THE TANSTAAFL PRINCIPLE: SECONDARY IMPACTS OF WATER CONSERVATION EFFORTS

NEWEA 2017 ANNUAL CONFERENCE & EXHIBIT
BOSTON, MA

RAMBOLL ENVIRON

NEW ENGLAND WATER ENVIRONMENT ASSOCIATION
NEWEA
WORKING FOR WATER QUALITY

TOPICS FOR DISCUSSION

- Drivers and Methods for Water Stewardship
- What is the Tanstaafl Principle?
- Trading Quantity for Quality
- The Water-Energy Nexus
- Trans-Media Impacts

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RISK DRIVERS FOR WATER EFFICIENCY

- Economics
- Community “License to Operate”
- Physical Scarcity / Competing Interests
- Brand Reputation – Customers, Consumers, Community
- Corporate Reporting of Material Risks
- Regulatory Constraints

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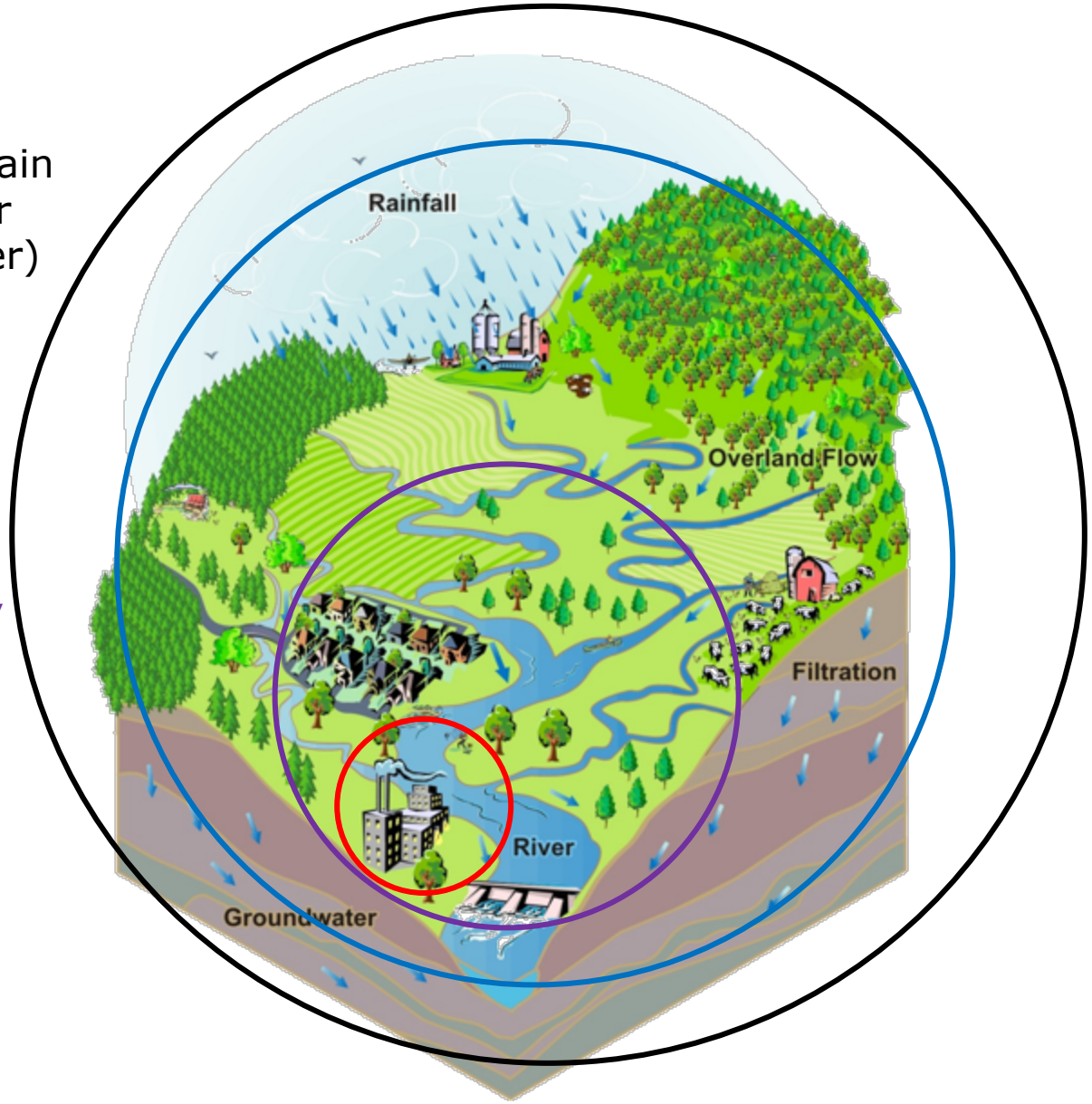
EXPANDING WATER STEWARDSHIP

Life Cycle
(Supply Chain
+ Producer
+ Consumer)

Watershed

Community

Facility



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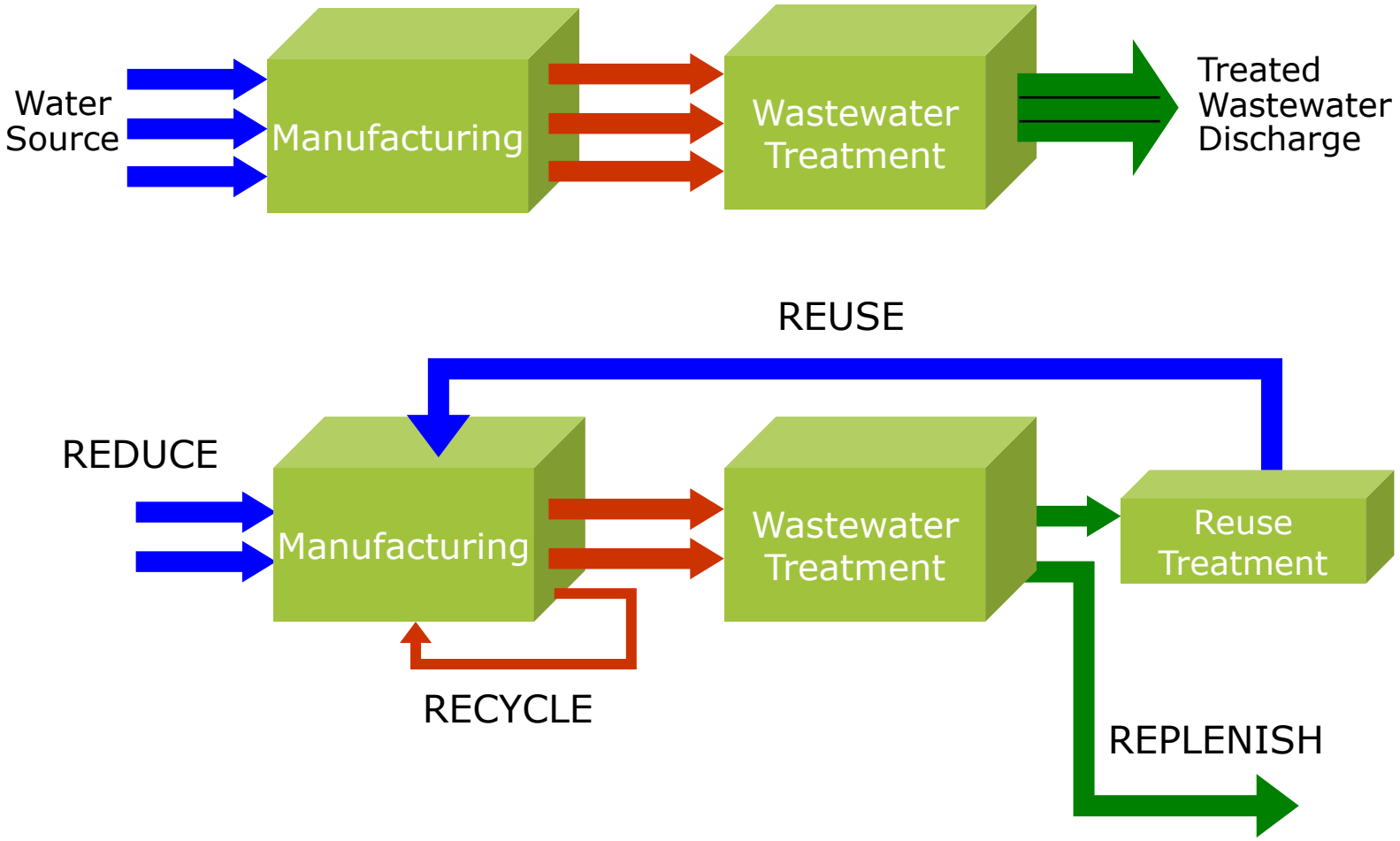
THE FOUR "R"S OF WATER EFFICIENCY



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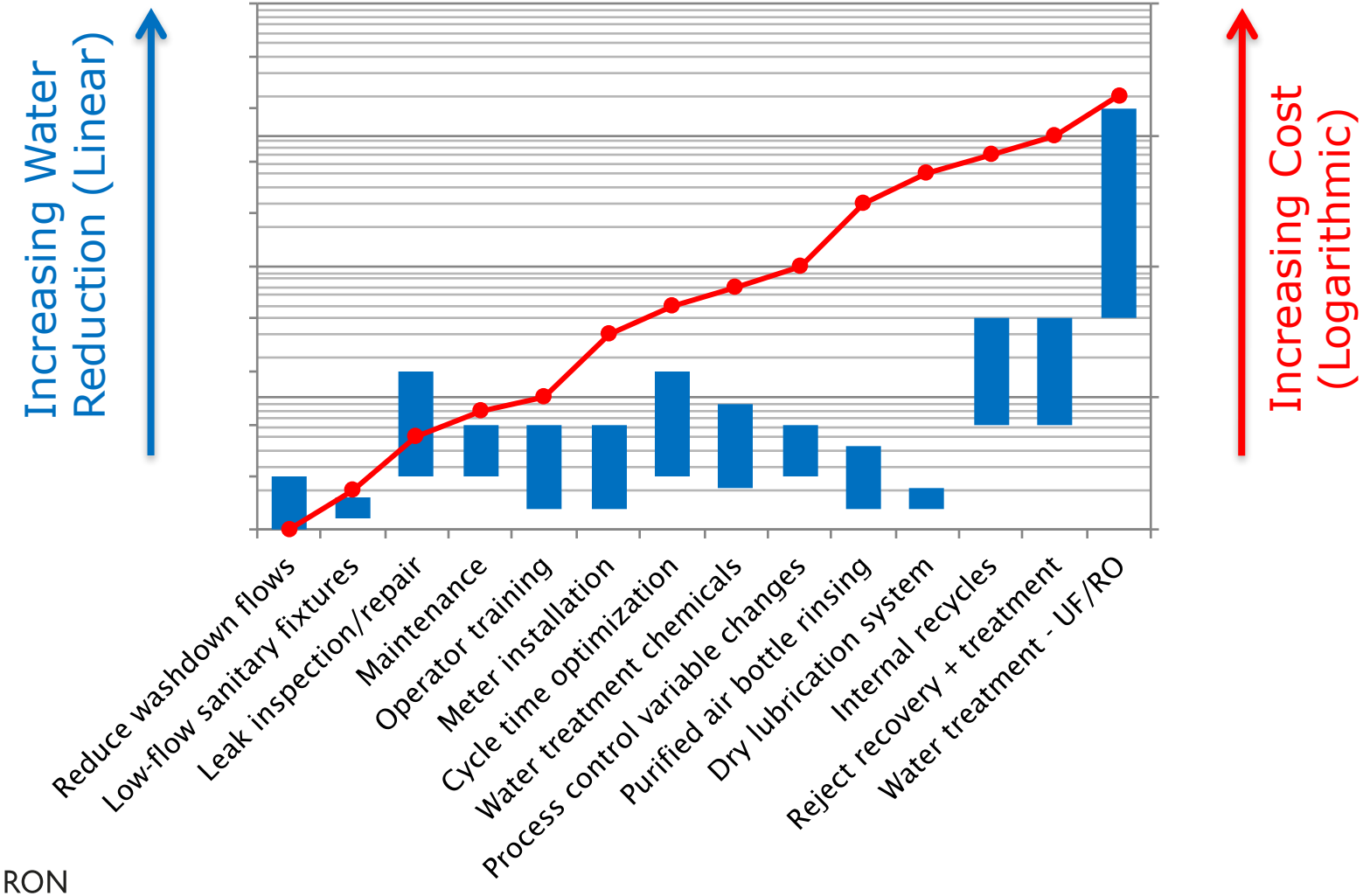
DETERMINING WATER "QUALITY"

- General chemistry
  - pH
  - Conductivity/TDS/Salt
  - TSS
- Process-specific chemistry
  - Organics
  - Metals
  - Other QA/QC constraints
- Parameters for recycle technologies
  - Cations/anions
  - Scaling potential
  - Silt Density Index

CATEGORIZING WATER REDUCTION EFFORTS

- Behavioral Reductions
  - Housekeeping/Maintenance
  - Employee Training/Buy-In
- Procedural Reductions
  - Metering
  - Process Controls
- Mechanical Reductions
  - Low-Flow/No-Flow Processes
  - End-of-Pipe Water/Wastewater Recycle

WATER REDUCTION COST-BENEFIT ANALYSIS



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THE TANSTAAFL PRINCIPLE

- There Ain't No Such Thing As A Free Lunch

- Water savings will have impacts on other operations

THE WATER-ENERGY NEXUS

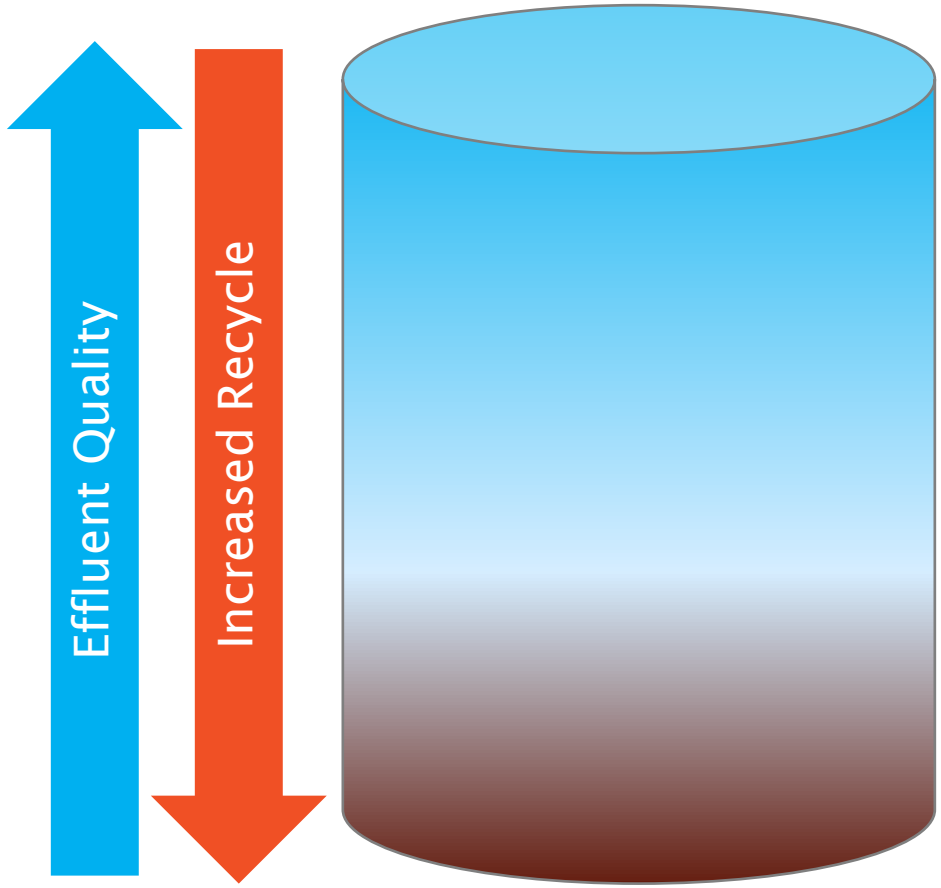
- Energy required for water transport, recovery, and treatment
  - Pumps
  - Cooling tower fans
  - Evaporation/condensation
- Energy to water ratio increases with higher water quality, recovery, or recycle
- Low-energy alternatives may also carry higher water demand
  - Low-energy data centers
  - Roof cooling technologies
  - Cooling towers vs. chillers

EXAMPLE ENERGY/WATER RATIOS

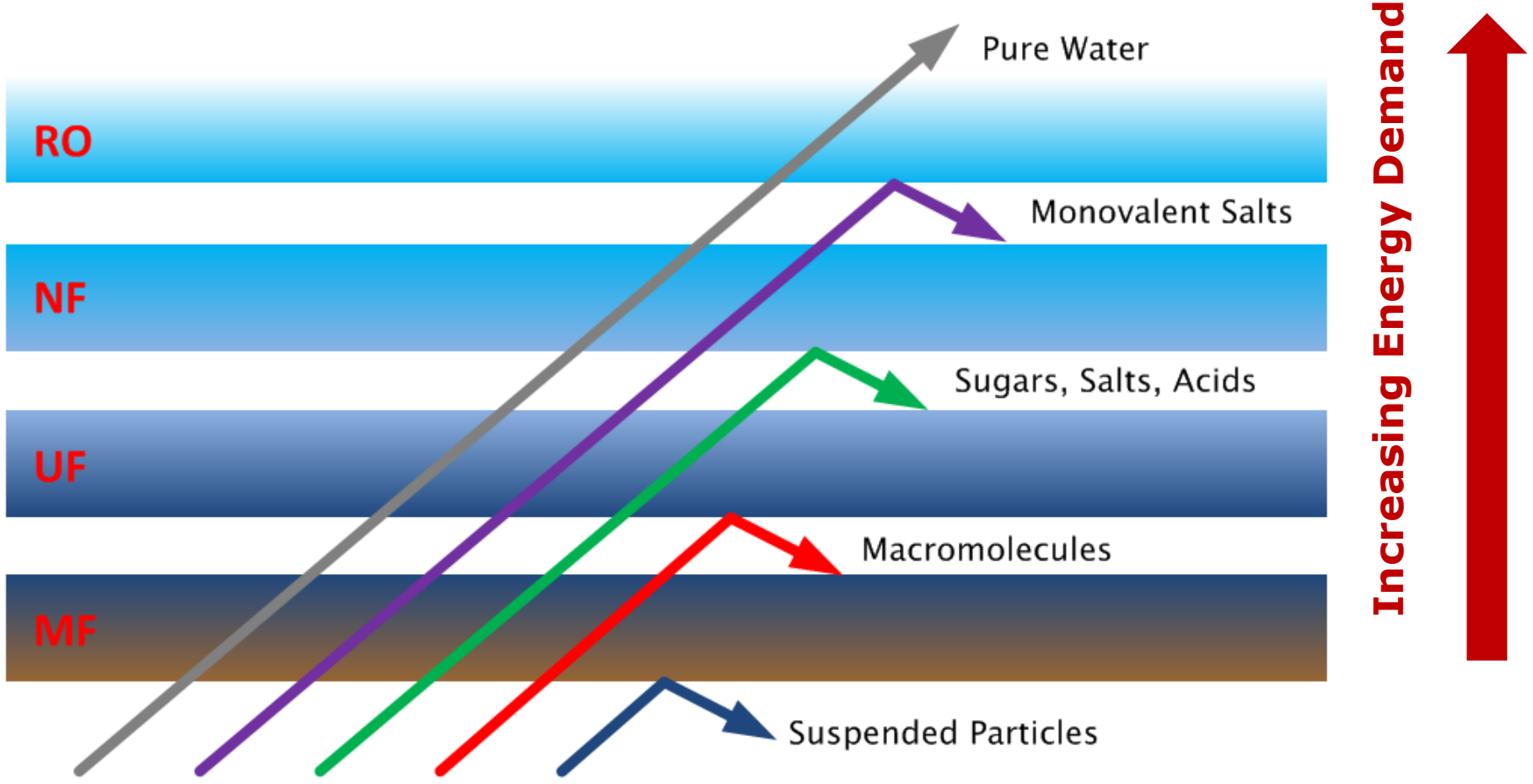
Project Type	Energy/Water Ratio (kWh used per 10^6 gal saved)
High-Efficiency Sanitary Fixtures	May save energy
Xeriscaping	May save energy
Cooling Tower Optimization	200-300
Cooling Towers to Replace Single-Pass	500-700
End-of-Pipe Wastewater Recycle	1,000-1,500
Demineralization (Reverse Osmosis)	6,000-10,000

TRADING QUANTITY FOR QUALITY

- Water reduction inherently impacts wastewater quality
  - Residual organics (BOD, TOC)
  - TDS (salt)
  - Heavy metals
  - Suspended solids
- Additional treatment or pretreatment may be needed
- Quality changes may impact existing treatment
  - Chemical usage rates
  - Solids removal
  - New unit processes



THE WATER-ENERGY NEXUS & WATER QUALITY



IN-PLANT IMPACTS

- Higher concentrations of acidity/alkalinity
  - Corrosion
  - Scaling
- High concentrations of solids/bacteria
  - Fouling
- Higher concentrations of salt/TDS/chloride
  - Corrosion
- May require additional pretreatment steps
  - Neutralization
  - Softening
- May require MOC changes
  - HDPE/PVC vs. Cu/steel

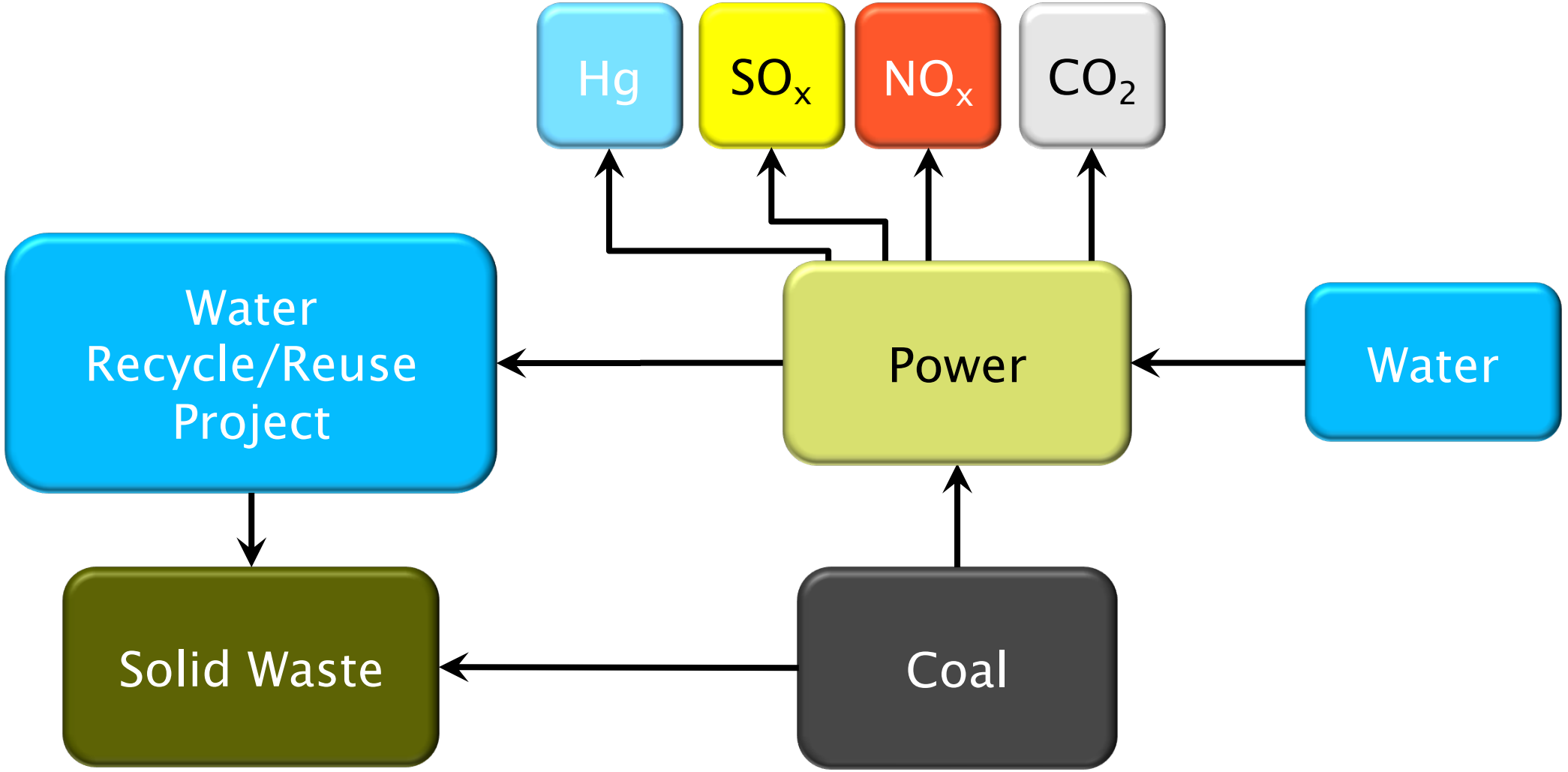
INDIRECT DISCHARGE IMPACTS

- Higher concentrations of materials subject to surcharge
  - BOD
  - Total Suspended Solids
- Higher concentrations of materials subject to pretreatment limits
  - Heavy Metals
  - Toxic Organics
  - Micropollutants
  - Pass-Through Interferences

END-OF-PIPE IMPACTS

- NPDES Compliance
  - Individual Parameters
- Whole Effluent Toxicity - aggregate impacts of increased dissolved solids
  - Alkalinity/hardness
  - Chloride toxicity
- Temperature
- Refractory organic compounds
- Micropollutants

TRANS-MEDIA IMPACTS



CASE STUDY ON TRANS-MEDIA IMPACTS

- Food processing facility – Michigan
- WWTP effluent tertiary treatment concept design
  - 1.7 mgd design flow
  - Cartridge filtration
  - Reverse osmosis (75% recovery)
  - Brine concentrator/crystallizer on RO reject
- Estimated capital cost $36 million
- Estimated O&M cost $1.4 million/year
  - ~70% of O&M cost as electricity

CASE STUDY ON TRANS-MEDIA IMPACTS

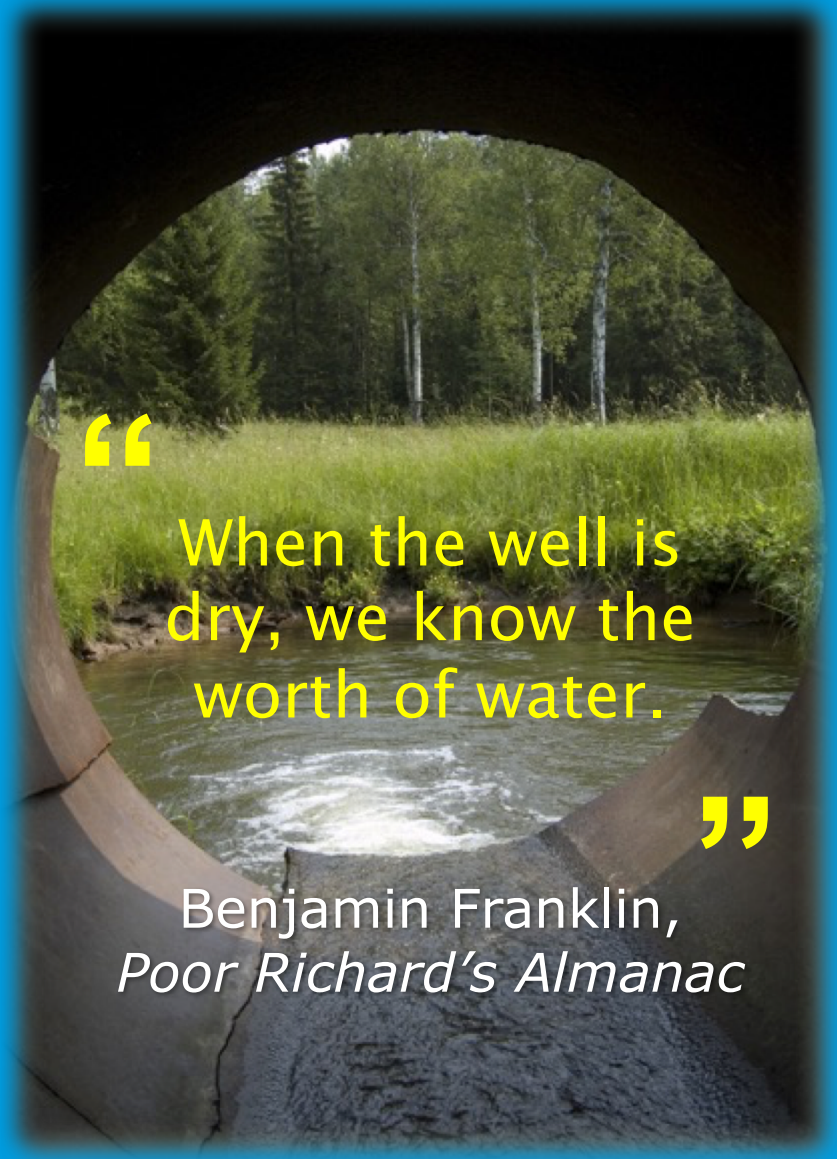
Parameter	Quantity
Solid Waste	
Solid Waste Generation	8,000 dry tons/yr
Equivalent Landfill Space	20,000 yd^3/yr
Power Required	13,500 MW-hr/yr
Equivalent Air Emissions[1]	
CO_2	14,900 tons/yr
SO_x	350 tons/yr
NO_x	27 tons/yr
Hg	2.8 lb/yr

1. Based on typical emissions factors for coal-fired power plant.

THE SEVEN HABITS OF HIGHLY EFFECTIVE WATER STEWARDSHIP

- **Be Proactive** – collect data
- **Begin With the End In Mind** – set appropriate reduction goals
- **Put First Things First** – set priorities on reduction efforts
- **Think Win-Win** – optimize plan for all stakeholders
- **Seek First to Understand** – consider secondary impacts
- **Synergize** – use a holistic approach
- **Sharpen the Saw** – continuously revisit data and revise goals

THANK YOU – QUESTIONS?



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