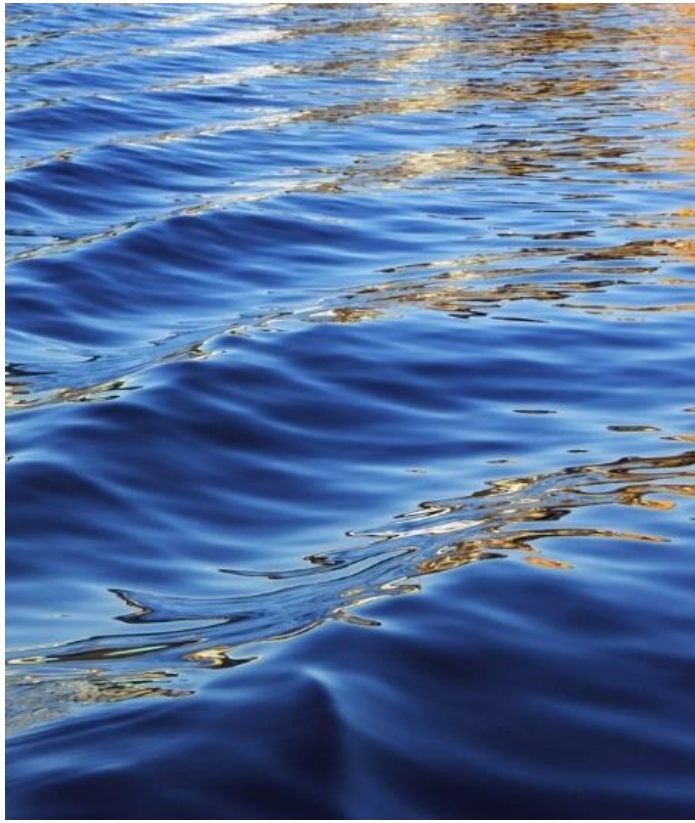
Appendices



Water Use by Primary Use of facilities

Rank	Primary use of facilities	Number of companies	Ground water	Surface water	Total water	Percent of water use
1	POWER	14	-	10,338,938.1	10,338,938.1	74.1%
2	PUBLIC	189	144,645.3	2,317,075.7	2,461,721.0	17.7%
3	INDUSTRY	55	32,243.3	774,492.0	806,735.4	5.8%
4	MINERAL EXTRACTION	73	183,688.2	34,929.4	218,617.6	1.6%
5	AGRICULTURE	175	8,019.2	37,788.7	45,807.9	0.3%
6	MISC	51	3,530.8	35,348.7	38,879.5	0.3%
7	GOLF COURSE	172	7,814.4	27,965.6	35,780.1	0.3%
Total		729	379,941.3	13,566,538.1	13,946,479.5	100.0%

Example of a Website with Step-by-Step Directions

http://www.edaincubatortool.org/toolkit.html

Home

Practitioner's Toolkit

Published Materials

Research Team

Benchmark Your Incubator Management Practices

–

and Access Tools for Continuous Improvement

Dedicated incubation professionals are always looking for ways to enhance their program's effectiveness and efficiency. This online tool, based on research funded by the U.S. Department of Commerce Economic Development Administration, will provide incubator managers with the input they need to do just that. Using this tool, incubation practitioners can measure their program's performance compared with the business incubation practices deemed most important to client success, as well as receive feedback on how to improve their program's operations.
Use this tool to:

- Evaluate your incubation program's performance in correlated best practice areas
- Discover your incubation program's areas of excellence
- See where your program can improve
- Learn more about incubation best practices and how to achieve them

How to use this tool

- Click on "Practioners Toolkit" below to start.
- Answer each question and then click on "Submit Answer." The box to the right of the question will display information that explains why a particular practice is important and provides links to resources that will help you improve in this area.
- To proceed to the next question, click on "NEXT." You must click on "Submit Answer" before you can go on to the next question. You can go back to previous questions by clicking on "PREVIOUS."
- When you finish the tool, you will be able to create a PDF copy of the report. The toolkit **does not** save your responses, so it's important to create this PDF report for your records and further review.

Click here to begin using the Practitioner's Toolkit.