



Socioeconomic Aspects of Wastewater Treatment and Water Reuse

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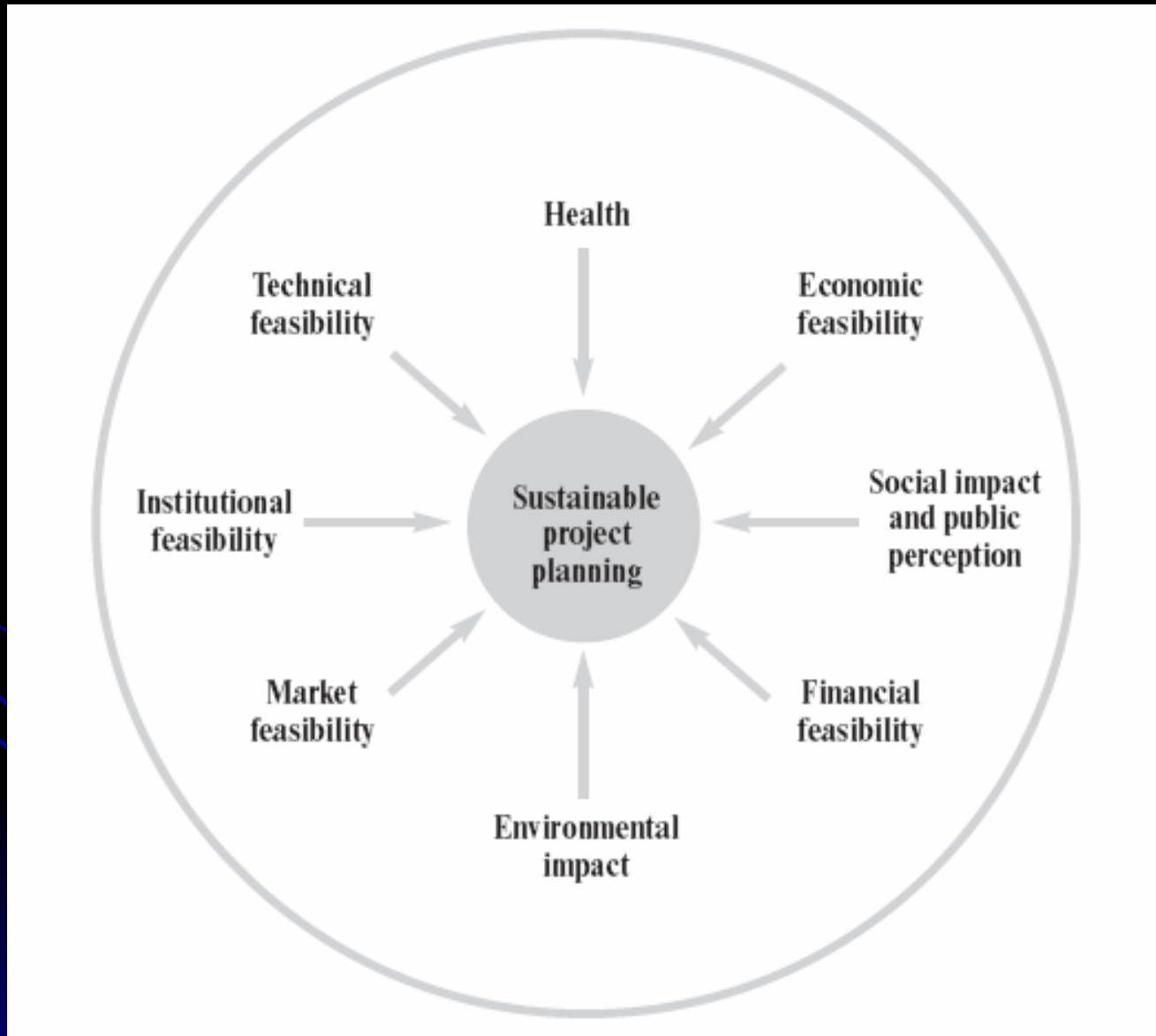
30 October 2006

Amman, Jordan

SOCIOECONOMIC ASPECTS

- Recognizing the Full Value of Water
- Public Perceptions of Water Reuse
- Quality of Treated Water and Costs of Treatment
- Pricing Recycled Water
- Interagency Collaboration and Agreements
- Climate Change
 - Global Warming
 - Energy Intensity
 - A Moral Issue
- Integrated Water Resources Planning and Management = Sustainable Planning...

Wastewater Treatment, Water Reuse



Source: WHO

Value of Water

- Vital for All Life

- Yet, Water Is Taken for Granted:

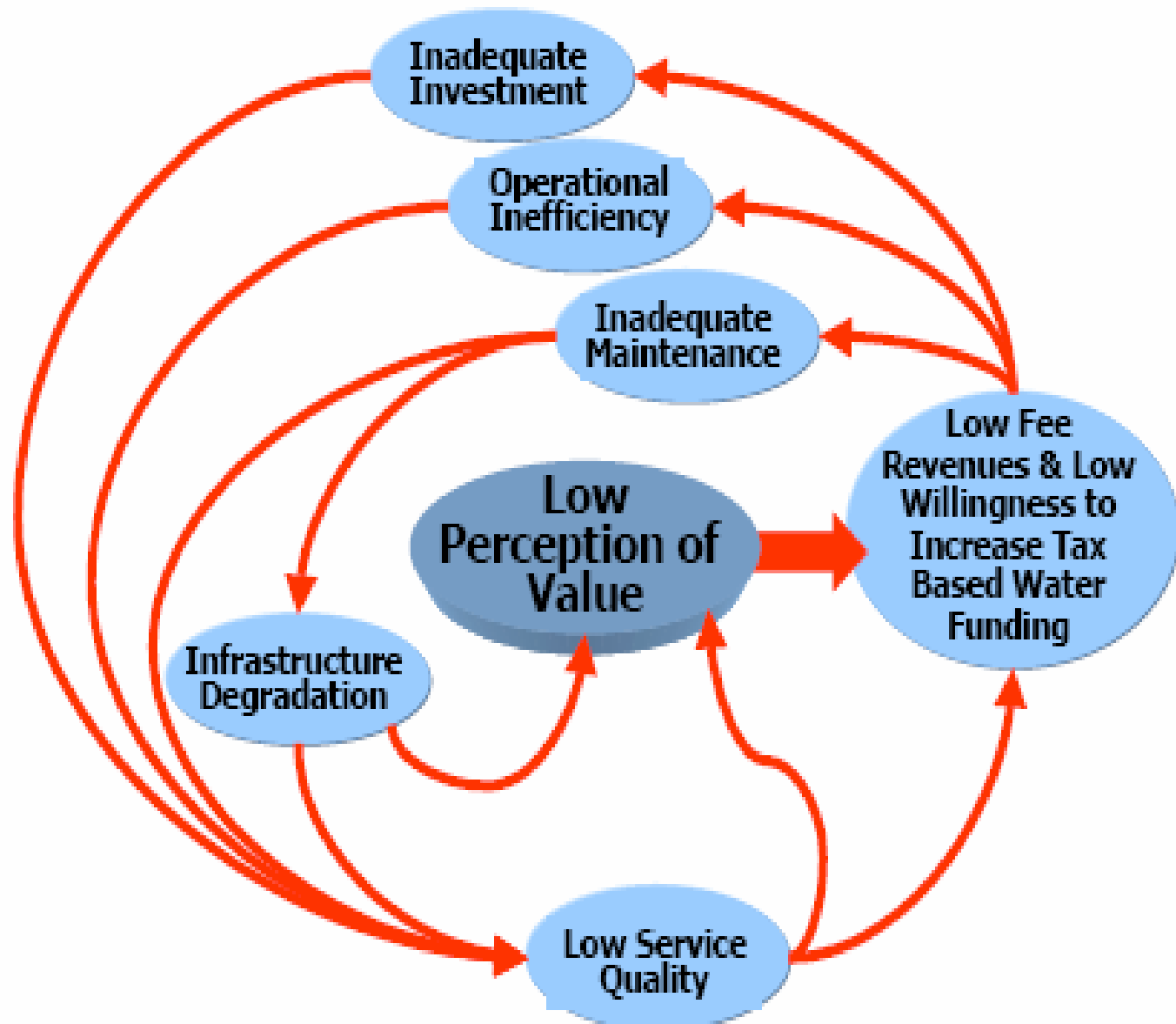
“Can somebody answer me the question why?”

You don't miss your water till the well runs dry”

Value of Water

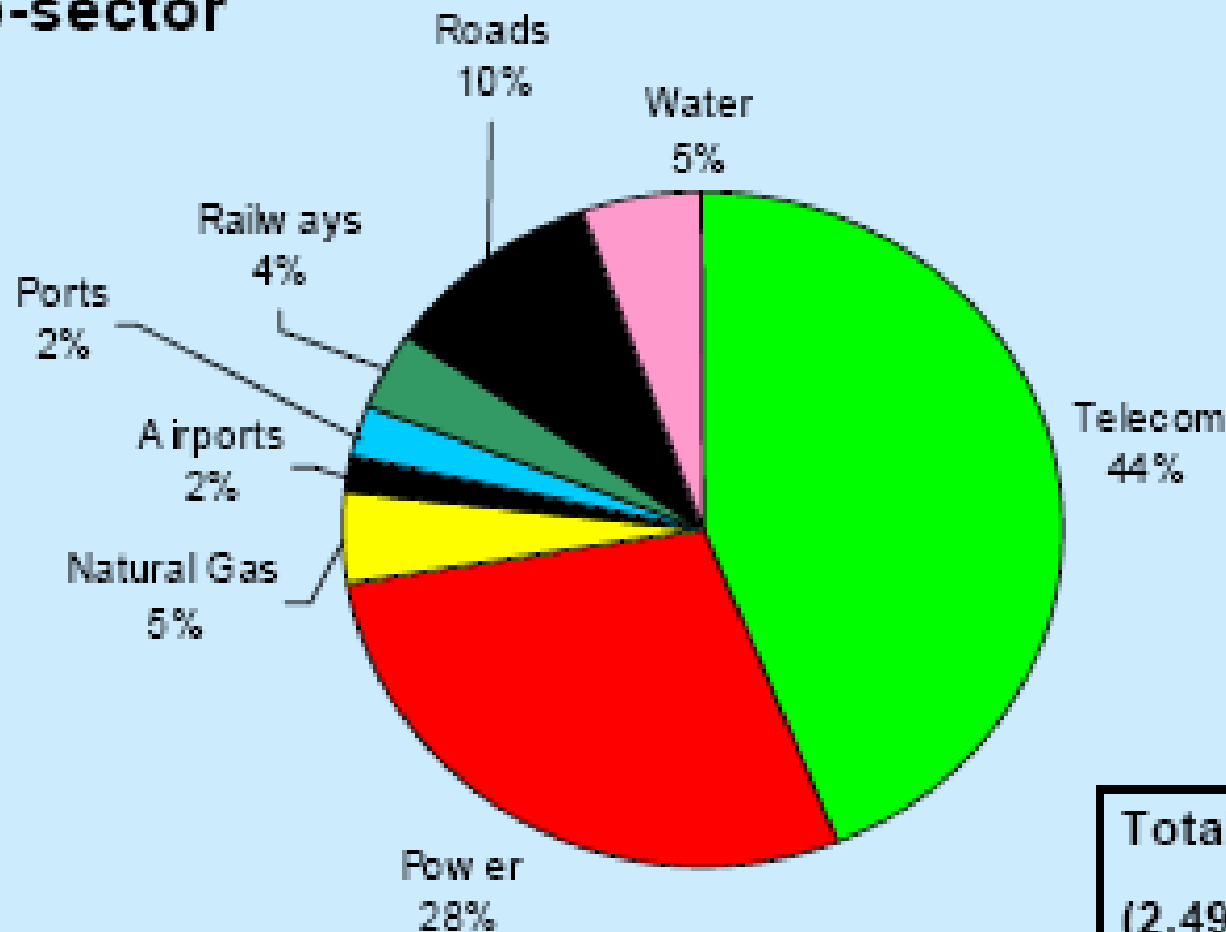
- Water Is Life
 - Yet, Water Is Considered “A Gift of God”
 - Therefore, It Is Free—or Nearly Free
 - Because It Is Cheap, Water Is Undervalued
- Water Is Wasted
- Infrastructure Investment Is Inadequate
 - Efficiency of Use of Water Is Very Low
 - Water Becomes More Scarce and of Lower Quality

The Vicious Spiral of Low Funding



Only 5% of private investments directed to water sector

By sub-sector



Total: \$754.1 bn
(2,493 projects)

Source: World Bank PPI Database

Value of Water

- Environmental Values
- Social Values
- Public Health Values
- Economic Values
- Production (Including Agriculture and Product Use Values)
- Political Values

What People Want with Water

Availability "I MUST have water"

Reliability "I NEED a regular water supply"

Cost "I want my water to be cheap"

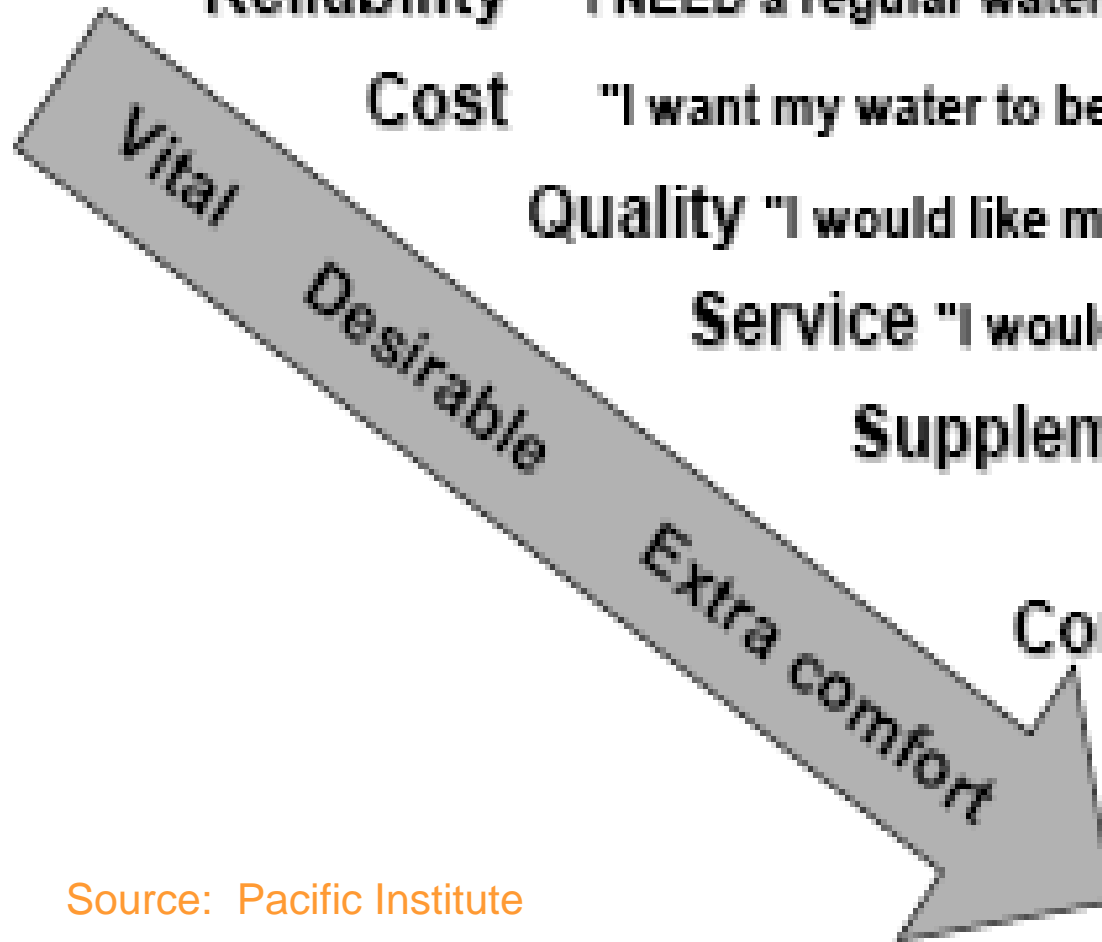
Quality "I would like my water to be good quality"

Service "I would like to have improved service"

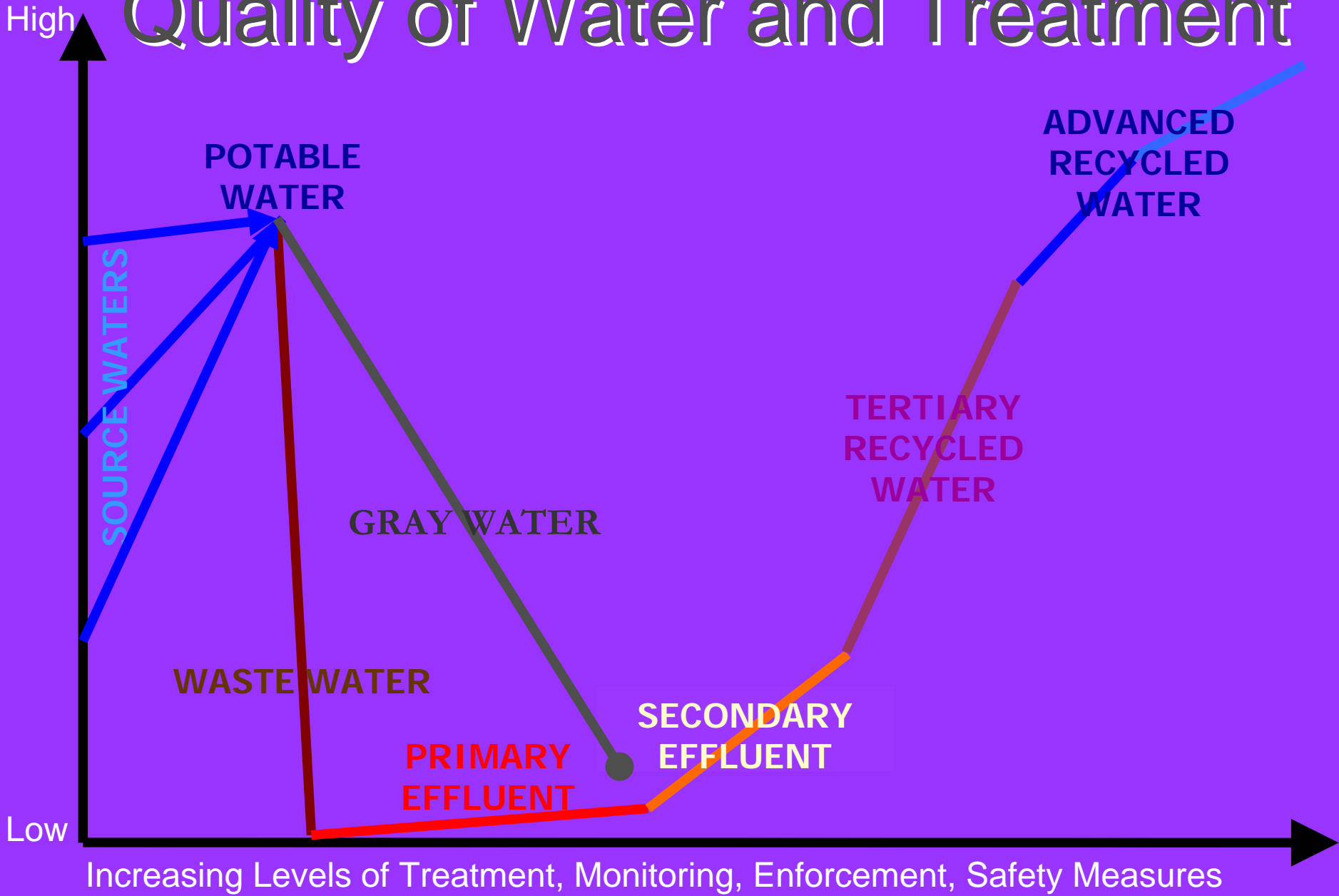
Supplementary Service "I would like something extra"

Conscience "I am concerned for the environment"

Choice "I would like to choose supplier"



Quality of Water and Treatment

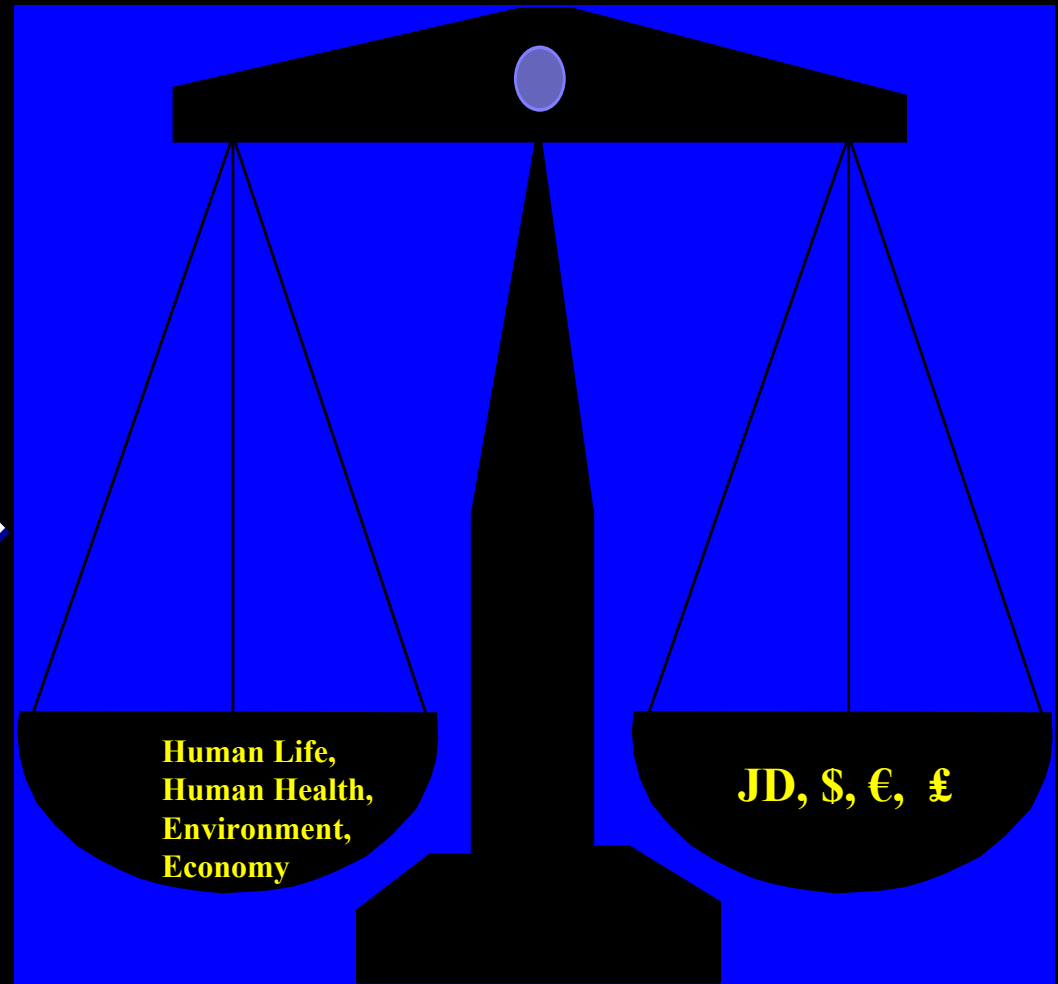


A Delicate Balance!

- Human Life
- Human Health
- Environment
- Economy



- Risk Reduction
versus
- Cost



Treatment Costs

- Costs Vary Widely with Locality and Level
- Primary Treatment
- Secondary (Ponds, Mechanical)
 - Secondary + Disinfection
- Tertiary
 - Filtration
 - Nitrogen and/or Phosphorus Removal
 - Tertiary + Disinfection
- Advanced
 - Micro, Nano, Ultra-Filtration Membranes
 - Reverse Osmosis Membranes
 - MF + RO + Advanced Oxidation + Disinfection

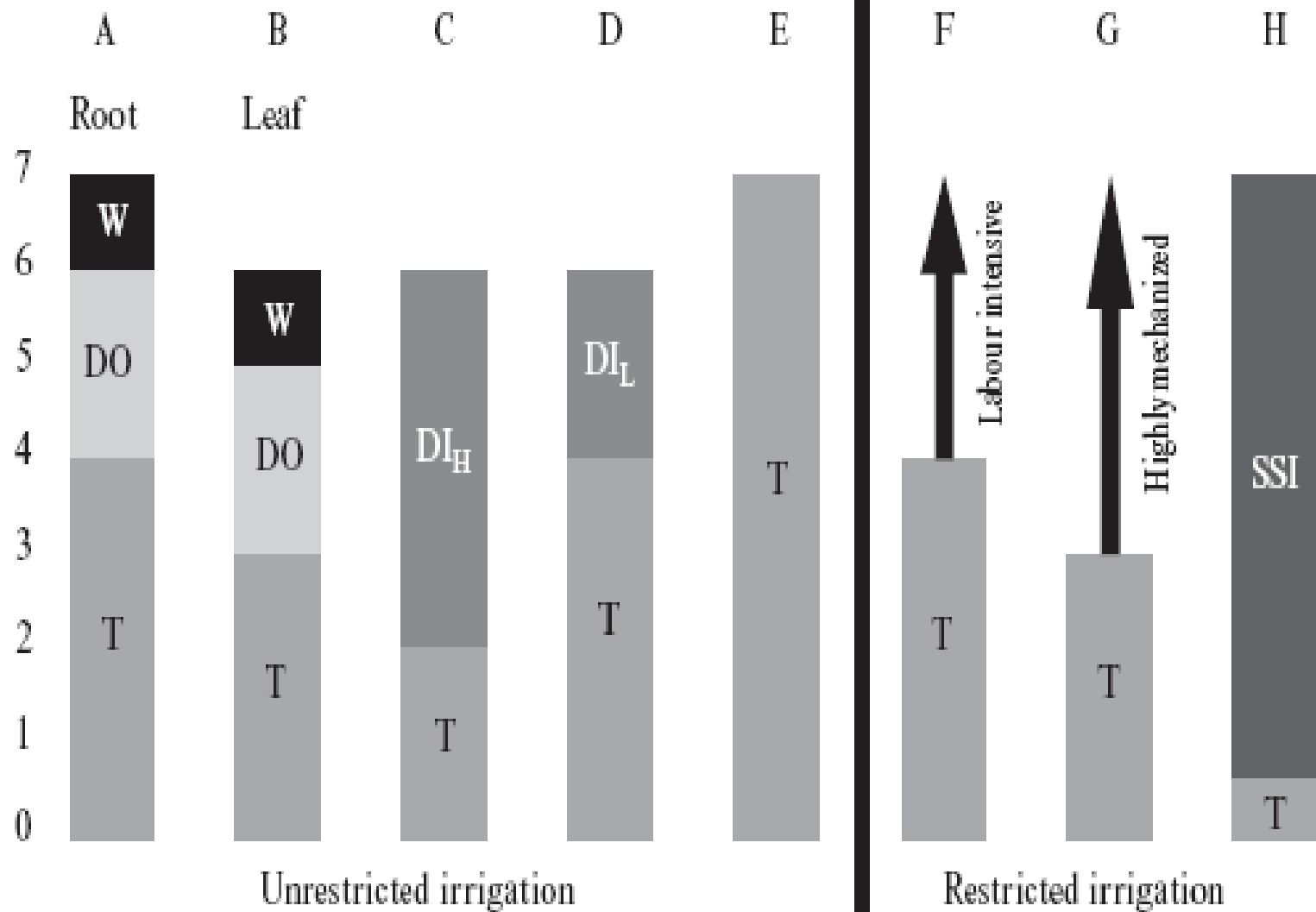
Treatment Cost and Energy Intensity

Treatment Process	Cost, \$M (5000 m³/d)	kWh/m³
Membrane Bio Reactor (MBR)	32	2.03
MBR + N removal	65	2.59
Extended Aeration	17	1.13
Extended Aeration + N removal	42	1.13
Activated Sludge BILOAC®	18	0.65
Sequencing Batch Reactor (SBR)	20	0.97

Treatment Cost and Energy Intensity, Cont.

Treatment Process	Cost, \$M	kWh/m³
Oxidation Ditch	22	0.97
Trickling Filter	18	0.57
Rotating Biological Contactor	18	0.49
Packed Bed Pods	33	0.65
Pond Systems	15	0.65
Air Diffusion	19	0.65

Log₁₀
pathogen
reduction



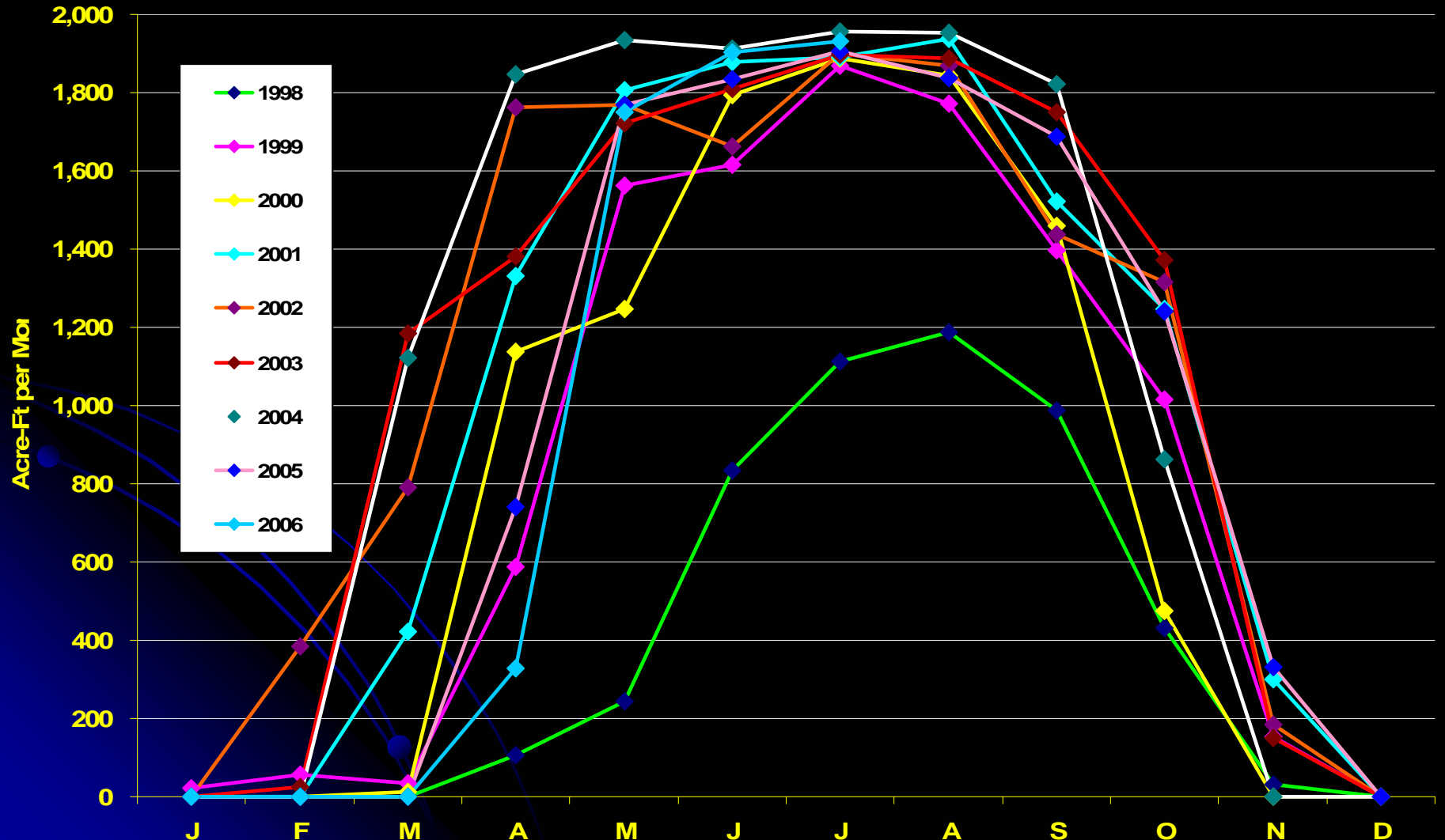
Source: WHO

T = Treatment DO = Die-off W = Washing of produce
DI = Drip irrigation (H = High crops; L = Low crops) SSI = Subsurface irrigation

Additional Costs of Water Reuse

- Transmission
- Distribution, Application
- Daily Storage
- Seasonal Storage
- Long-Term Storage
- Monitoring
- Record Keeping
- Reporting (Regulatory, Public)

SEASONAL USE OF RECYCLED WATER



Public Perceptions of Water Reuse

- Intimacy of Contact
 - Potable Reuse Is Less Readily Accepted
 - Irrigation and Industrial Use is Acceptable
- Cultural Taboos
 - Moslem Rules of Purity
 - *Fatwas* for Recycled Water (UAE, Oman, KSA)
 - Toilet Training Influences
- Customary Practices
- Inertia
- Education, Affluence, Age, Gender
- Familiarity

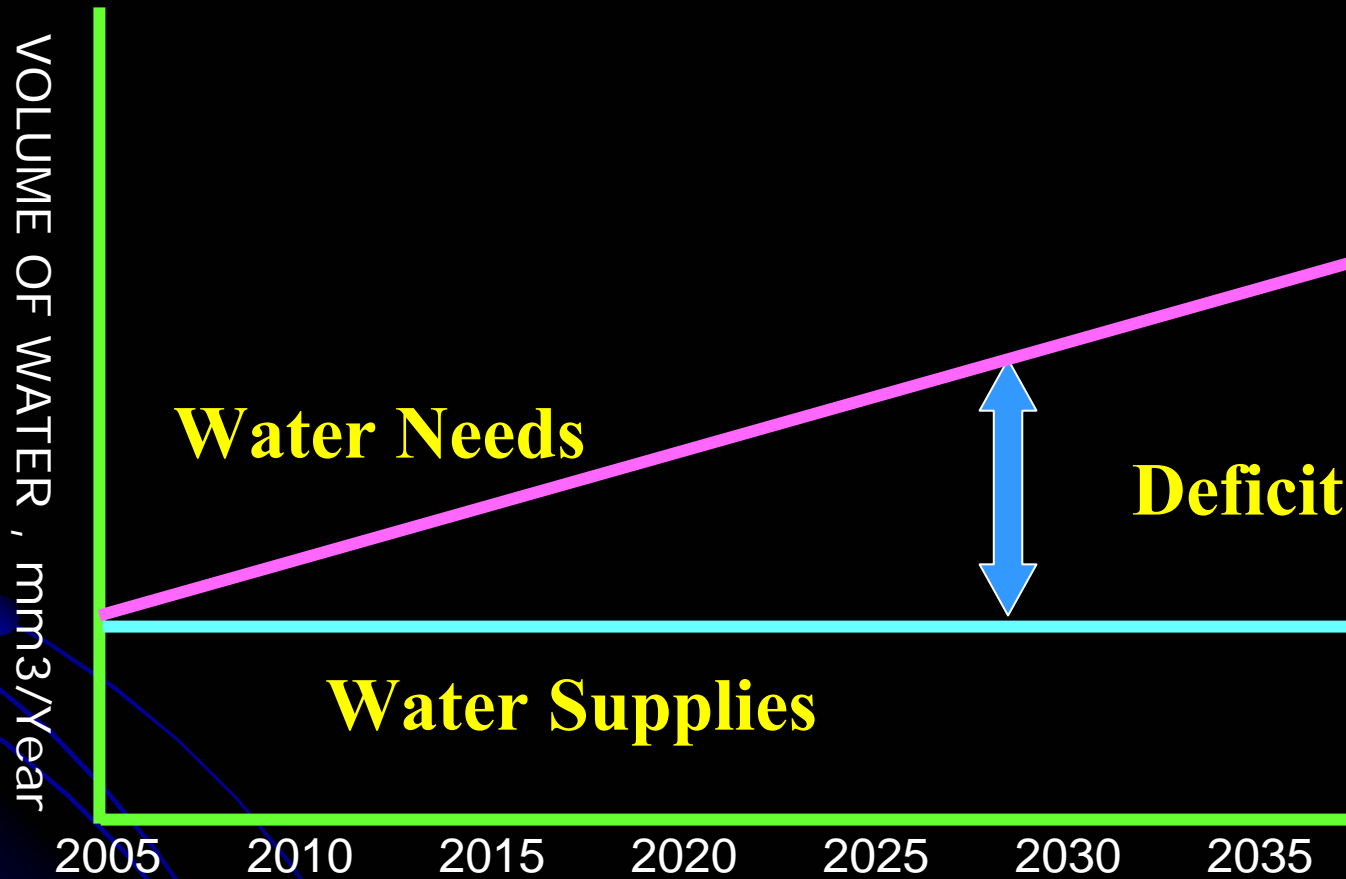
Increasing Public Acceptance

- Valuing Water
- Branding
 - A Water Service or A Wastewater Service ?
 - “Recycled Water ” or “TSE” ?
- Knowledge of Water Scarcity
- Knowledge of Alternatives
- Trust, Reputation, Past History
- Quality of Water
- Reliability of Service

Pricing of Recycled Water

- Generally Priced Lower than Potable
 - From Free to 100 Percent
 - Salt Content, Quality Issues, Quality Consistency
 - Fertilizer Value
 - Reliability
 - Local Resource
- Economic Incentive for Reuse
- Sending the Wrong Message about Value

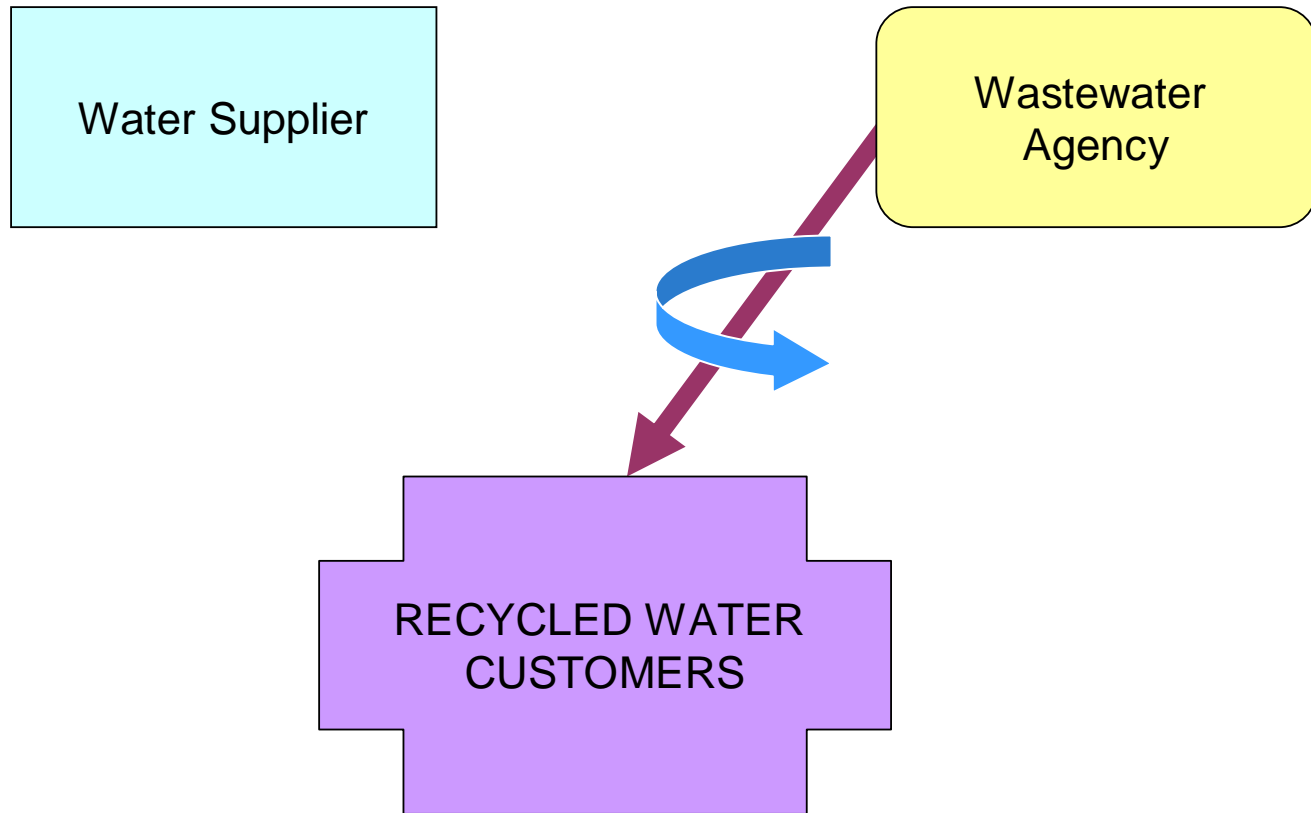
Water Needs vs. Water Supply



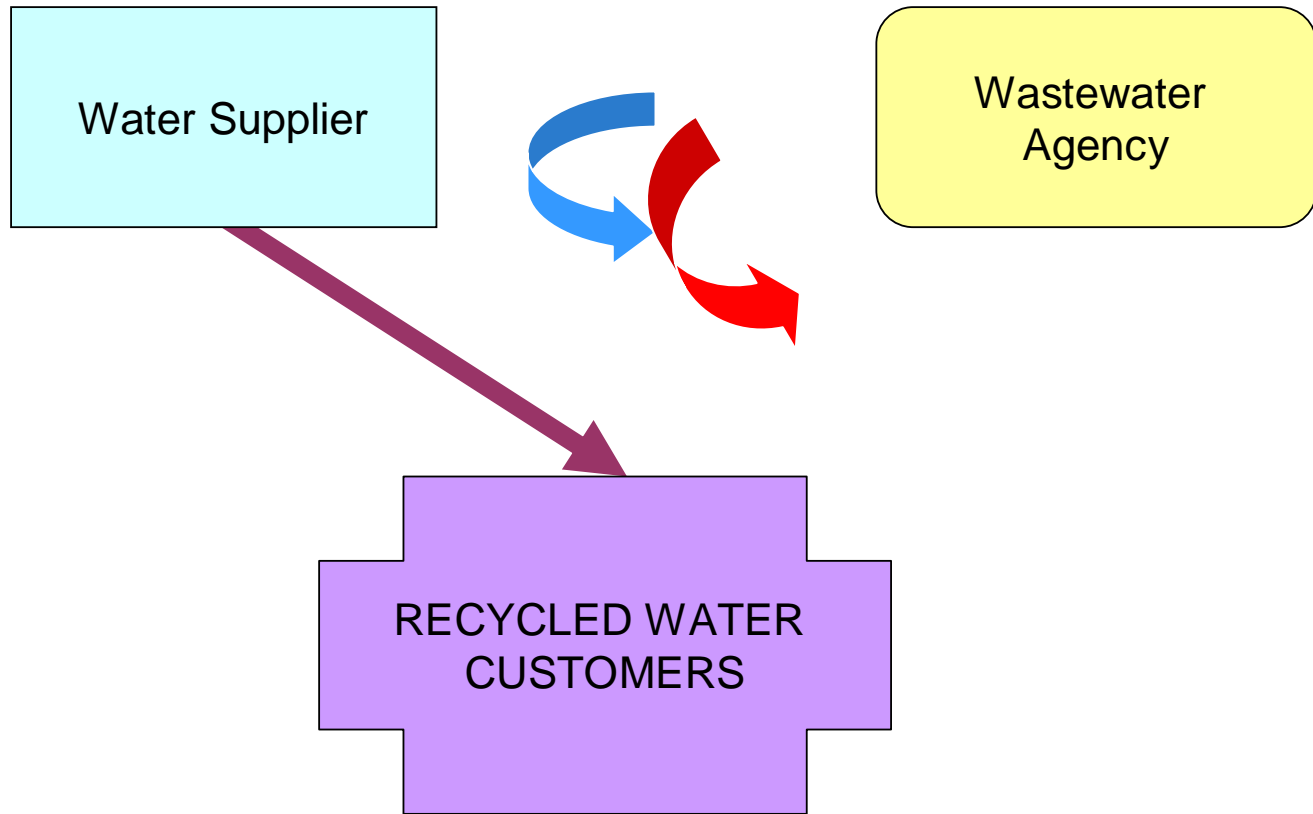
Interagency Agreements

- Water Reuse Often Requires Cooperation of Several Public Agencies
- Disjointed Management of Water and Wastewater
- Obstacle to Integrated Water Resources Management
- Ideal Situation: Same Public Agency Manages The Entire Water Cycle
- Contracts, Agreements, MOUs

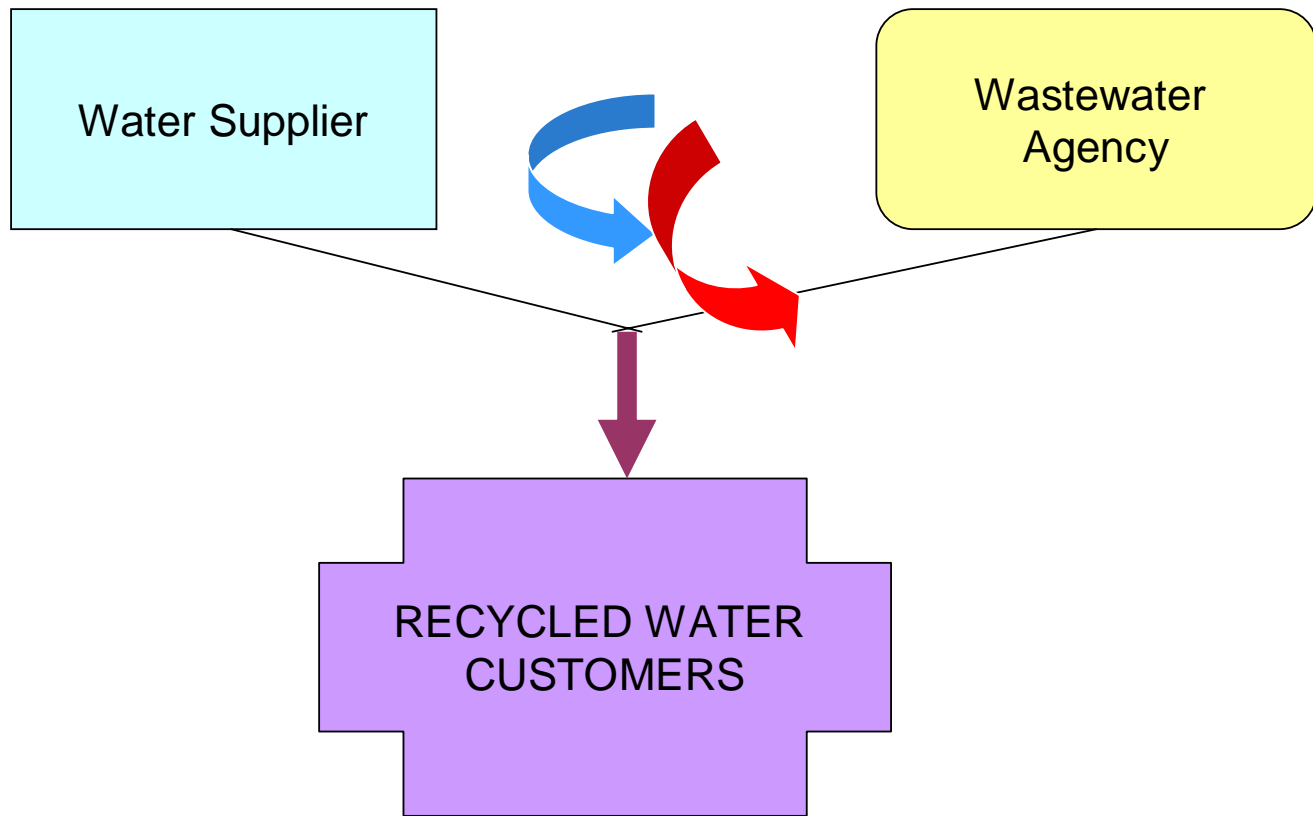
2. Wastewater Agency Leads, Serves Direct to Customers



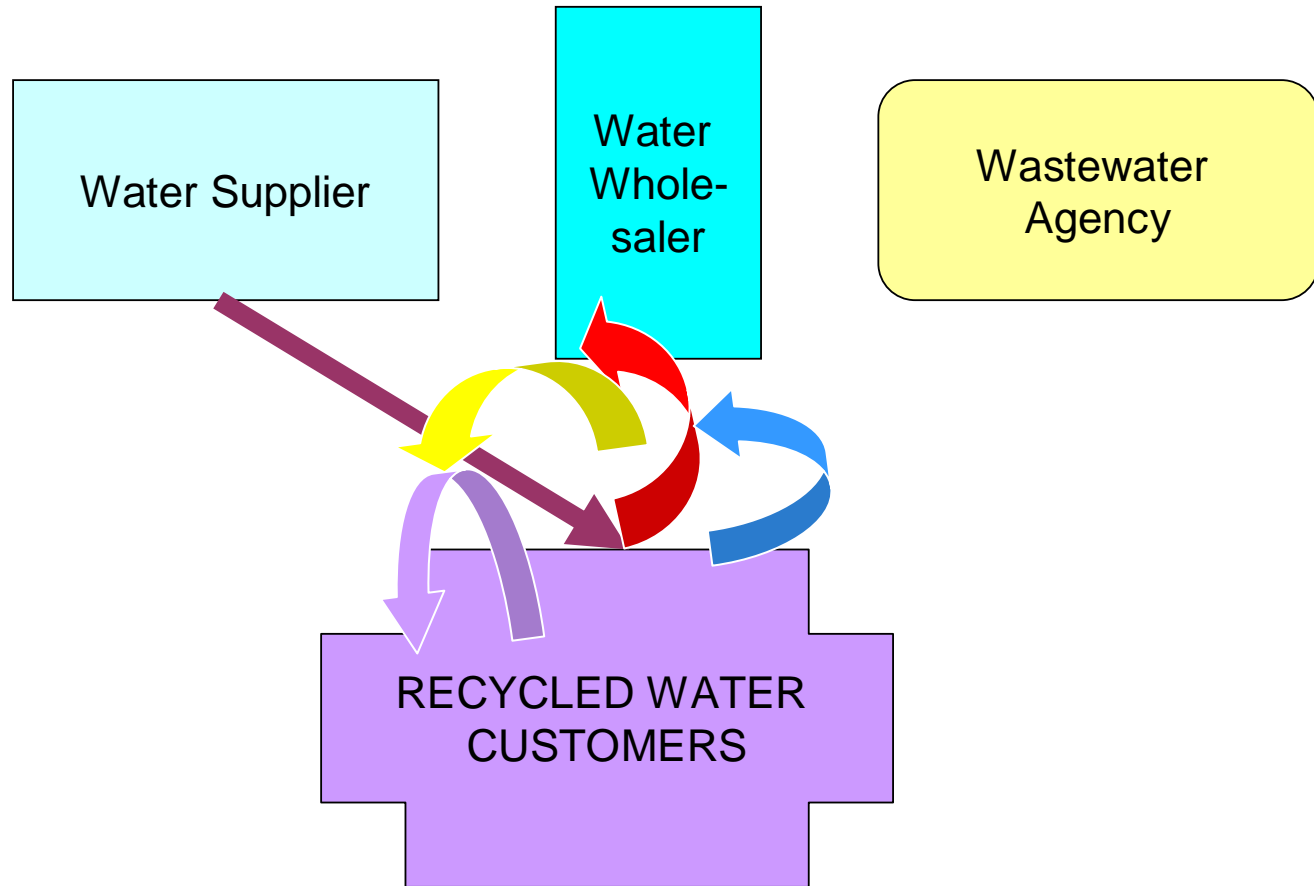
3. Water Agency Leads, Procures Water, Serves Customers



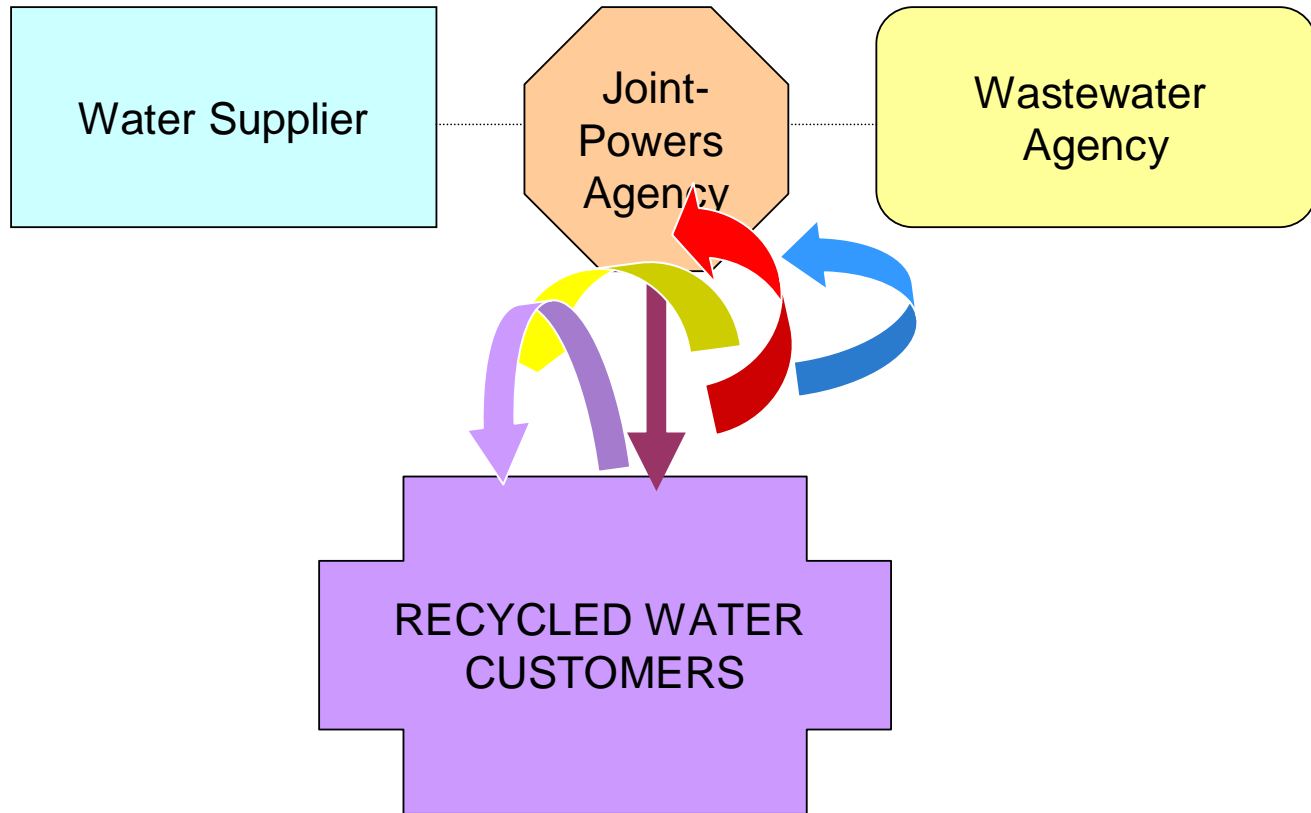
4. Water and Wastewater Agencies Partner, Serve Customers



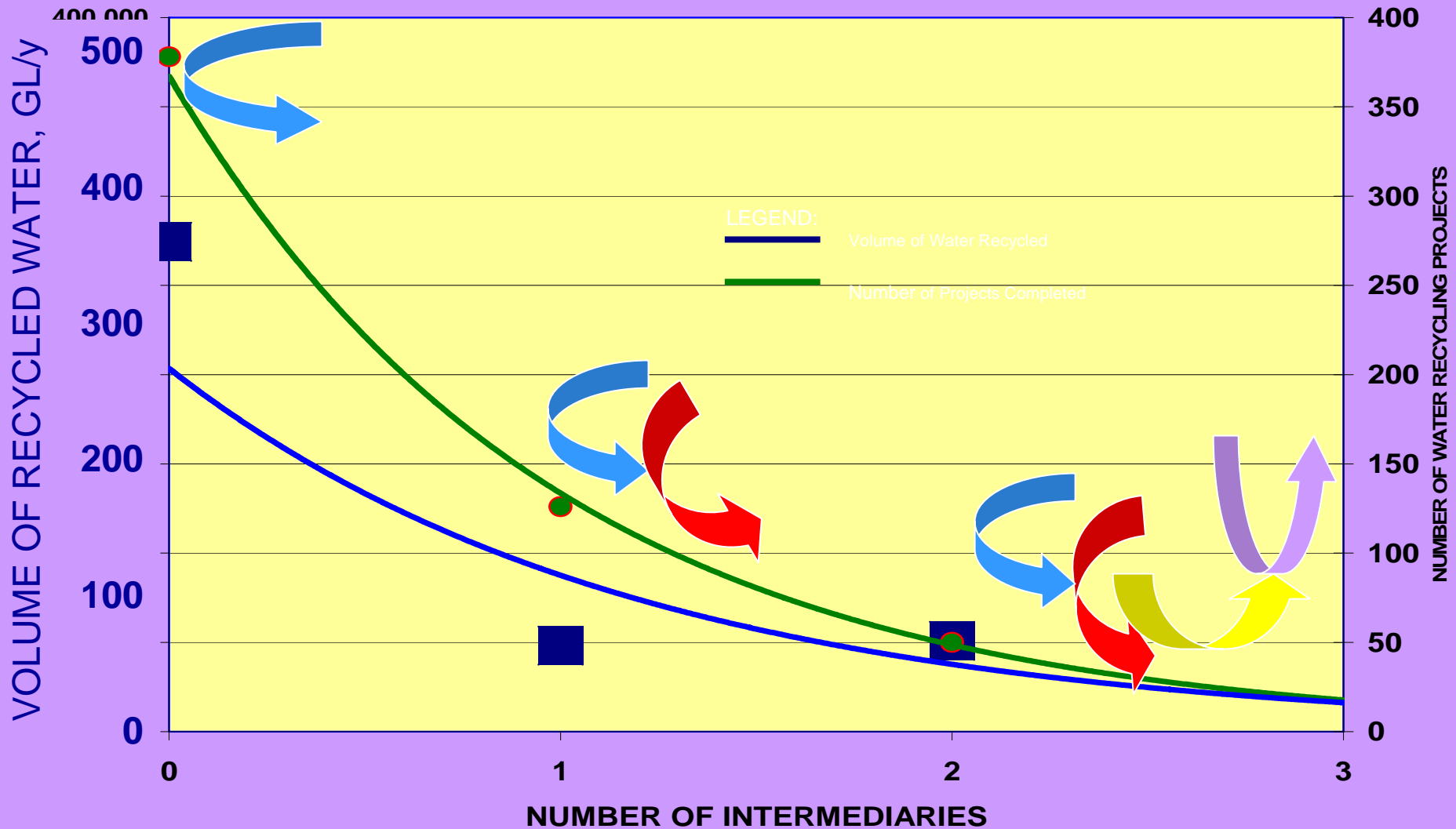
5. Water Passes from Producer to Wholesaler to Retailer to Customer



6. A Joint-Power Agency Is Formed to Serve Customers



Number of Intermediaries vs. Success of Reuse Projects



Global Warming

- The Evidence Is Now Incontrovertible
 - Receding Glaciers in Africa, Switzerland
 - Melting of Polar Ice
 - Desertification
 - Migratory Patterns
 - CO₂ Levels in the Atmosphere
 - Ocean Water Temperatures
 - Oceanic Stream Patterns

A Moral Issue

- Impacts on Water Resources
- Food Production and Availability
- Quality of Life for Future Generations
- Call to Action
 - Value Our Water
 - Reduce, Reuse, Recycle
 - Devote Resources to Water Infrastructure
 - Educate the Children on Value of Water

Integrated Water Resources Planning and Management

- Include All Water Resources
 - Surface Waters
 - Groundwater
 - Stormwater
 - Imported Water
 - Virtual Water
 - Wastewater, Treated Effluent, Recycled Water
- Account for Environmental Impacts
- Involve All Stakeholders
- Plan for the Sustainable Long Term

Sustainable Water

- Clean Water for Human Consumption
- Wastewater Treatment
 - Sanitation, Public Health Protection
 - Environmental Protection
- Water Recycling and Reuse
 - Reliable Non-Potable Supply of Water
 - Food Safety
 - Destruction of chemicals of emerging concern
- Ensuring Water for Future Generations
- Taking Account of Global Warming

Conclusions

- Water Reuse Mends the Hydrologic Cycle
 - Broken in Urban Hydrology
 - Sickened with Pollution and Contamination
 - Interrupted with Overdraft of Natural Resources
 - Groundwater Over-draft, Land Subsidence
 - Dried Lakes in Central Asia
- Water Reuse Is Integral to IWRP
- Water Reuse Is A Side Benefit of Sanitation
- Water Reuse Is A Sustainable Water Resource
- Cost Is Reasonable Viewed In Light of Benefits