107:Water Rights: Why Businesses Should Care About Scarcity & Accessibility

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General Counsel
Metropolitan Water District of Southern California

Harry Ott
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Faculty Biographies

Jeffrey Kightlinger

Jeffrey Kightlinger is general counsel for the Metropolitan Water District of Southern California. As general counsel, Mr. Kightlinger is responsible for directing Metropolitan's legal staff and consulting attorneys, leading the district's legal strategies in pending and potential litigation, and protecting Metropolitan's interests in all legal matters.

Before becoming general counsel, Mr. Kightlinger represented Metropolitan in environmental issues and water right matters. At Metropolitan he worked primarily on Colorado River matters, water rights issues, and a number of the district's water transfer and storage programs. Prior to joining Metropolitan he worked in private practice representing numerous public agencies including municipalities, redevelopment agencies, and special districts.

Mr. Kightlinger spent a year specializing in environmental law at George Washington University in Washington DC, while working for the U.S. Environmental Protection Agency. He earned a bachelor's degree from the University of California, Berkeley, and his law degree from the University of Santa Clara.

Harry Ott

Harry J. Ott is director, global environmental assurance for The Coca-Cola Company in Atlanta. In this current role he is responsible for ensuring the development and implementation of effective environmental management systems worldwide for the company and directs a group of professionals who have responsibility for environmental auditing, water and wastewater projects, due diligence assessments, training programs, communication materials, and new technology research. He also currently serves as a key member of the corporate quality department management team His previous positions with the company include environmental technologies manager and senior environmental administrator.

After receiving his initial degree, Mr. Ott spent several years in research and operation of water and wastewater treatment facilities for municipal and industrial applications. He then supervised the operation of water and wastewater treatment facilities for Schlitz Brewing Company and the Adolph Coors Brewing Company including can plant, ceramic pretreatment systems, and sludge processing plants. Following that assignment he was promoted to manage overall environmental programs in the corporate services group for Adolph Coors Brewing Company.

He has maintained a proactive role in the environmental community at large serving on several governmental and industrial environmental task forces in the past and recently served as chairman for the Global Environmental Management Initiative (GEMI) organization *Environment: Value to Business* and *Creative Water Strategies; a Water Sustainability Tool* projects. For several years now he has been a key member of the Metro Atlanta Chamber of Commerce environmental policy committee and water resources subcommittee. He is also a part of the environmental science technology advisory committee for Texas State Technical College. He currently holds a Grade A level certification in Texas for operation of wastewater treatment facilities.

His educational background includes a Bachelor of Technical Science from Texas State Technical College. He also completed policy development and environmental law courses toward a Masters Degree at the University of Denver.

Scott T. Rickman

Scott T. Rickman is associate general counsel at Del Monte Foods, the country's leading producer of premium quality processed fruit, vegetable, and tomato products. He manages Del Monte's litigation and provides legal counsel to the company's manufacturing facilities, including environmental compliance, agricultural issues, and general business and contract law.

Prior to joining Del Monte, Mr. Rickman was an associate with the San Francisco law firm of Gordon & Rees. He was also an associate with the law firm of Varnum, Riddering, Schmidt & Howlett in Grand Rapids, Michigan.
Mr. Rickman served in the U.S. Marine Corps and was selected as Marine of the Year for the Marine Barracks in London, England.

Mr. Rickman received a BA from the University of Michigan and his JD, *cum laude,* from the University of Wisconsin Law School.

Barton H. Thompson, Jr.

Barton H. Thompson, Jr. is the vice dean and Robert E. Paradise professor of natural resources law at Stanford Law School and senior fellow, by courtesy, at the Institute for International Studies. In 1999, he was a visiting scholar at the Hoover Institution. At Stanford, Professor Thompson heads the environmental and natural resources law and policy program and teaches courses in water law, natural resources law, property, and various environmental subjects. His scholarship and research focus on water and biodiversity policies, fisheries management, market and other alternative approaches to environmental issues, and constitutional protections of property, contracts, and water rights. He is coauthor of *Legal Control of Water Resources* and *Environmental Law: Concepts and Insights.*

Until joining the faculty at Stanford, he was a partner in the Los Angeles office of O'Melveny & Myers. Following law school, he clerked for Judge Joseph T. Sneed of the U.S. Ninth Circuit Court of Appeals and Justice William H. Rehnquist of the U.S. Supreme Court.

Professor Thompson consults for a variety of private, governmental, and non-profit organizations on water issues. He is chair of the board of the Natural Heritage Institute and also serves on the board of the Resources Legacy Fund. At Stanford, he has been the recipient of both the Hurlburt Award for Excellence in Teaching and the Robert E. Paradise Fellowship for Excellence in Teaching and Research.

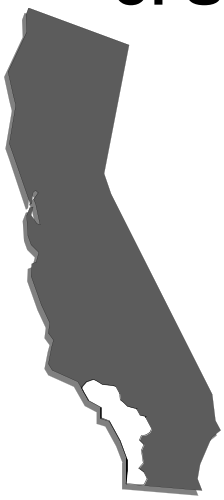
Professor Thompson earned his BA, JD, and MBA from Stanford University.

Water Rights: Why Businesses Should Care About Scarcity and Accessibility

The Metropolitan Water District
of Southern California

October 8, 2003

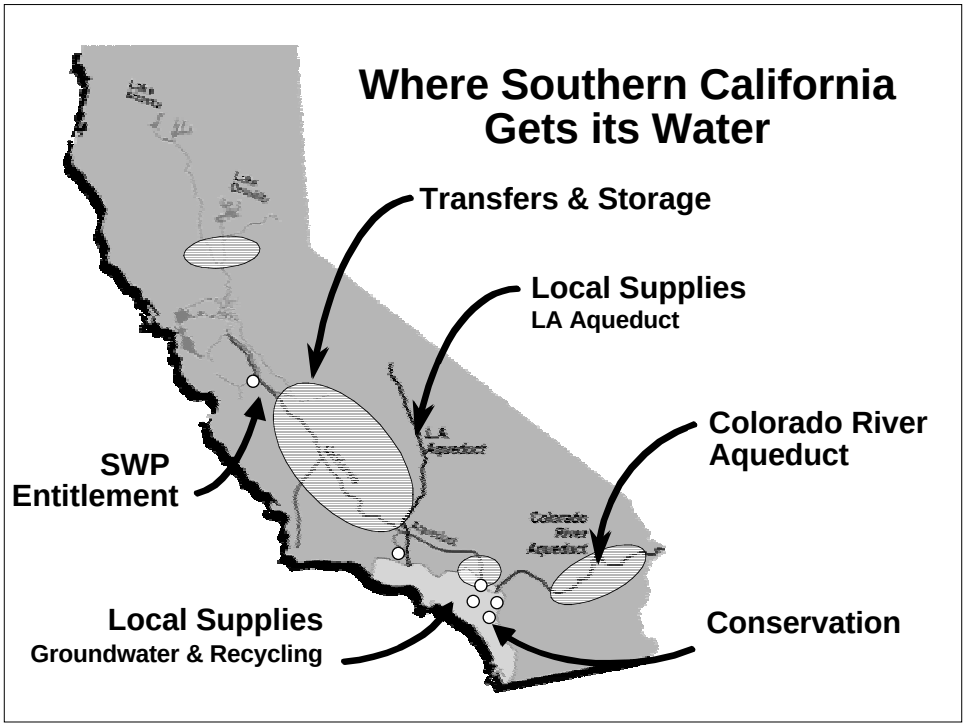
Metropolitan Water District of Southern California



- 6 counties; 5,200 square miles
- 17+ million people
- Regional economy: $600+ billion
- Projected growth:
  ~220,000 people/year
- MWD provides about half of southern California's supply

Report On Metropolitan's Water Supplies

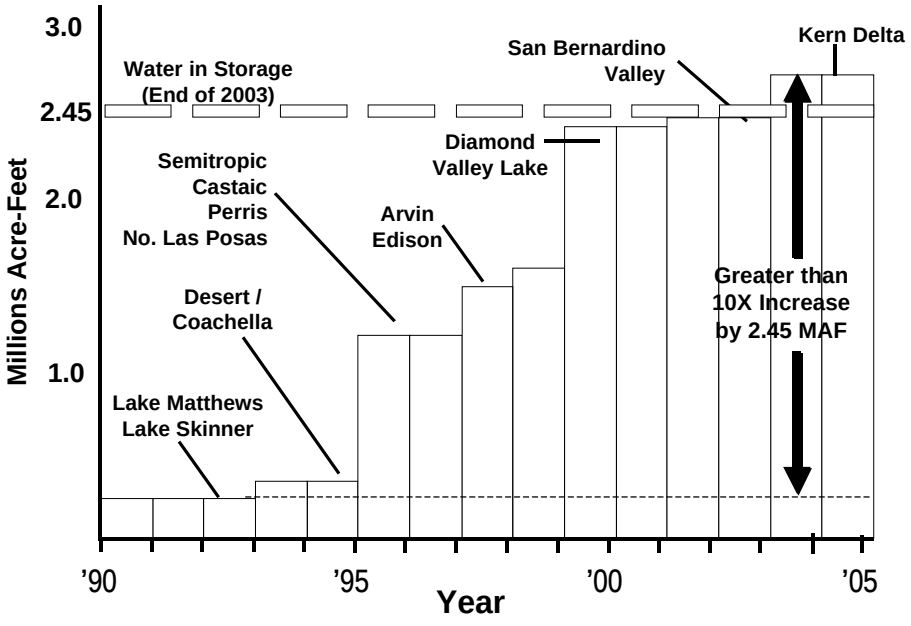
- **Premise**
  - **Retail water supply reliability is dependent on the development of both local and supplemental imported water supplies**
- **Law (SB221 / SB610)**
  - **Require new, large-scale developments to provide substantial evidence of available supplies in the event of drought**
- **Objective**
  - **Demonstrate a comprehensive plan to provide sufficient supplemental supplies**
  - **Assist member agencies and local agencies in complying with SB 221 and SB 610**



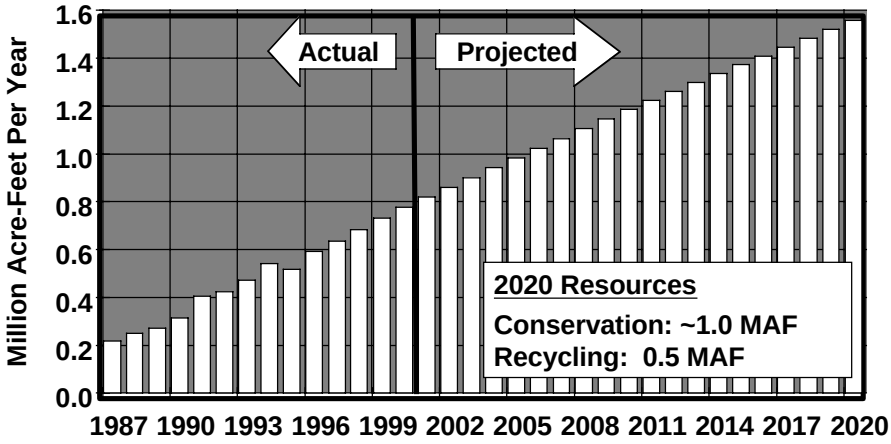
Changed Conditions for Southern California Resources

- **Challenges**
  - **Reduced Colorado River deliveries**
  - **Water quality constraints**
- **Opportunities**
  - **Full Diamond Valley Lake**
  - **Re-operation of storage and transfers**

Metropolitan's Storage Capacity



Conservation & Recycling

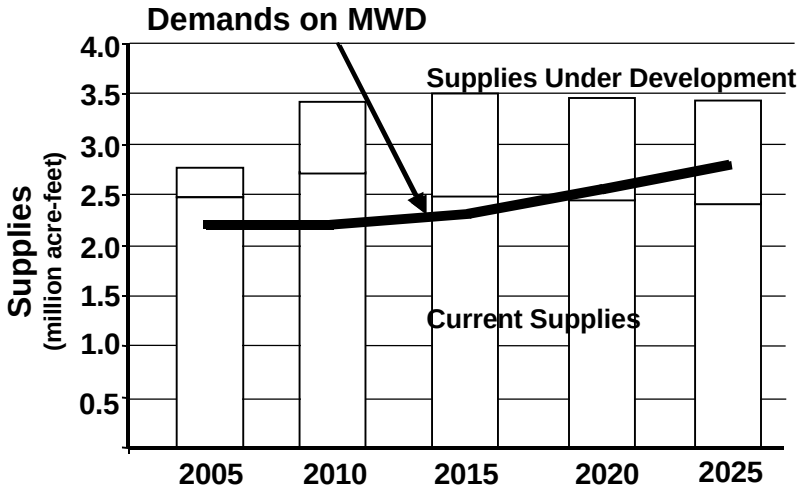


Cumulative Investments:	As of 2000	By 2020
Conservation	$220 mil	$1,300 mil
Recycling	$1,200 mil	$4,100 mil
Total	$1,420 mil	$5,400 mil

Metropolitan's Supply Inventory

- Colorado River Aqueduct Deliveries
- California Aqueduct Deliveries
- In-Basin Storage Deliveries

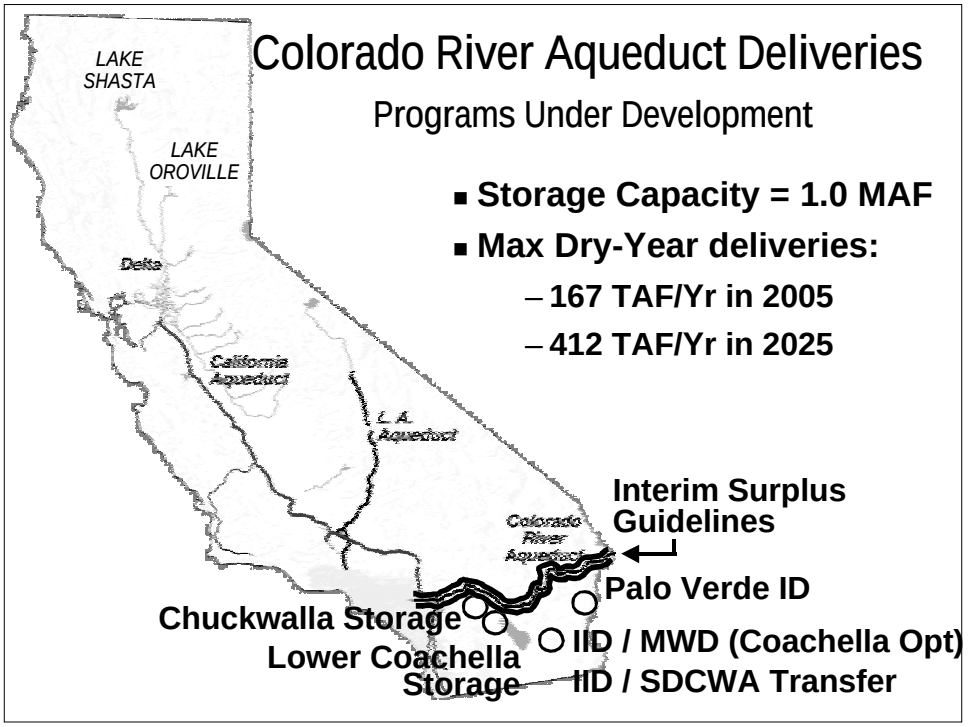
Multiple Dry-Year Supply Capability & Projected Demands

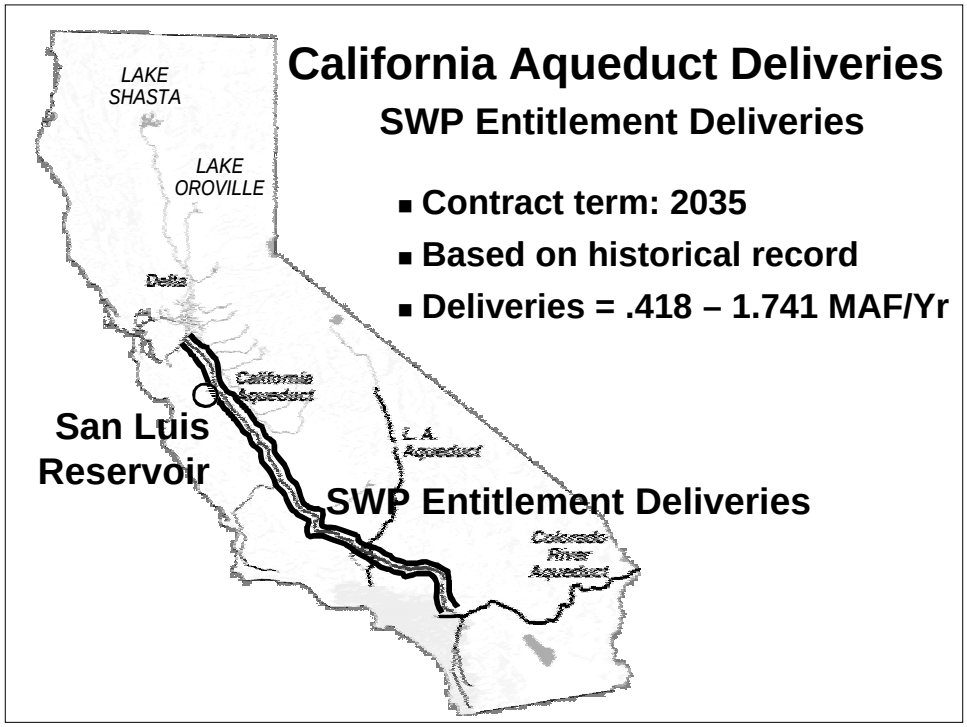


Colorado River Aqueduct Deliveries

Programs Under Development

- **Storage Capacity = 1.0 MAF**
- **Max Dry-Year deliveries:**
  - **167 TAF/Yr in 2005**
  - **412 TAF/Yr in 2025**

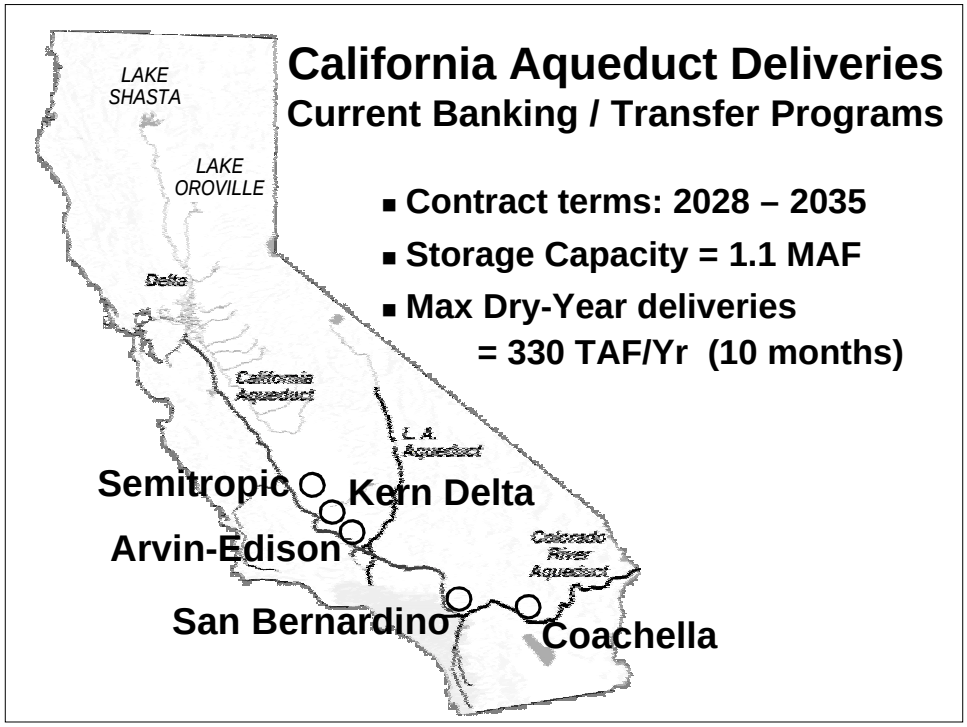




California Aqueduct Deliveries

SWP Entitlement Deliveries

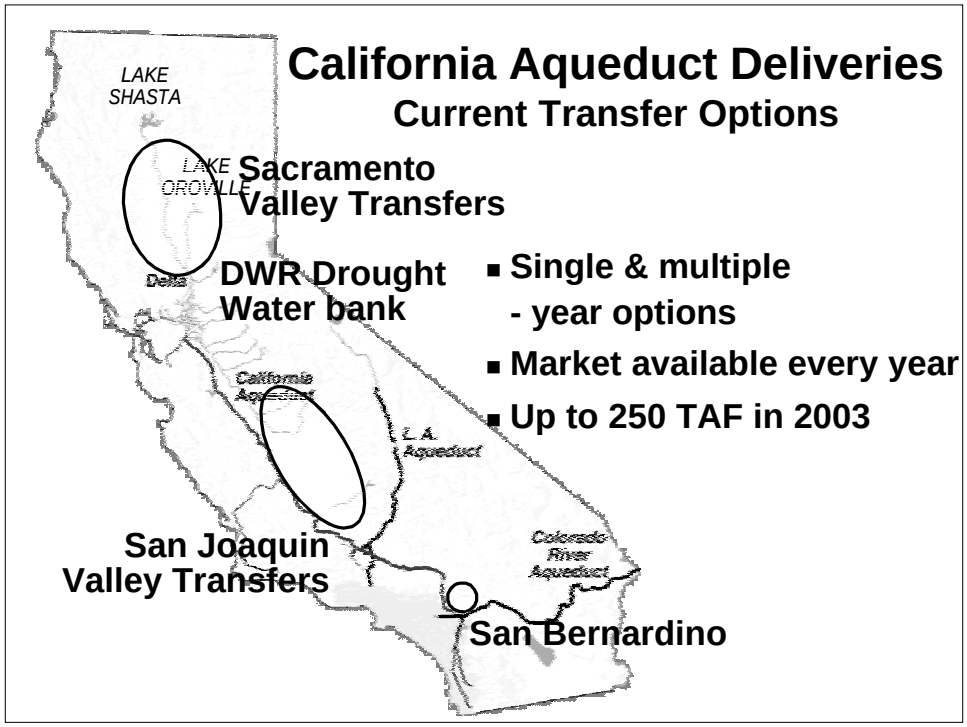
- Contract term: 2035
- Based on historical record
- Deliveries = .418 – 1.741 MAF/Yr

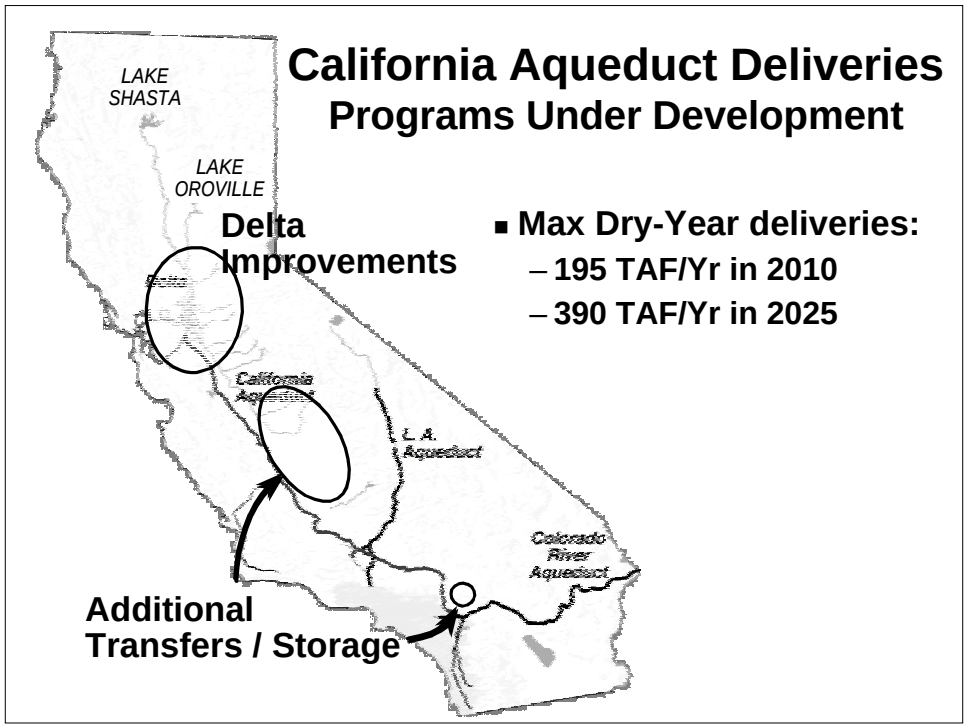


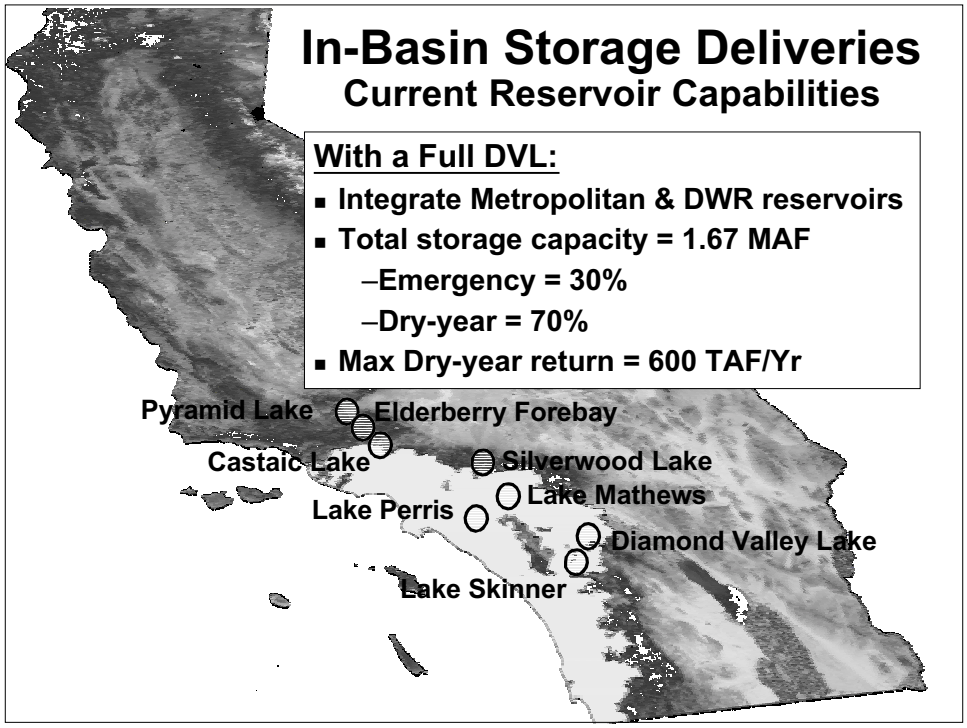
California Aqueduct Deliveries

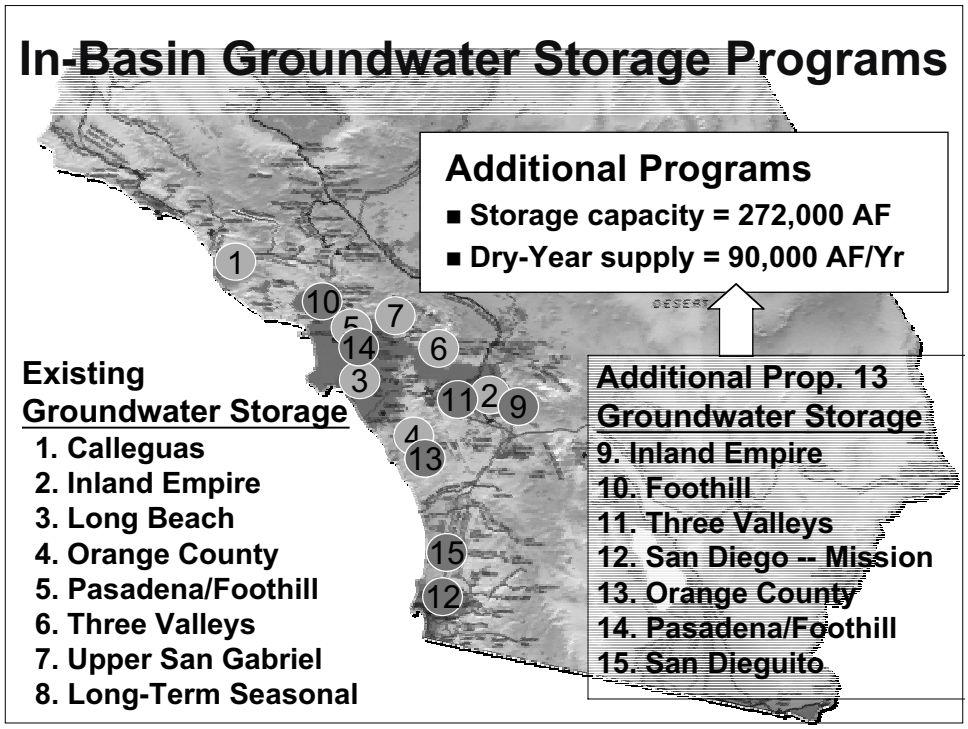
Current Banking / Transfer Programs

- Contract terms: 2028 – 2035
- Storage Capacity = 1.1 MAF
- Max Dry-Year deliveries
  = 330 TAF/Yr (10 months)









The Global Environmental Management Initiative (GEMI)

Connecting the Drops Toward Creative Water Strategies -- A Water Sustainability Tool

A New Guidance Document

http://www.gemi.org/water

GEMI

Vision:

"To be globally recognized as a leader in providing strategies for businesses to achieve EHS excellence, economic success, and corporate citizenship."

Mission:

"Business *helping business improve EHS performance, shareholder value, and corporate citizenship."*

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- 3M
- Abbott Laboratories
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- BNSF Railway
- The Coca-Cola Company
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- The Dow Chemical Company
- Duke Energy
- DuPont
- Eastman Kodak Company
- Eli Lilly and Company
- FedEx
- General Motors Corporation
- Georgia-Pacific Corporation
- Goodyear Tire & Rubber
- Halliburton Company
- Hewlett-Packard Company
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- Motorola, Inc.
- Novartis Corporation
- Occidental Petroleum Corporation
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- Pfizer Inc
- Pharmacia Corporation
- Philip Morris companies
- Pitney Bowes Inc.
- Procter & Gamble Company
- Southern Company
- Temple-Inland, Inc.
- Texas Instruments
- Wyeth

GEMI Recent Reports

- *Exploring Pathways to a Sustainable Enterprise: SD Planner™*
- *Environment: Value to the Top Line*
- *New Paths to Business Value: Strategic Sourcing – Environment, Health & Safety*
- *Environment: Value to the Bottom Line*
- Business & Climate Change web site (www.businessandclimate.org)
- HSE Web Depot web site (www.hsewebdepot.org)
- Fostering Environmental Prosperity—Multinationals in Developing Countries

GEMI Water Sustainability Work Group

Background Information:

- 2000: GEMI members identified growing importance of water issues; formed Work Group
- 2001: Conducted industry benchmarking survey – access to freshwater supplies identified as an increasing area of vulnerability
- 2001: Began development of a Water Sustainability Tool for business
- June 2002: Published *GEMI Water Sustainability Tool* and companion web site

Business Case for Pursuing Sustainable Solutions to Water Management

- Total water costs are increasing in unexpected ways.
- Business disruption risks are growing. Current water "allocations" are not assured into the future.
- Customer expectations related to water use and impacts are evolving.
- Businesses' "license to operate" and ability to expand are increasingly tied to water-related performance.

Water as a Sustainability Challenge

- Water is a shared resource
- Business, communities, and ecosystems all depend on clean freshwater
- Increasing vulnerability of local water supplies' ability to meet competing demands
- Window of opportunity exists for business to "get out in front" of this issue.

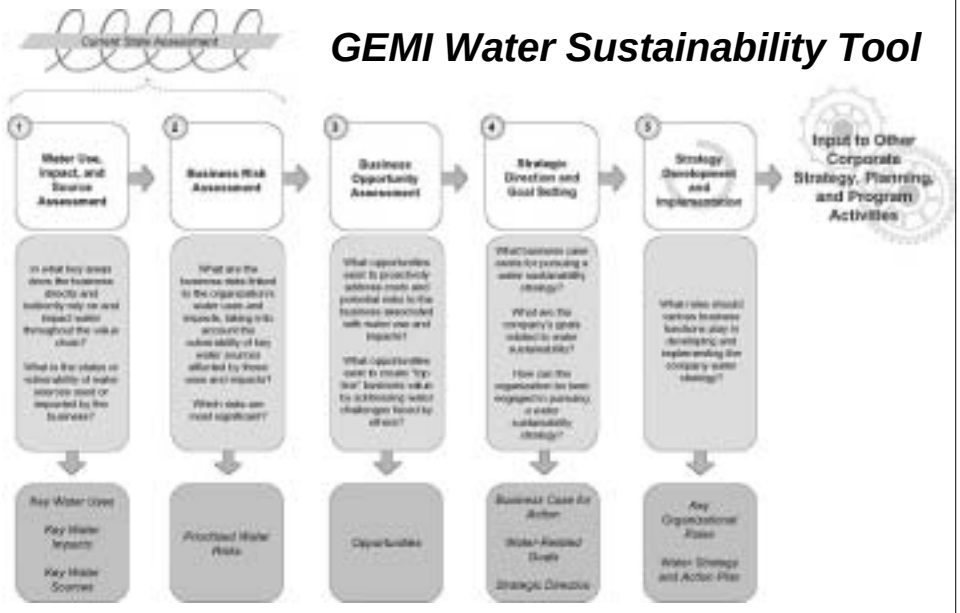
Water Sustainability Concepts

- Reduce overall use of water and improve water efficiency
- Match water quality with appropriate use
- Minimize adverse impacts on water quality or improve the quality of available water
- Solve water quality challenges through prevention rather than treatment.

Water Sustainability Concepts (cont'd)

- Engage local stakeholders in dialogue about water management challenges using a meaningful participation process
- Consider local human and ecosystem water needs in business decision-making
- Raise awareness about water sustainability and the importance of effective stewardship.

GEMI Water Sustainability Tool



GEMI Water Sustainability Tool

Module 1: Water Use, Impact, & Source Assessment

Module 2: Business Risk Assessment

Module 3: Business Opportunity Assessment

Module 4: Strategic Direction & Goal Setting

Module 5: Strategy Development & Implementation

Supplemental web site: www.gemi.org/water

Case Studies Provided by the Following GEMI Companies

- Abbott Laboratories
- Anheuser-Busch Inc.
- Bristol-Myers Squibb Company
- The Coca-Cola Company
- ConAgra Foods
- DuPont
- Eastman Kodak Company
- Georgia-Pacific Corporation
- Intel Corporation
- Johnson Controls, Inc.
- Novartis Corporation
- Olin Corporation
- Procter & Gamble Company
- Southern Company
- Texas Instruments

Key Lessons from the Case Studies

- Failure to strategically address water challenges can result in significant constraints and costs.
- Water risks and opportunities are present throughout the value chain.
- Numerous cost-effective opportunities exist to reduce water use, impacts, and risks.
- Companies are enhancing revenues and creating shareholder value by addressing water sustainability challenges.
- Cross-functional business teams can be highly effective in developing and implementing successful business water strategies.

How to Contact GEMI

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Connecting the Drops Toward Creative Water Strategies

A Water Sustainability Tool

GEMI

About the Global Environmental Management Initiative

The Global Environmental Management Initiative (GEMI) is a non-profit organization of leading companies dedicated to fostering environmental, health, and safety excellence worldwide. Through the collaborative efforts of its members, GEMI also promotes a worldwide business ethic for environmental, health, and safety management and sustainable development through example and leadership.

The guidance included in this document is based on the professional judgment of the individual collaborators listed in the acknowledgements. The ideas in the document are those of the individual collaborators and not necessarily their organizations. Neither GEMI nor its consultants are responsible for any form of damage that may result from the application of the guidance contained in this document.

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The Coca-Cola Company
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The Dow Chemical Company
Duke Energy
DuPont
Eastman Kodak Company
Eli Lilly and Company
FedEx
General Motors Corporation
Georgia-Pacific Corporation
The Goodyear Tire & Rubber Company
Halliburton Company
Hewlett-Packard Company
Intel Corporation
Johnson & Johnson
Johnson Controls, Inc.
Koch Industries, Inc.
Lockheed Martin Corporation
Merck & Company, Inc.
Mirant Corporation
Motorola, Inc.
Novartis Corporation
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Preface

June 2002

Dear friend,

There are emerging signals, some strong, some faint, that the business case is building for companies to develop more coordinated and forward-looking water strategies. Water costs are increasing, business disruption risks are growing, and stakeholders are becoming more concerned about companies' water-related performance. Global demand for freshwater continues to grow, while many water sources are showing signs of stress such as rising pollutant levels or withdrawal rates that exceed replenishment rates. While these trends do not affect all companies and geographic regions equally, these signals are likely to grow stronger in the coming years. Companies that understand the trends shaping the global business environment will be better positioned to identify new market opportunities, mitigate risk, develop sustainable water strategies, and create shareholder value.

Freshwater availability and quality are not just issues for business. Perhaps more than any other issue, freshwater stands out as a sustainability challenge. Businesses, communities, and ecosystems everywhere depend on clean freshwater to survive and prosper. When water needs in one area—economic, social, or environmental—become threatened, the risks to all increase.

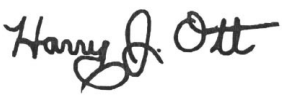
Balancing competing water needs requires creative, collaborative, and coordinated management. Companies need to think in new ways, listen closely to critical customers, and innovate. Water resources can be managed more efficiently within the factories, fields, and other places where businesses operate. Businesses are finding benefits in taking steps beyond their fence lines to address water challenges. Partnerships with local communities, investments in source water protection, and supply chain initiatives offer promising results. In addition, significant business opportunity lies in assuring that people, ecosystems, agriculture, and industry have sufficient access to clean freshwater into the future. Those companies that listen to the signals and find ways to meet global and local water sustainability needs will increasingly create shareholder value and competitive advantage.

GEMI's Water Sustainability Work Group has developed this tool to help you better understand and guide your own organization's relationship to water. The five steps, or modules, in this tool assist you to identify water-related opportunities and risks, determine the business case for action, and engage your organization—whether it is a department, facility, or company—in developing and implementing an effective water strategy. Case studies demonstrate how several of our companies have reduced risk and created significant business value through coordinated action. Sections on common challenges, water trends, and perspectives on water sustainability provide additional guidance and context. GEMI has also developed a companion website (www.gemi.org/water) with additional resources to help you use this tool.

As Ben Franklin wrote in *Poor Richard's Almanac* in 1746, "When the well is dry, we learn the worth of water." We believe it is within our collective ability to design a future of opportunity in which the well is full for all.

Sincerely,

Paul S. Halberstadt
ConAgra Foods



Harry J. Ott
The Coca-Cola Company

Co-Chairs, GEMI Water Sustainability Work Group

Connecting the Drops Toward Creative Water Strategies

A Water Sustainability Tool

Acknowledgements

This guidance document was developed in a collaborative process by the Global Environmental Management Initiative's (GEMI) Water Sustainability Work Group. Paul Halberstadt of ConAgra Foods and Harry Ott of The Coca-Cola Company co-chaired the project. The document was developed by Danny Consenstein and Tim Larson of Ross & Associates Environmental Consulting, Ltd. with guidance from Rob Greenwood and Martha Prothro. Additional research, writing, and editing was contributed by Anne Dettelbach, Todd Roufs, and Dan Stonington. Amy Goldman and Steve Hellem of GEMI provided substantial input and support to the project.

Graphic design: Todd Roufs
Cover photo: Courtesy of Eastman Kodak Company

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Keith Zook, The Procter & Gamble Company

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Module 2: Business Risk Assessment
Module 3: Business Opportunity Assessment
Module 4: Strategic Direction and Goal Setting
Module 5: Strategy Development and Implementation
Overcoming Challenges on the Path to Water Sustainability
Water Trends
Moving Forward
Perspectives on Water Sustainability

Case Studies

Exploring Water Connections Along the Supply Chain
Anheuser–Busch Inc.
Looking Down the Value Chain: Recognizing the Importance of Water to Consumers
The Procter and Gamble Company
Using a "Water Balance" to Identify and Characterize Water Uses
Texas Instruments Incorporated
Using Source Protection Planning to Identify Source Vulnerabilities
The Coca-Cola Company
Managing Strategic Risk Through Innovative Wastewater Treatment
DuPont
Reducing Facility Costs with Water Reuse and Recycling
Abbott Laboratories
Redesigning Facility Water Use: A Watershed Management and Water Reuse Initiative
Bristol-Myers Squibb Company
Developing Services to Address Customers' Water Conservation Needs
ConAgra Foods
Using Best Management Practices to Improve Water Quality
Eastman Kodak Company
Building on Core Competencies to Expand Markets
Johnson Controls, Inc.
Cutting Costs by Recycling Materials from the Water Waste Stream
Olin Corporation
Finding Solutions to Watershed Issues Through Effective Cooperation with Stakeholders
Southern Company
Using Performance Goals to Focus Organizational Attention to Water Sustainability
Georgia-Pacific Corporation
Engaging Corporate-Level Support for Plant-Level Water Initiatives
Intel Corporation
Engaging Employees to Reduce Water Use and Impacts
Novartis Corporation
Engaging the Organization in Water Strategy Implementation
Anheuser-Busch Inc.
Tracking Water Performance: Metering and Metrics
DuPont

Business Case

The Business Case for Pursuing Water Sustainability: New Opportunities, New Risks

As business leaders plan for the future, they scan for opportunities and risks created by emerging trends that may impact their company, industry, customers, and the world. There are now signals, some faint, some strong, that water is emerging as an issue of strategic importance to business.

Over the past several decades, many businesses have improved the efficiency of water use and reduced the discharge of pollutants to surfacewaters and aquifers. In fact, in some areas, despite increases in population and economic activity, freshwater consumption has dropped since 1980 in response to water conservation, reuse, recycling efforts, and changing priorities for water use. Following such successes, many companies are taking a renewed—and more coordinated—look at their relationship to water and seeing both expanding opportunities and heightening risks.

New Signals, New Opportunities, New Risks

The business case for strategically addressing water challenges is getting stronger. While each organization must assess the business case arising from its own relationship to water risks and opportunities, companies are increasingly encountering four strategic water signals that the business case to address water issues is building in

"The Coca-Cola Company exists to benefit and refresh everyone it touches. Access to fresh water is key to our continued success. We work every day to manage water resources responsibly for our consumers and the communities we serve. As such, we have an ongoing commitment to clean water to sustain healthy individuals, healthy families, healthy businesses, healthy communities, and healthy ecosystems."

Douglas N. Daft, Chairman, Board of Directors, and Chief Executive Officer, The Coca-Cola Company

multiple industry sectors. Business benchmarking and case studies conducted as part of this effort are evidence that these signals are growing in strength and frequency.[1]

1 Signal 1: Total water costs are increasing in unexpected ways.

Businesses are experiencing increases in water-related costs, not only those reflected in direct prices. In fact, water prices in many locations fail to accurately represent shifting supply and demand for water. Other direct and indirect water-related costs have emerged or risen in both industrialized and developing countries, including:

- Treatment costs to ensure that water inputs meet the business' quality specifications
- Wastewater treatment and pollution mitigation costs to meet more stringent pollutant discharge and run-off standards as regulatory approaches shift from technology-based requirements to watershed health-based limits and levels necessary to support endangered species protection and restoration efforts
- Supply expansion costs associated with dam construction, water diversion, well drilling, and securing new water allocations
- Indirect costs from suppliers with water-intensive processes or significant water impacts
- Worker absenteeism costs stemming from employee contraction of water-borne illnesses

2 Signal 2: Business disruption risks are growing. Current water "allocations" are not assured into the future.

Many companies now realize that even greater risks lie in the potential for water-related constraints on business activity. Current "allocations" of water rights for use and for discharge of pollutants are not assured into the future. In many regions of the world, pressures are growing to give higher priority to ecosystem and basic human needs for water. Changing local water supply and quality levels, combined with increasing competition for clean, freshwater resources, make past allocations vulnerable to disruption and revision. Businesses lacking contingency plans and failing to take proactive steps to address facility and local water challenges may find it difficult to avoid or respond quickly to surprises. Potential water-related business risks include:

- Water supply disruptions due to temporary or chronic water shortages, infrastructure deterioration, surface and groundwater contamination, or terrorist activity
- Pressures to change water allocations to address other industrial, agricultural, residential, and ecosystem needs, particularly in times of tight supply
- Supplier disruptions from water shortages in other regions, particularly those affecting energy and agricultural inputs
- Opposition to proposed facility siting or expansion stemming from existing or anticipated company or community water uses or impacts
- Public opposition to or government prohibitions against certain wastewater discharge techniques or certain types of water quality impacts

3 Signal 3: Customer expectations related to water use and impacts are evolving.

GEMI member companies report that they are increasingly hearing from customers—shareholders and those who buy a company's products and

services—about the growing importance of water issues. Failure to understand evolving customer expectations can affect a company's bottom-line performance. Increasing water-related costs throughout the value chain can affect product costs and pricing, reducing product or service demand. Many publicly traded companies are experiencing shareholder initiatives aimed at corporate environmental performance or decision-making. Such initiatives and associated shareholder expectations can create pressure for a company to alter its water-related practices or strategic plans.

At the same time, some companies are finding ways to enhance revenues by applying core competencies to address water-related needs experienced by others, such as products that use less water or services that reduce customers' water dependency.

4 Signal 4: Businesses' "license to operate" and ability to expand are increasingly tied to water-related performance.

As public expectations shift to embrace concepts of sustainability, companies are also discovering that their definitions of critical customers may need broadening. Critical customers are no longer just shareholders and those who buy a company's products and services. They include those individuals and groups—financial markets, suppliers, neighbors, non-governmental organizations, and regulators—whose behavior or responsiveness a business depends on to maintain its "license to operate" and to deliver consistently increasing shareholder value. Addressing the water needs of a company's critical customers will require new thinking and more strategic approaches. For example, increased community awareness and recognition of local water challenges can alter public acceptance of and support for a company's strategic plans or water-related practices.

Creating Business Value Through Water Sustainability

Business has a strategic opportunity to get out in front of water sustainability challenges before they impose constraints on business activity. Localized environmental issues of water availability and quality—that could often be "solved" through technical, policy, or behavioral approaches—are transforming, in many communities, into sustainability challenges that demand ongoing balancing efforts to satisfy competing needs. Balancing such demands on water resources will increasingly require thoughtful, collaborative management.

Case studies in this tool demonstrate how specific companies have recognized these strategic water signals, evaluated the business case for action, and taken steps to address the emerging challenges in ways that reduce risk, create shareholder value, and benefit the environment and others dependent on shared water resources.

Lessons from company experience, combined with advice from water experts, suggest several practical concepts that can guide efforts to manage water resources sustainably while creating shareholder value. While incorporating these concepts into company actions may not be practical in all situations, doing so frequently reduces risk, opens opportunities, and enhances water security.

Water Sustainability Concepts

- Consider local human and ecosystem water needs around shared water resources in business decision-making
- Reduce overall use of water
- Match water quality with appropriate use
- Minimize adverse impacts on water quality or improve the quality of available water
- Solve water quality challenges through prevention rather than treatment
- Engage local stakeholders in dialogue about water management challenges using a meaningful participation process
- Raise awareness about water sustainability and the importance of effective stewardship

Connecting the Drops: Building a Company Water Strategy that Fits

Individual companies face the challenge of understanding what all of these evolving water signals mean for them and what steps they should take. Each company has a different relationship to water throughout its value chain—from production inputs, raw materials, and suppliers to ultimate service or product use and disposition. Each company must assess its own business case for action. By understanding some of these signals early, companies may find paths that prevent future crises.

While water challenges persist at the local level, businesses are finding advantages in taking a more coordinated and strategic approach to addressing water challenges. Coordinated corporate attention to water challenges can support, promote, and transfer successes across facilities and sites, while engaging multiple business functions in reducing water-related risks and pursuing value-adding opportunities. Historically, at many companies, water-related responsibilities have been divided among separate functions, such as facilities management, engineering, and environmental affairs, with ownership of overall strategic water considerations falling through the cracks. Leadership, however, can come from many places—and plant managers will undoubtedly have a growing responsibility to navigate facility operations through local water challenges.

GEMI has developed this tool, and a companion website (www.gemi.org/water), to help you "connect the drops" and build a creative water strategy that fits your needs and circumstances. The tool and the website enable organizations to better understand their relationship to water throughout the value chain, identify opportunities and risks, assess the business case for action, and develop and implement continual improvement-based water strategies.

Tool Overview

GEMI has developed this analytical process—the Water Sustainability Tool—to assist individual companies and other organizations to better understand what emerging water issues might mean for them, given their operations, needs, and circumstances. The tool is designed to help individual companies build a business water strategy. The tool encourages businesses to:

- Conduct a systematic assessment of their relationship to water
- Identify specific opportunities and risks associated with this relationship
- Assess the business case for action
- Tailor a water strategy that addresses specific needs and circumstances of the organization
- Ensure that water-related opportunities and risks are tracked and managed effectively into the future using a continual improvement framework

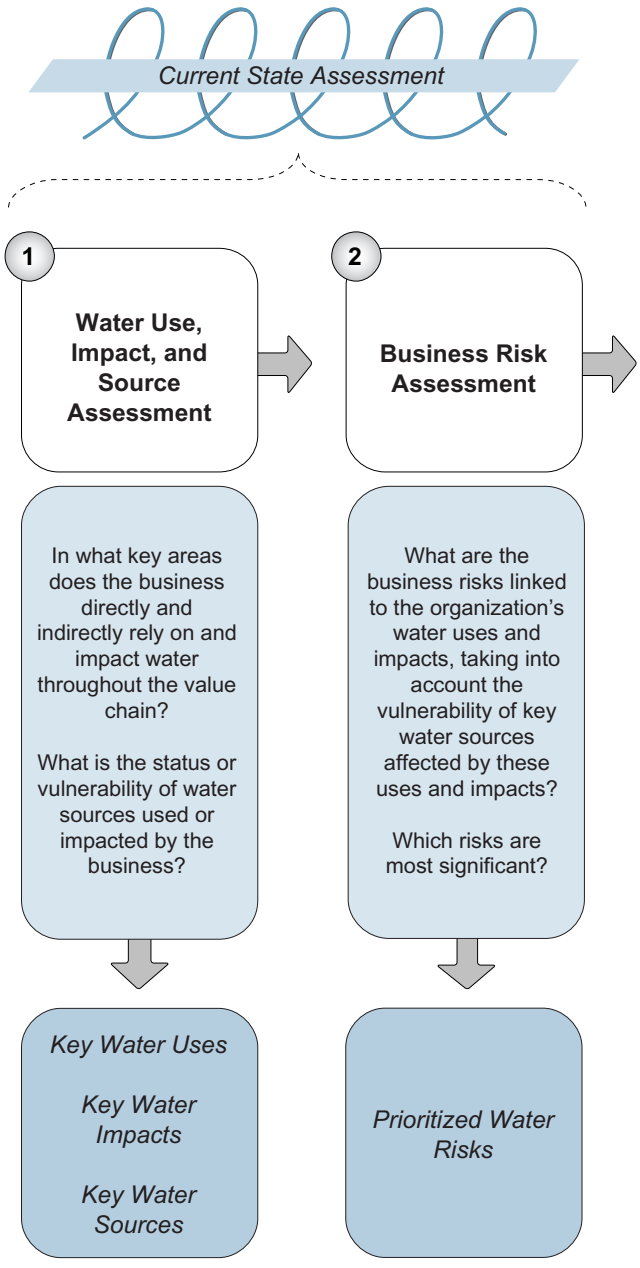
Water opportunities and risks are emerging throughout companies' value chains.

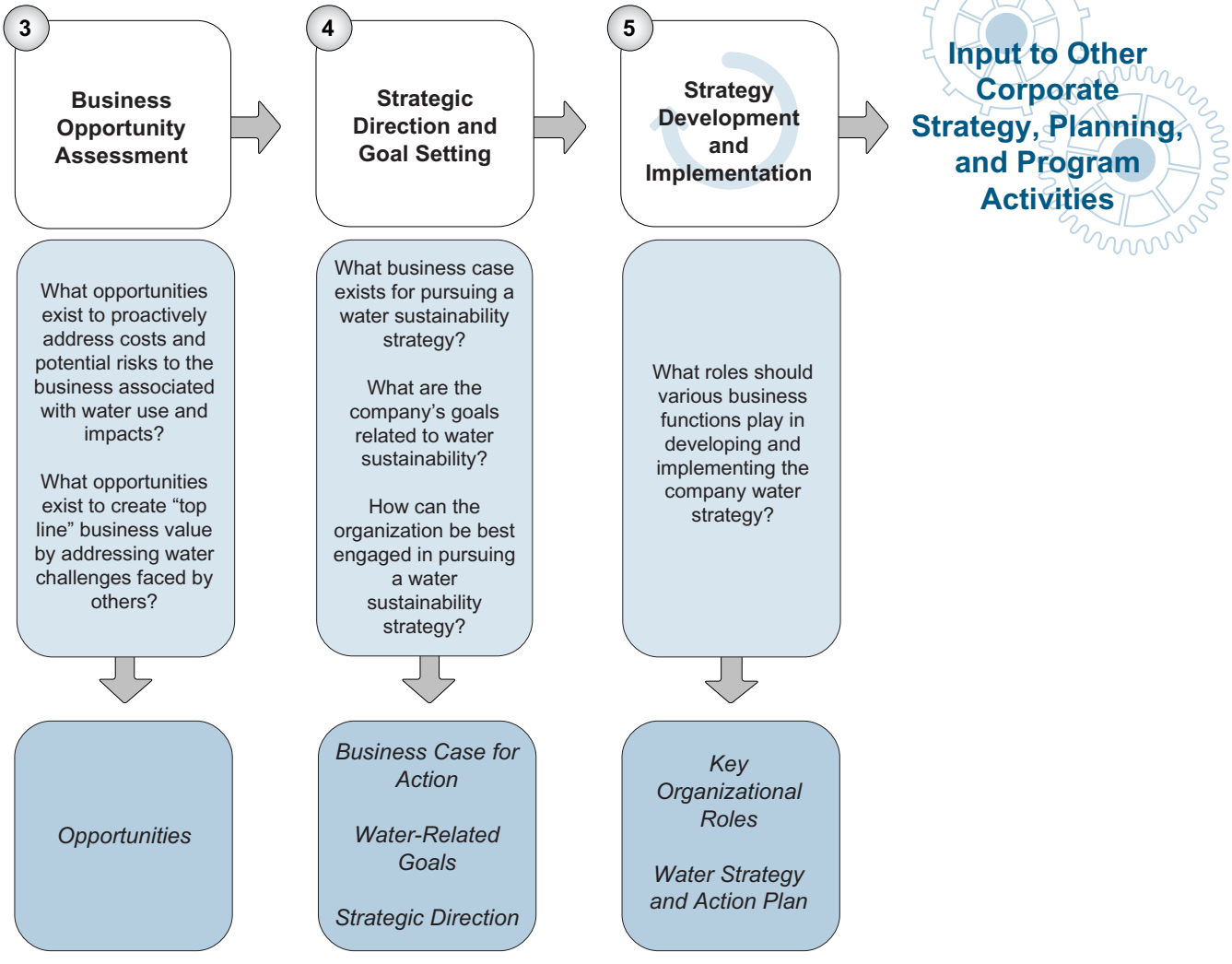
The Tool Roadmap

GEMI's Water Sustainability Tool contains five core analytical stages, or modules. These include:

- Module 1: Water Use, Impact, and Source Assessment
- Module 2: Business Risk Assessment
- Module 3: Business Opportunity Assessment
- Module 4: Strategic Direction and Goal Setting
- Module 5: Strategy Development and Implementation

Water Sustainability Tool Roadmap





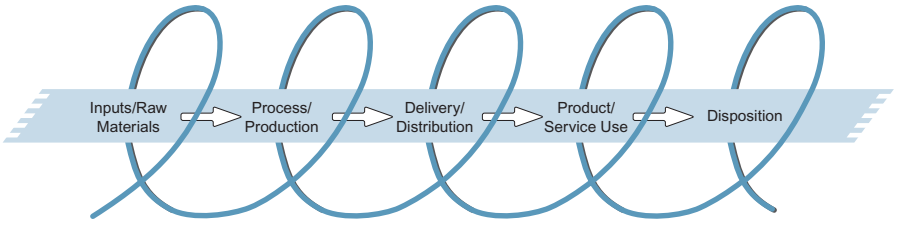
Each of the five analytical modules includes specific steps that can help answer the key questions associated with each module (see the tool roadmap diagram on the previous page for an overview of the modules, key questions, and outputs). Each module is supplemented by brief case studies that highlight how companies have approached the analytical steps. GEMI has also prepared a companion website to assist individuals in applying the analytical modules to their own companies or organizations. The icon to the left is used throughout this tool to indicate places where the user is encouraged to visit the website for more information. The website (www.gemi.org/water) includes the full content of this document, plus specific *Web Tool Resources*—key questions, checklists, forms, and additional case studies—to support tool users in applying each module. Web Tool Resources are listed under the analytical steps that they support.

Modules are sequenced to assist users in evaluating the business case and developing a strategy to address water challenges. The modules also can be used in an iterative manner. For example, the current state assessment modules (Modules 1 and 2) are designed to enable both a "first pass" assessment as well as a more detailed assessment that could be conducted at a later point. Users are encouraged to adapt this analytical framework to meet their company's specific needs, taking into account steps that may have already been completed.

Focus on the Full Value Chain

Water opportunities and risks are emerging throughout companies' value chains. For example, certain suppliers may be vulnerable to water supply availability risks that could impact a business' costs or availability of key production inputs, from raw materials to energy. At the other end of the value chain, the use or final disposition of a company's products or services could affect water resources in beneficial or detrimental ways. In order to help businesses consider upstream and downstream opportunities and risks related to water, this tool utilizes a five-stage value chain (or material flow chain). The value chain figure below presents the five value chain stages used for the current state assessment (Modules 1 and 2).

The value chain approach is designed to help companies identify and assess water uses and impacts in places where they might not be immediately obvious. For example, water-related risks and opportunities may appear in raw material or production stages, linked with key process inputs and suppliers, or in later stages, associated with product use or final disposition. Companies may find that they rely upon or impact water in unexpected ways.



Water Can Touch the Full Value Chain

Module 1

Module 1: Water Use, Impact, and Source Assessment

Module Purpose

Understanding how a product, facility, or company is connected to water—through direct and indirect water use and through impacts to water from business activities and products—is the critical first step in determining how an organization should respond to water risks and opportunities in a sustainable manner. This module helps organizations answer the following questions:

- In what key areas does the business directly and indirectly rely on and impact water throughout the value chain?
- What is the status or vulnerability of water sources used or impacted by the business?

Exploring water uses and impacts from a variety of approaches will help the user complete a comprehensive picture of a company's key connections to water.

Water uses and impacts identified in this Module will be used to complete the risk assessment and prioritization in Module 2. Together, Modules 1 and 2 make it possible for each company to complete a current state assessment. Only after building an understanding of your current water uses, impacts and risks, can you begin to develop appropriate strategies to achieve your business goals.

Module Approach

For each stage in the value chain, the user should examine how water "flows" through the business activities in that area. Many companies using environmental management systems may have already identified water uses in the context of

identifying environmental "aspects." The tool is intended to build on those assessments and focus on identifying additional direct and indirect water uses at other stages in each company's value chain.

1 Step 1: Identify and Characterize Water Uses

- In what ways does the organization directly and indirectly use water at each stage in the value chain?

> Identify Water Uses

By asking this question at each stage in a company's value chain, tool users are encouraged to think broadly about water use. Tool users should begin developing an understanding of key water uses at the company, from raw material or production stages, through customer use and final disposition. There are several areas of water use and reliance shared by many companies, such as facility landscaping, process heating/cooling, cleaning of parts during production, and transportation of materials. There are also areas of water use that are common to specific industry sectors. In addition, companies are often connected to water in very indirect, yet critical ways. These connections may be associated with the way your suppliers, employees, and customers use water. Each stage of the value chain also has unique water uses that are common to many companies. Exploring these water uses from a variety of approaches will help the user complete a comprehensive picture of a company's key connections to water.

> Characterize Water Uses

Tool users need to collect sufficient information about key water uses to identify associated opportunities and risks (see Modules 2 and 3). Characterization of each water use should include information about the quantity of water used, the quality of water used, the purpose of the water use, the source of water used, and seasonal or other fluctuations in water use. A "water balance" is a helpful means of documenting water uses within a facility or process, as highlighted in the Texas Instruments case study on page 13.

www > Web Tool Resources

- Definitions of "water use"
- Checklist of common areas of water use and reliance
- Key questions to identify water use at specific stages of the value chain
- Guidelines for characterizing water uses
- A downloadable Water Use Profile form to compile and organize important information about each individual water use

2 Step 2: Identify and Characterize Water Impacts

- In what ways does the organization impact surfacewater and/or groundwater through activities at each stage of the value chain?

It may be useful to think of water impacts in two main arenas. First, water impacts may be associated with *water discharges*. Examples of water discharges include water released from a facility wastewater treatment plant, stormwater run-off from company property, and cooling water returned to a nearby waterway. In many cases,

water uses identified in Step 1 will have associated water discharges if the water is not completely consumed by the use. Second, water impacts can result from business activities that do not directly relate to water use, but involve other materials potentially impacting the quality of water sources. For example, air deposition can affect the quality of surfacewaters. Leaching of materials and chemicals can impact the quality of groundwater aquifers. Spills or leaking tanks can impact surface and groundwater quality.

> Identify Water Impacts

In certain stages of the value chain, such as "process/production," direct water impacts will often be easy to identify because they involve activities that are likely to be regulated by government agencies. At each end of the value chain, however, direct and indirect impacts may be less obvious. Using several different approaches will help to identify hidden water impacts. For water discharges, be sure to consider all the ways that water quality can be changed by an activity. In looking for possible impacts arising from contact with raw materials, production intermediates or finished product, consider all of the materials used in your company's supply chain as potential sources. Then, consider the value chain. Use it as a lens to focus a systematic search for water-related impacts. For example, customers may require water to use, clean, or maintain a company's products or services. Key water impacts should be identified in this step. Tool users should consider *potential* impacts, and not just those that may occur routinely.

> Characterize Water Impacts

Tool users need to collect sufficient information about key water uses to identify associated opportunities and risks (see Modules 2 and 3).

The following elements should be considered in characterizing each water impact: the type of impact, the amount of water affected, the quality of the water discharged or impacted, the location of impact, the magnitude of impact, potential affects on ecosystems, and potential affects on public health, society, and culture.

> Web Tool Resources

- Checklists of common water impacts
- Key questions to identify water impacts at specific stages in the value chain
- Guidelines for characterizing water impacts
- A downloadable Water Impact Profile form to compile and organize important information about each individual water impact

3 Step 3: Identify and Assess Water Sources

- What are the primary water sources connected to the company's water uses and impacts?
- To what degree is the water source(s) under stress?
- To what degree does the business affect this source through its water use or impacts?

For each water use and impact identified in Steps 1 and 2, it is important to identify the primary source(s) of water relied upon and/or impacted. Companies should explore the vulnerabilities associated with sources that the company directly and indirectly relies upon and/or impacts. Water use, impact, and source information is then brought together in Module 2 to identify and prioritize potential business risks. Tool users should consider information such as the general description of the source, the size of source, the source's rate of replenishment, the source's quality, other industrial,

agricultural, domestic, commercial, and ecosystem demands on the source, as well as climatic conditions or weather patterns, such as drought.

In many cases, it will be sufficient for the tool user to perform a brief assessment of primary water sources on which the facility or company relies or impacts. If there are signs of vulnerability associated with a water source, a more in-depth assessment might be warranted. A case study on page 36 in Module 5 presents an approach that Anheuser-Busch Inc. has found to be helpful in assessing the status of water sources on which its facilities depend.

www **> Web Tool Resources**

- Guidance on assessing water sources
- Key questions to ask about source status
- A downloadable Water Source Profile form to compile and organize important information about each critical water source

Module 1 Outputs

Identified water uses and impacts at each stage of a company's value chain and source status information from Module 1 will drive the assessment and prioritization of potential business risks in Module 2.

Exploring Water Connections Along the Supply Chain

Anheuser–Busch Inc.

In 2001, Anheuser-Busch (A-B), the world's largest brewer of beer, experienced business impacts from unexpected water shortages affecting its supply chain. A temporary drought in the U.S. Pacific Northwest rapidly increased the price and reduced the availability of key inputs to Anheuser-Busch's brewery operations—barley and aluminum. An unusually dry winter, coupled with a turbulent West Coast electricity market that is highly dependent on water for power generation, created intense short-term competition for limited freshwater resources. Reduced allocations of water for irrigation in Idaho resulted in low yields of barley, a key brewery ingredient, leaving A-B to rapidly search for high quality alternative sources. At the same time, aluminum production, which relies on large amounts of low-priced energy generated from hydroelectric dams in the region, was brought to a standstill as electricity prices skyrocketed. A-B was forced to find alternative sources of aluminum for its can manufacturing operations. This experience in facing water-related challenges along the supply chain has resulted in an expanded business case which includes a more comprehensive, strategic, and sustainable approach to water issues.

Looking Down the Value Chain: Recognizing the Importance of Water to Consumers

The Procter and Gamble Company

The Procter and Gamble Company (P&G) markets approximately 250 brands of consumer products to nearly five billion consumers in more than 130 countries. The products include laundry detergents, toothpastes, shampoos, feminine hygiene products, pharmaceuticals, snacks, diapers, cosmetics and cold remedies. As P&G looked at their water use and impacts along the value chain, the company identified a number of areas for improving water management. Over the past few years, it has significantly reduced water usage and pollution at its manufacturing plants. However, one of the company's biggest challenges is to address consumer use of water.

Water is essential for the use and disposal of virtually all of P&G's products. Nearly 85% of sales are associated

Module 1 Case Studies

in some way with household water use. Because water has such a tremendous effect on both consumers' lives and its business, P&G has identified water as one of two priority sustainability focus areas.

To focus itself on this subject, P&G has established a water sustainability guideline for its product development efforts. "*As you improve current products, or develop new-to-the-world products and services, think about how you could apply our technologies to use less water, use water differently, or use no water at all.*"

P&G is pursuing cleaning and laundry products that use less water, cold water, non-potable water and even salt water. They are developing shampoo and personal cleaning products that use less water or no water at all. To help consumers improve the quality of their water use, P&G is also developing filtration and treatment systems that treat and recycle water in the home.

Using a "Water Balance" to Identify and Characterize Water Uses

Texas Instruments Incorporated

Texas Instruments (TI) has found that developing "water balance" diagrams that map water inflows, outflows and intermediate reuse between production and support areas in a manufacturing plant provide valuable information for improving water management and reducing costs. A water balance is very beneficial during the design of manufacturing plants as well as during efforts to optimize subsequent plant operations, particularly where appropriate flow meters are installed. Identifying the amount and quality of water needed in all (or major) water use areas allows the development of a better-integrated water use program during process design that may reduce demand for freshwater. A water management system can also match water use requirements with other water streams in the facility of appropriate quality, enabling reuse without additional treatment.

TI's semiconductor fabrication plant in Miho, Japan has been in operation since the early 1980s as a zero industrial wastewater effluent plant. The plant was built this way at the request of the local neighbors and government. At the time, the area lacked the infrastructure to support a more conventional plant design, which typically uses over a million gallons of water per day. The production area at the Miho plant reuses process water over and over again, enabling the plant to consume a much smaller amount of water than comparable semiconductor plants. Some generated production "byproducts" are segregated from process water and collected for reuse as raw materials at other companies or disposed of as concentrated waste solutions.

The Miho plant has found water balances to be useful tools for improving process designs and communicating about water use. A sample water balance for the Miho plant is available with this case study on the GEMI Water Sustainability Tool website (www.gemi.org/water).

The complexity of a water balance depends on the type of facility and the characteristics of the local area. A site with only a few water use requirements might need only a simple water balance prior to starting a water management program. For a complex site with many water uses, an accurate site water balance should consider seasonal impacts as well as water use at various production rates. For example, at the Miho plant, and a similar plant in Hiji, Japan, there are actually many water pipeline interconnections between areas to minimize water use. Many of these connections at the Miho and Hiji plants are measured on varying frequencies to assure gains are being maintained and to identify additional opportunities.

Using an accurate water balance in a sound water management program can improve:

- Identification of current and future water uses
- Consideration of water conservation opportunities during the plant design phase
- Ability to troubleshoot problems during actual plant operation by using flow meters to compare actual water use with plant design
- Identification of water reuse opportunities during plant expansions
- Identification of other future cost-effective water conservation projects
- Ability to communicate water use issues within the company and to external critical customers

Module 2

Module 2: Business Risk Assessment

Module Purpose

Based on the identified areas of water use and impact, Module 2 helps tool users identify, characterize, and prioritize potential corresponding business risks. Business risk often comes in the form of potential constraints on economic activity. These may result from cost increases, process and production delays, limits on capacity expansion, decline in demand for products and services, and changing customer preferences and expectations. Module 2 helps organizations answer the following questions:

- What are the business risks linked to the organization's water uses and impacts, taking into account the vulnerability of key water sources affected by these uses and impacts?
- Which risks are most significant?

Prioritized risks from Module 2 highlight the focus areas for consideration in Module 3. Module 3 helps tool users to identify creative options to reduce risk, create business value, and contribute to water sustainability.

By exploring the business' sensitivity to water-related changes, tool users should be able to make a qualitative assessment of the business 'importance' of each use.

Module Approach

Understanding the business *sensitivity* to water-related changes, as well as the relative *likelihood* of these changes occurring (which is often linked to the vulnerability of the affected water sources), provides important information regarding potential business risks. Such information enables business

managers to assess and articulate the business case for developing a strategy to mitigate potential water-related constraints to business activity.

Most businesses employ well-established procedures for identifying and evaluating potential business risks. Tool users are encouraged to seek opportunities for incorporating the risk information and evaluation criteria into such core business risk evaluation processes, including due diligence assessments for site acquisition, issue identification systems, environmental management system risk assessment processes, and other risk assessment activities. Such processes help ensure that water-related risks are routinely considered as changes in business operations and water trends occur.

1 Step 1: Water Use Risk Assessment

- How much would an external change in water availability affect the current business use?
- What is the likelihood of change?

> Business Importance of Each Water Use

Consider each water use identified in Module 1 to determine how sensitive the business is to external changes that could affect this water need. A business would be highly sensitive to a change if it, or the company's response options, would result in significant business constraints. External changes can result in steep increases in water costs, production delays, limits on production, or strong community opposition to company activities. For each water use, consider how sensitive the business is to a change in 1) water price, 2) water availability, 3) water quality, or 4) the loss of a specific source. By exploring the business sensitivity to water-related changes, tool users should be able to make a qualitative assessment of the business "importance" of each use.

> Probability of Change (in water price, quantity or quality)

Next, tool users should consider the water source assessment information prepared in Module 1 to assess the likelihood of the changes considered in the sensitivity analysis actually occurring. Frequently, this will be linked to the vulnerability of the water source(s) relied on for the use. For example, an aquifer that is being rapidly depleted or contaminated would likely be vulnerable to changes or response actions such as public policy changes or price increases that can affect the business. However, changes in water prices and allocations are often not directly related to the vulnerability of local water sources, but may instead stem from broader changes in public opinion and policy related to the needs of other water users.

www > Web Tool Resources

- Key questions to assess sensitivity to external changes in water availability
- Key questions to assess probability of change in water price, quantity, or quality

2 Step 2: Water Impact Risk Assessment

- How much would an external change in water impact requirements affect the current business use?
- What is the likelihood of change?

> Business Significance of Each Water Impact

Consider each water impact identified in Module 1 to determine how sensitive the business is to

external changes related to this water impact. A business would be highly sensitive to a change if the change, or the company's response options, would result in significant business constraints. For example, stricter effluent standards can result in significantly higher treatment costs to remove contaminants. Community concerns about a company's water impacts can affect your "license to operate." Certain spills have potential for high liability and impact on company reputation. In some industries, product use has been linked to water quality problems. For each water impact identified in Module 1, at each stage of the value chain, consider how sensitive the business is to increased costs or short time turnarounds to reduce water impacts. By considering the organization's sensitivity to external changes associated with its water-related impacts, tool users should be able to make a qualitative assessment of the business "significance" of this impact.

> Probability of Need to Change Current Water Impacts

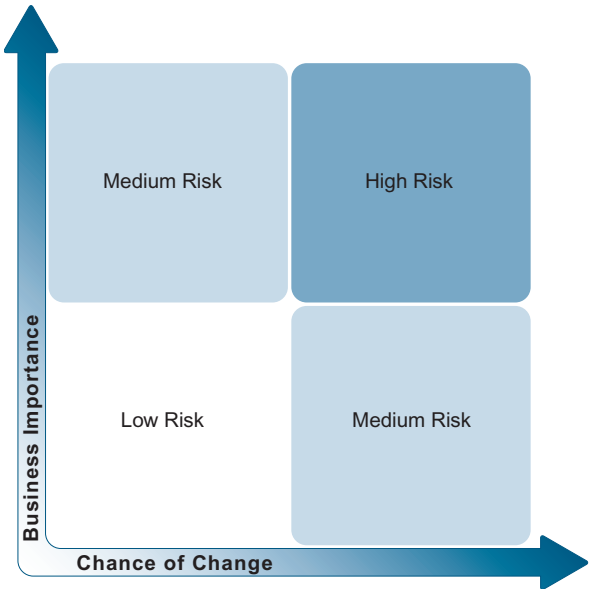
Next, tool users should consider the water source assessment information prepared in Module 1 to assess the likelihood of the changes considered in the sensitivity analysis actually occurring. Frequently, this will be linked to the vulnerability of the water source(s) affected by the water impact. For example, response actions to address more stringent regulatory requirements, opinions of the public and NGOs, or legal liability are more likely to be necessary when the water impacts are contributing to harm or degradation that impinge upon other water demands—including human needs, other industrial or agricultural needs, and ecosystem needs. Users should also assess changes in broader public opinion, policy and regulatory approach.

www > Web Tool Resources

- Key questions to assess sensitivity to change in current water impacts
- Key questions to assess likelihood of change in water impact requirements

3 Step 3: Prioritize Water-Related Risks

Once tool users have identified the importance or significance of water uses and impacts, and assessed the vulnerability of affected water sources and the likelihood of external changes stemming from those source vulnerabilities, the information can be plotted on a simple risk matrix to help prioritize the resulting business risks.



Water uses and impacts that fall in the high and medium risk quadrants are likely to demand further consideration and assessment. Tool users are

encouraged to adapt the output format from Module 2 to match the risk evaluation and ranking formats used in their organization's core risk identification and management processes.

Module 2 Outputs

Prioritized risks from Module 2 signal key areas of focus for Module 3, as tool users develop options for mitigating water-related business risks.

Using Source Protection Planning to Identify Source Vulnerabilities

The Coca-Cola Company

The Coca-Cola Company oversees the operation of more than a thousand beverage manufacturing plants in nearly 200 countries around the world. Water is an essential ingredient to their products. To assure a continuous supply of high quality freshwater, all facilities are expected to evaluate the reliability of water sources on which they depend.

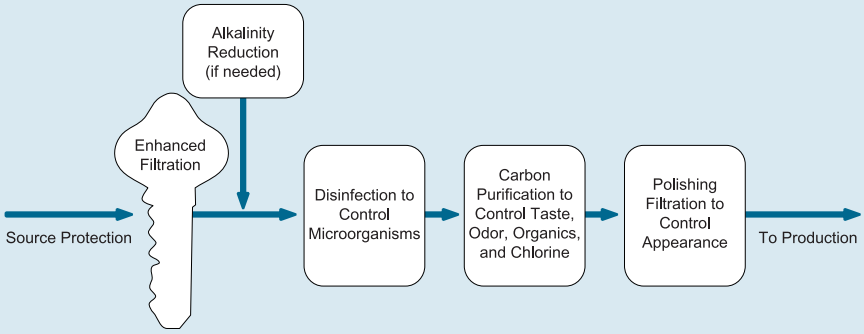
The Coca-Cola Company has recently undertaken source protection planning, a cost-effective program to improve the safety of their water treatment systems, without increasing treatment costs. Source protection plans must include a comprehensive assessment of potential sources of contamination, strategies to protect wellheads and aquifer recharge zones, and active participation in local watershed management efforts. Each of the 25 plants located in areas of water scarcity received increased technical and financial support from the regional offices, sometimes using consulting services to assess in-depth water supply reliability. A self-assessment tool was developed to support long term planning of water use for the bottling operations as well as for their broader hydrographic basins.

To assure high quality water in production, Coca-Cola plants operate a complete multiple-barrier water treatment system using the approach on the following page.

Watershed management initiatives may reduce treatment costs by improving the quality of the water inputs at the source. Reduced microbial load and lower concentration of nutrients, which will generate less algae, limit the need for expensive treatment steps.

For example, since 1995, a Coca-Cola bottling plant in Brazil has invested more than $2 million in partnership with the municipality and other businesses to protect the Jundiaí River watershed, the primary source of water for that community. As a result, two key sanitation projects (a new solid waste landfill and a new wastewater treatment plant) were built, dramatically improving the quality of the water reaching the reservoir. The plant, which is the largest in the Coca-Cola system, also improved water use efficiency by lowering its usage ratio from 2.9 to 1.7 liters of water per liter of beverage.

Module 2 Case Studies



Coca-Cola's Multiple-Barrier Water Treatment Approach

Educational activities focused on water conservation are also sponsored by the Jundiaí plant, including daily school visits to the new fish habitat created at the plant's wastewater treatment plant.

Coca-Cola is finding that source water protection is an effective business continuity strategy that can reduce costs, improve ecosystem health, and benefit the communities where it operates.

Managing Strategic Risk Through Innovative Wastewater Treatment

DuPont

DuPont operates a nylon and polyethylene manufacturing plant in Victoria, Texas along the Guadalupe River and Victoria Barge Canal. The plant, which began operation in 1951, historically relied on deep well injection as its sole wastewater discharge method. While this approach continues to be a wastewater disposal option approved by the U.S. EPA, DuPont was concerned about the business disruption that could result from increasing community concerns and potential regulatory changes that would restrict this technique in the future. To eliminate this risk, DuPont worked with experts and the local community to develop an innovative water treatment facility and wetlands water recovery system to replace DuPont's use of deep well injection.

DuPont modified production processes to recover and reuse over 250,000 pounds of material formerly lost to wastewater streams each day. Of this material, 75% is sold to customers or recycled as catalyst and raw material, and the other 25% serves as fuel and offsets natural gas use at the plant. The remaining wastewater is then treated in an on-site biological treatment facility, before being released to the newly constructed wetlands for further polishing prior to its return to the Guadalupe River.

The wetlands construction concept originated within the local Community Advisory Panel (CAP) in 1994. (CAPs are recommended and some type of formal community interaction process is required for all member facilities as part of the American Chemistry Council's Responsible Care® initiative.) Leading experts and consultants researched and developed the design for the wetland. Broad community input was sought and received through public meetings, addressing factors such as water quality, safety, aesthetic value, wildlife, and academic and community use of the habitat. Plans were also developed for a "Wetlab Education Center" at the wetlands, with nature trails and boardwalks, to conduct scientific and environmental education programs for the community.

Since the wetlands water recovery and treatment facility began operation in 1998, a variety of ecological and community benefits have emerged, including:

- The wetlands now host a variety of flora and fauna including hundreds of bird species
- More than 2.4 million gallons of recovered water are returned to the Guadalupe River each day
- Thousands of students have toured the constructed wetlands and participated in programs at the Wetlab Education Center

By building the wetlands treatment facility, DuPont found not only that the project provided needed functionality at competitive cost and reduced risk, but also that it created benefits for community education and habitat creation.

Module 3

Module 3: Business Opportunity Assessment

Module Purpose

Module 3 assists tool users to identify water-related opportunities in two main areas and to answer the following questions:

- What opportunities exist to proactively address costs and potential risks to the business associated with water use and impacts?
- What opportunities exist to create "top line" business value by addressing water challenges faced by others?

Water challenges can expand existing market opportunities and even create new ones.

The purpose of this module is to develop a range of options for responding to the water-related risks identified in Module 2. The ideas generated in this module will be considered and evaluated as the business develops a strategic direction and a water sustainability strategy in Modules 4 and 5.

Module Approach

Module 3 uses the *water sustainability concepts* (see page 4) as a framework for generating new ideas and opportunities to reduce "bottom line" risks and create "top line" business value. The concepts are drawn from the research of water sustainability experts and the innovative business responses to water challenges, as illustrated in the case studies in this tool. The concepts can be applied to each of the prioritized areas of risk identified in the current state assessment (Modules 1 and 2). For

For each water challenge identified in Module 2, companies should explore a broad range of sustainable options to reduce risk and increase water security.

Water challenges also present new opportunities to use core competencies to create "top line" business value.

example, to reduce overall use of water, a company may launch a water conservation initiative at its production facilities. Alternatively, to address water quality challenges through prevention, and engage local stakeholders, a company may invest in local watershed conservation initiatives to help ensure a safe, clean, and reliable water supply in the locality in which the company has operations. For each identified risk, there are likely to be numerous opportunities for mitigation of the risk or costs.

Other concepts can be applied to the search for business opportunities that address the global and local water challenges experienced by others. Global water challenges can expand existing market opportunities and even create new ones. This module is designed to assist companies in identifying such opportunities.

1 Step 1: Identify "Bottom Line" Risk and Cost Reduction Opportunities

- What actions can the business take to reduce the prioritized water-related business risks and costs in a manner consistent with the water sustainability concepts?

During this step, tool users are encouraged to draw from a number of different sources to develop a list of potential response actions for each significant risk identified in the current state assessment (Modules 1 and 2). The water sustainability concepts should be applied to each prioritized risk. For each risk, tool users may also want to categorize response actions into areas that require: 1) using new technologies, 2) adopting new practices, and 3) using incentives to motivate change in water use culture and behavior. The user may also want to organize a team to brainstorm a range of options. Certain actions, such as installation of meters, should be considered as an initial step, if more information is needed. Many opportunities to reduce water related impacts and risks are specific to certain industry sectors, operations, and processes.[1] There are numerous trade publications and industry-specific resources that include information on practices, technologies, and other techniques for addressing water use and impact issues. Case studies throughout this tool and on the website (www.gemi.org/water) provide examples of innovative opportunities to conserve, reuse, and recycle water, as well as to reduce water impacts. GEMI has also developed a guidance document to help businesses understand the ways environmental activities can add business value.[2]

www

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- Checklists of common opportunities associated with each water sustainability concept
- Links to resources on water conservation, reuse, and recycling

2 Step 2: Identify "Top Line" Value Creating Opportunities

- What water-related products or services can be developed that may lead to increased market opportunities and revenues?
- Are there opportunities to enhance corporate goodwill or safeguard the company's "license to operate" by addressing broader community water needs?

Step 2 is designed to help an organization identify value-creating opportunities for addressing the water-related needs experienced by others.[3] Depending upon the organization's core competencies, each organization may be able to identify areas in which it can create business value by addressing local and global water needs. Many companies are already developing new products and services that improve water quality. Others are developing products that use less water by consumers. Companies that follow evolving customer needs and expectations may find new market opportunities. Opportunities to provide indirect benefits can also be found through a more expansive view of a company's critical customers. Tool users should consider water-related actions that address the concerns of communities, regulators, employees, and financial markets. This approach is likely to foster creative thinking about potential business opportunities linked to water sustainability.

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- Key questions to identify opportunities for creating "top line" benefits

Module 3 Outputs

The options for mitigating risks and creating business value developed in Module 3 will be evaluated in the context of the strategic direction and goals established in Module 4.

Reducing Facility Costs with Water Reuse and Recycling

Abbott Laboratories

Ross Products, a division of Abbott Laboratories and a leading manufacturer of adult and pediatric nutritionals, including infant formula, has reduced costs and risk at several facilities by eliminating "non-value-added water use" and pursuing water reuse and recycling opportunities. At its Michigan plant, the installation of a new cooling tower enabled Ross Products to shut down three groundwater wells, reducing water use by over a million gallons per day. At other facilities, before discharge, boiler blowdown water is circulated through a heat recovery exchanger system to preheat water. Heat recovery projects save each facility over $30,000 per year. Water from process cooling is used for irrigation and cooling tower make-up water. Recovered water systems save some Ross Products facilities over $100,000 per year.

Ross Products' Arizona and Michigan facilities have taken creative steps to minimize potential wastewater discharge impacts to local surfacewaters from its nutritional operations. Wastewater with high biological oxygen demand (BOD) concentrations is applied to local fields used to produce straw grass for livestock feed. The recycled wastewater serves as a fertilizer while also reducing agricultural watering needs.

Redesigning Facility Water Use: A Watershed Management and Water Reuse Initiative

Bristol-Myers Squibb Company

Faced with a proposed expansion of a research and development campus in Hopewell, New Jersey, Bristol-Myers Squibb Company (BMS) developed a comprehensive Watershed Management Program to demonstrate corporate commitment to sustainable development principles. The Program is an integrative approach to managing water resources on-campus and downstream. The centerpiece of the Program is a water reuse initiative that will replace up to 500 gallons per day of groundwater and surfacewater with treated effluent from the on-site wastewater treatment plant. This treated water will be reused for non-potable uses, including heating, ventilation and air conditioning (HVAC) make-up water, fire protection water, and toilet flushing water. Currently, water from on-site groundwater extraction wells and diversion of surfacewater from an on-site stormwater detention pond serves these uses.

Using a structured method for gathering information, BMS conducted a rigorous study to assess water uses in the existing facility and proposed future development. They found that internal metering at multiple points is the most helpful assessment tool to determine water use. After evaluating opportunities for wastewater reuse, they developed a conceptual design and began construction in early 2002. Using existing infrastructure in the design controlled capital costs. When the system is operational, the watershed management project will support continued expansion of the Hopewell Campus by addressing community concerns, and providing increased ecosystem benefits to the local stream, wetlands, forest and agricultural habitats.

Developing Services to Address Customers' Water Conservation Needs

ConAgra Foods

United Agri Products, a ConAgra Foods company, has pioneered an innovative service through its mPOWER3 subsidiary that helps to improve agricultural productivity while reducing water use and improving water quality. The Greeley, Colorado company developed applications in its suite of software and web-based tools that assist growers to enhance the efficiency and effectiveness of agricultural and irrigation resources. Farmers synchronize mPOWER3's software on their personal computers with the company's web-based systems to share and process data. This software and information management service uses databases, historical algorithms, and geographic information systems (GIS) to process data on weather, soil, hydrology, and other factors that influence crop yields. The resulting information and maps enable growers to release water to plants when they need it, and not according to predetermined schedules. The result: less irrigation water and healthier crops. mPOWER3's systems also generate information that allows growers to better target and time pesticide and fertilizer use and application. The result: less pesticide and fertilizer use, less run-off of pesticides and fertilizer to surface waters, and healthier crops.

mPOWER3 is discovering that the market for these services extends beyond growers. Irrigation authorities, local governments, and other organizations are finding

Module 3 Case Studies

mPOWER3's information management and aerial imagery services to be powerful tools for managing water in a more sustainable manner.

Using Best Management Practices to Improve Water Quality

Eastman Kodak Company

Kodak wanted to demonstrate that an innovative regulatory option to reduce silver discharges from photoprocessing facilities could achieve environmental goals more effectively and efficiently than traditional regulatory approaches, delivering cost savings and simplifying municipal pretreatment program administration.

Kodak worked with The Silver Council, the Association of Metropolitan Sewerage Agencies, the U.S. EPA, and others to develop a best management practices approach to maximizing the recovery of silver and minimizing its release to the environment by recommending specific technologies, equipment, and management practices for controlling silver discharges. In 1995, the results of this collaboration produced the Code of Management Practice (CMP) for Silver Dischargers. Pollution prevention recommendations for facilities to minimize wastes and conserve water were also a key part of the CMP.

Both customers and regulatory authorities have experienced the benefits of the CMP. Municipalities can now implement the CMP as a legally authorized and fully enforceable element of their industrial wastewater pretreatment program, or as a voluntary program. Either approach provides a cost-effective alternative to traditional numerical discharge limits for silver and results in consistent and significantly improved silver recovery. The photographic industry's customers now have cost-saving tools for recycling a non-renewable natural resource (silver), conserving water, and ensuring environmental protection.

Building on Core Competencies to Expand Markets

Johnson Controls, Inc.

Johnson Controls is a leading manufacturer of automotive parts and a global leader in integrated facility management services and building controls systems. One of the company's goals is to provide energy efficient building systems and operations, designed explicitly to help customers conserve energy and protect the environment.

As part of their efforts to provide integrated, energy efficient systems in large commercial buildings, Johnson Controls develops Water Management Programs to reduce facility water use and provide cost savings. For example, a simple program of enhancing plumbing technology and metering water-cooled mechanical equipment at the Johnson City Medical Center in Tennessee reduced water usage by 22% and produced substantial annual cost savings. By adding water management as a new facility service, Johnson Controls has been able to create new markets, build top-line value, and offer a full scope of facility solutions. Johnson Controls has found that the cost savings from proposed water conservation measures often provide the additional funds needed to achieve paybacks from energy efficiency upgrades in a reasonable period.

The company is also expanding markets by promoting the construction of "green buildings" that include efficient water systems. They have participated in the U.S. Green Building Council's program, "Leadership in Environmental Energy and Design (LEED)," a building rating system that evaluates environmental performance from a "whole building" perspective, including impacts on local water resources. Johnson Controls, along with several partners, has developed a new initiative, Buildings for a Livable Future™. The initiative is designed to increase awareness of the positive impact that green buildings have on the natural environment, on providing healthier indoor environments, and on a company's bottom line. The company offers seminars on the topic across the nation.

Johnson Controls has also increased awareness of "green building" by constructing the Brengel Technology Center, the first LEED-certified building in the nation, next door to the company headquarters in Milwaukee, Wisconsin. The Center uses rainwater recovery, metering, and other innovative technology to reduce water use and discharge.

‹ Module 3 Case Studies

Cutting Costs by Recycling Materials from the Water Waste Stream

Olin Corporation

Olin Corporation has been continuously pursuing opportunities to meet one of their sustainability goals: reducing the amount of waste generated by their facilities. They have found that waste reduction activities can also result in increased revenues to the company and improved relationships with critical customers. Olin's Chlor Alkali plant in Niagara Falls, NY, recently received the New York State Governor's Award for Pollution Prevention for an innovative project that eliminated the daily discharge of 16,500 gallons of wastewater to the City of Niagara Falls' sewage treatment facility and that captures former waste materials for reuse in the company's manufacturing processes. The new recycling system, which has been successfully operating since January 2000, eliminated the discharge of a waste stream and cut costs by using recycled materials to help make saleable products, such as liquid bleach and hydrochloric acid.

Finding Solutions to Watershed Issues Through Effective Cooperation with Stakeholders

Southern Company

Southern Company is one of the largest electricity producers in the U.S., with more than 34,000 megawatts of electric generating capacity across the Southeast. The region's population has exploded by 63% since 1970, and is projected to almost double by 2015. This growth has placed significant pressures on the availability and quality of regional water resources. Southern Company subsidiaries rely on water in the production of power in its hydroelectric projects. Coal, gas, oil, and nuclear plants also require large quantities of water for cooling and other purposes. In light of the increasing pressures, Southern Company recognized the importance of working cooperatively in the region to balance and meet competing demands for freshwater resources.

Southern Company is in the process of applying to the Federal Energy Regulatory Commission (FERC) for new operating licenses for its hydroelectric projects on the Chattahoochee River. The river supports a wide diversity of uses, including other industries, recreation, municipal water treatment, and ecosystem functions. Southern Company is faced with the challenge of reaching agreement among river stakeholders on project operations that will allow the company to continue providing affordable and reliable energy to the growing region, while meeting the shared water needs of the community and the ecosystem. Southern Company has found that paying close attention to the interests of stakeholders and addressing resource agency issues can result in successful outcomes for the company and the community.

Because of the company's attention to building relationships with key stakeholders, Endangered Species Act consultations with federal agencies resulted in a positive outcome. In addition, an agreement was reached with a major property owner to protect river tributaries and local NGOs agreed to a process to monitor water quality outside the relicensing proceedings.

Southern Company has learned that solving water problems cooperatively requires building trust among the parties and following a number of simple guidelines:

- Establish clear ground rules and boundaries early in the process. Be prepared to be flexible, but stick to established guidelines. The regulatory framework often provides guidance, but it requires strong company discipline to contain the scope of the process to the relevant issues.
- Do your internal homework by clarifying company goals, strategy and decision-making authority; and understanding the full range of facility issues.
- Do your external homework by understanding interests and communicating clearly with stakeholders and regulators.

Module 4

Module 4: Strategic Direction and Goal Setting

Module Purpose

Based on an evaluation of the potential water-related risks and opportunities, the tool user must decide if there is a sufficient business case for engaging the organization in the development of a water sustainability strategy. This preliminary assessment necessitates some consideration of organizational factors, such as the business mission and policies, current goals and priorities, and organizational receptivity to addressing water sustainability issues and risks. Using information on risks and opportunities identified in Modules 2 and 3, Module 4 assists tool users to establish the business case and a general direction for pursuing a water sustainability strategy. Module 4 helps tool users to answer the following questions:

- What business case exists for pursuing a water sustainability strategy?
- What are the company's goals related to water sustainability?
- How can the organization be best engaged in pursuing a water sustainability strategy?

The benefits of addressing water-related challenges, such as reduced risk, enhanced competitiveness, and improved relationships, become more salient in making the business case when they relate to important business priorities or critical customers' expectations.

Module Approach

1 Step 1: Assess the Strength of the Business Case for Pursuing a Water Sustainability Strategy

Assessing the business case typically involves comparing the *cost of action* to address an opportunity or risk with the *benefits derived from taking action*. If the value of pursuing an action is greater than the costs associated with the action (adjusting future costs and benefits with a time discount rate), then there is likely a business case for doing so—a positive net present value (NPV). This NPV approach applies whether one is determining the business case for upgrading a wastewater treatment facility or assessing the business case for establishing a cross-functional committee to develop a company water strategy.

The challenge often lies, however, in determining the cost and benefits of taking action. While the organizational costs of taking action are often relatively straightforward to estimate, the benefits—or avoided costs of inaction—can be more difficult to quantify due to future uncertainty. Estimating the value of less tangible benefits, such as reduced risk and improved relationships with critical customers, can be particularly difficult.[1] Some companies have developed or adapted "total cost assessment" or probabilistic risk assessment tools to support their efforts to determine costs and benefits. Nonetheless, business managers are accustomed to making decisions that involve weighing difficult-to-quantify costs and benefits.

Yet the common toolbox of valuation and decision-making tools, such as NPV, can lead companies to underestimate the value of decisions and investments that create options for future action. Recent research has highlighted the difficulty of selecting appropriate discount rates for comparing short-term costs and longer-term benefits of environmental investments.[2] New tools, however, are emerging to assist business managers in making investment decisions amidst significant uncertainty about the future. The concept of "real options" adapts financial options tools to the evaluation of a business' opportunities.[3] Incorporating the value of future "options"—such as secured access to sufficient quantities of clean freshwater at an affordable price—into corporate decision-making can significantly improve the financial attractiveness of strategic investments. Steps that expand, or keep open, future options for a company often create value. For example, a company's investment in watershed protection could contribute to a valuable future "option" for its facility to expand production capacity in the future by alleviating local water quality pressures.

Even when the benefits of pursuing an action outweigh the costs (e.g., a positive NPV exists), the activity may not compete effectively for limited organizational investment resources and attention. Some water sustainability projects may be too small to easily attract management interest, or they may have a lower return on investment than other projects under consideration. To the extent that investments in water sustainability initiatives can reduce costs, increase competitiveness, safeguard the business' "license to operate," and remove potential constraints to future growth, these benefits are likely to resonate with company leadership. The benefits of addressing water-related challenges, such as reduced risk, enhanced competitiveness, and improved relationships, become more salient in making the business case when they relate to

important business priorities or critical customers' expectations.

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- References and links to information on total cost assessment, options valuation, and making the business case for environmental initiatives
- Key questions to identify organizational priorities and customer expectations

2 Step 2: Identify the Organization's Water-Related Goals

Most companies have three explicit or implicit core goals related to water: comply with all applicable regulatory requirements; assure continued access to sufficient supplies of clean freshwater at an affordable price to meet the company's needs; and maintain "license to operate" through attentiveness to community needs and concerns.

Some companies see value in pursuing additional water goals to mitigate potential long-term risks, to address the expectations of critical customers, or to support certain sustainability commitments. Tool users should seek to understand the organization's explicit and implicit goals related to water and sustainability. Through their environmental management systems, many companies have developed vision statements, policies, and goals stating their commitment to environmental performance and, sometimes, sustainability. These may include specific goals addressing water security, water use, and water impacts. If not, they may provide insight into implicit water goals. For example, "working with communities in which the company operates to address their environmental concerns" may be a commitment that implies certain goals or focus areas related to water.

Common Business Water Goals

- Comply with applicable regulatory requirements
- Assure continued access to sufficient supplies of clean freshwater at an affordable price
- Maintain "license to operate" through attentiveness to community needs and concerns

For businesses that pursue a coordinated water strategy, there may be value in engaging multiple levels of the business—facility, business unit, corporate—as well as critical customers and interested members of the community, in establishing clear water-related goals and targets.

3 Step 3: Set Strategic Direction to Engage the Organization

Determining *whether* to engage a business in pursuing a water strategy depends on the strength of the business case. The strength of the business case will largely depend on the importance and magnitude of opportunities and risks facing the business (identified in Modules 2 and 3). Determining *how* to best engage a business in pursuing a water strategy depends on three key factors: the organization's culture, the organization's existing strategy and planning infrastructure, and employees' perceptions of water resources, opportunities, and risks.

> Fitting the Strategy Approach to the Organization

Strategies are typically designed to ensure coordinated action to achieve a desired goal. For some companies, particularly those with a weak or

narrowly focused business case, a water strategy may concentrate on specific opportunities or risks. Such a strategy might not engage many functions in the organization and not establish many water-focused activities, such as creation of a water task force. For other companies, the business case may be sufficient to engage the organization in a broad-based effort to pursue a coordinated water strategy. Such an approach would ideally involve multiple business functions to ensure that the water strategy and goals are effectively integrated into existing business processes. The approach that fits best will vary from company to company, and it may change over time. Module 5 provides guidance to ensure that whatever approach is selected contains a continual improvement framework for identifying emerging opportunities and risks that may alter the business case in the future.

> Identifying Whom to Engage

Tool users should identify key people and business functions within the organization to approach regarding the business case for pursuing a water strategy. Most tool users are probably well aware of their business' organizational culture and strategy, planning, and decision-making processes. From this understanding, one can identify who within the organization needs to be aware of the business case for pursuing a water strategy. There may be other personnel or functions within the business that may be affected by a key water opportunity or risk. For example, opportunities to develop partnerships with community-based water organizations may be of significant interest to senior business managers and external affairs staff.

> Building Organizational Interest

In many organizations, business personnel are accustomed to thinking about water resources as a "limitless frontier," without constraints or significant direct or indirect costs associated with water use. Other businesses may not be accustomed to thinking about potential risks associated with the final disposition of the company's products. In such cases, it may take substantial time and effort to change the organization's perceptions of water from "limitless frontier" to "valued resource and potential business opportunity." Several tips for raising organizational water awareness include:

- Measure water use and post results
- Charge departments or product cost centers for water use and treatment costs instead of including them in facility overhead
- Include water-related costs in project and product investment decisions
- Solicit employee suggestions for water conservation and recognize successes

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- Key questions to identify whom to engage in the organization
- Additional tips for raising organizational water awareness are included in the matrix tool under Module 5

Module 4 Outputs

Assuming a sufficient business case has been established, Module 4 assists tool users to identify the organization's water-related goals, as well as a strategic approach for engaging the organization in developing a water strategy.

Module 4 Case Studies

Using Performance Goals to Focus Organizational Attention to Water Sustainability

Georgia-Pacific Corporation

Georgia-Pacific (G-P) is one of the world's leading manufacturers and distributors of pulp and paper and building products. Paper mills use a significant amount of water in their operations and their wastewater discharges can impact water quality. Manufacturing packaging materials and thermosetting resins had the potential to save money by recycling or reusing wastewater. In 1994, in order to support G-P management's recognition that strong environmental and safety performance is vital to strong financial performance, the company established clear environmental performance goals in all the environmental media. By setting environmental performance as a top and measurable priority, the CEO led the company on a path toward environmental leadership.

G-P's 1994 Environmental and Safety Report established nearly 60 goals, with associated performance measures, to track environmental progress in each of the categories. The five water pollution prevention goals included:

- Beneficially reuse process wastewater or become closed loop at all G-P chemical plants by 1998.
- Beneficially reuse process wastewater or become closed loop at all G-P packaging plants by 2000.
- Reduce, through waste treatment plant upgrades, total suspended solids (TSS) per ton of product 25% by 1998 and biochemical oxygen demand (BOD) per ton of product 15% from pulp and paper mills by 1998, using 1993 as a base year.
- Measure the impact of color discharges from each major pulp and paper mill to the receiving water body using a delta system, with 1995 as a baseline. Apply Best Management Practices (BMPs) to develop site-by-site cumulative color delta reduction targets to be achieved by 1998.
- Complete underground storage tank upgrades or removals by 1998.

In 2000, after making significant progress toward meeting these goals, G-P developed, with input from employees, new performance measures to track continuous improvement of corporate-wide and individual business unit performance. The measures are designed to help employees, shareholders, communities, and others better understand and evaluate environmental performance. For example, water use is now measured in terms that are more directly integrated into the business bottom line, such as gallons per ton of product produced. These measurements provide incentives for individual business units to reduce costs associated with water use and discharge. In addition to the measurable improvements to performance since 1994, G-P has found that the principles and goals have helped build a new culture among G-P employees. Using the goals and the performance measures established in 1994, environmental protection and safety awareness have moved beyond being special programs and have become a way of life throughout the company.

Engaging Corporate-Level Support for Plant-Level Water Initiatives

Intel Corporation

Intel operates semiconductor fabrication and assembly/test facilities in seven countries around the world. Water is a primary production input used to clean silicon wafers during fabrication and packaging. Because of the sensitive nature of these processes, ultra pure water must be used. Several of Intel's plants operate in locations where water resources are limited, such as Chandler, AZ; Albuquerque, NM; Hudson, MA; and Israel.

Because the company operates water-intensive manufacturing plants, it has had to share limited resources with competing water needs in the local community, such as municipal drinking water and sanitation, ecosystem protection, agricultural production, and other industrial uses. Historically, Intel has responded to the community challenges at the plant level in different ways, reflecting local concerns and conditions. For example:

- In Albuquerque, NM, Intel used an integrated water management system to increase water purification efficiency and to improve water reuse. The site has offset over 50% of its freshwater needs through water reuse.
- In Chandler, AZ, Intel sends treated process water to an off-site, city-maintained treatment plant that further treats the water to drinking water standards before re-injecting nearly 1.5 million gallons per day to recharge the underground aquifer.
- In Hudson, MA, a state-of-the-art water management facility allowed Intel to boost production by more than 50% without increasing current levels of discharge to the local treatment plant.

‹ Module 4 Case Studies

- In Israel, wastewater is treated to stringent quality standards and then used for irrigating crops.

Although Intel recognizes the importance of meeting local water challenges with responses tailored to local conditions, it also realizes that it needs to support local efforts with broader company resources. As part of a strategic water management program, Intel established the Corporate Industrial Water Management Group to develop and implement program elements to improve water use efficiency at their major manufacturing sites. The group includes representatives from fabrication sites, corporate technology development experts, and regulatory compliance staff. The goals of the group are to:

- Develop water management strategies, standards, and tools to provide effective use and reuse of industrial water to satisfy new and existing manufacturing site requirements for sustainability, growth, and environmental compliance
- Develop tools to effectively communicate water use data throughout the corporation

The Group is helping Intel design appropriate local responses to local issues in the context of a company-wide approach. A number of benefits have emerged from Intel's water management efforts:

- Intel's worldwide water use has increased at a rate less than the production growth
- Principles of water management supporting water reduction, reuse, and recycling are now applied across all Intel sites and support each facility's development of water management strategies
- The Group has developed a set of technology packages that can be applied to meet the diverse water needs of each facility
- Intel has developed an Environmental Awareness team dedicated to raising awareness about water issues within the company and externally
- Intel's efforts have improved relations with local communities in water-stressed areas, such as New Mexico and Arizona

Engaging Employees to Reduce Water Use and Impacts

Novartis Corporation

Gerber Products Company, a producer of baby foods, discovered that employee education and involvement related to water management at its Fremont, Michigan plant can yield significant returns. Gerber is a business unit of Novartis Consumer Health, Inc. In January 2000, the plant's Water Team kicked off a year-long effort to cut water consumption. By year's end, they had saved 67.5 million gallons of water compared to 1999.

The Water Team worked with all areas of the plant to survey water use, collect water conservation suggestions from employees, and identify specific opportunities. Numerous projects emerged from the plant's water conservation initiatives, including:

- Installation of new equipment that uses 30% less water to cool jars of hot baby food
- Recycling of wastewater to wash down the plant's floors, gutters, and drains
- Recycling of wastewater to irrigate corn, oats, and alfalfa grown for animal feed on a 420-acre farm owned by Gerber four miles down the road

Gerber health, safety and environment personnel found that employee education was key to the plant's success, making wise water use a habit. The Water Team produced a video to increase employees' awareness of water issues and plant water use. Among other topics, the video encourages employees to routinely check for leaks and drips to reduce wasted water. Employee involvement with Water Team activities, combined with the video and other awareness raising efforts, has helped to change employees' water management behaviors while enlisting them in company efforts to continually improve the plant's water-related performance.

Module 5

Module 5: Strategy Development and Implementation

Module Purpose

Module 5 brings together the results of Modules 1 through 4, enabling the organization to develop a water strategy tailored to its needs and circumstances. Effective strategies are typically composed of measurable goals, achievable targets, clear responsibilities, prioritized action plans, and defined continual improvement processes. This module prompts the organization to consider how a range of continual improvement might be implemented across multiple business functions and activities to achieve a company's desired water sustainability goals. This module helps an organization answer the following questions.

Effective strategies are typically composed of measurable goals, achievable targets, clear responsibilities, prioritized action plans, and defined continual improvement processes.

- What roles should various business functions play in the development and implementation of a company water strategy?
- What steps and actions can the business take to achieve its desired water-related goals within a continual improvement framework?

The activities addressed in Modules 4 and 5 produce the building blocks of a company's water strategy—goals, roles and responsibilities, and action plans. This information could be organized into a comprehensive business water strategy or incorporated as specific elements into broader business strategy and planning efforts, depending on the company's needs.

Module Approach

Companies are likely to have established environmental and business strategy and planning processes. Integrating, or at least coordinating, water strategy development activities with these broader, established strategy and planning processes can mainstream the organization's water strategy, enhancing both efficiencies and effectiveness.

www For example, GEMI's SD Planner™ (www.gemi.org) provides a framework to assist organizations in their development and implementation of a comprehensive approach to sustainable development that encompasses water-related issues.

Step 1: Identify the Roles that Various Business Functions Can Play in Developing and Implementing a Business Water Strategy

The type of opportunities and risks, the strength of the business case, and the focus of the strategic direction determined in Module 4 should illuminate the roles that various business functions can play to support achievement of the business' desired water-related goals. Many of the companies profiled in the case studies have found significant benefit in engaging multiple business functions in developing and implementing the organization's water strategy. Cross-functional involvement broadens ownership for tracking and managing water opportunities and risks. It also promotes incorporation of water awareness into established business processes and activities. The following business functions can often play an important role in developing and implementing a business water strategy: Senior Management, Plant Management and Operations, Public and Government Relations, Marketing, Product Development, Project Leaders, Facilities, Research and Development, and Engineering.

At the same time, securing time and attention from various business functions to address water issues often necessitates that they understand the potential benefits of and business case for their involvement. In some situations, the business case may not be strong enough to warrant their time and attention.

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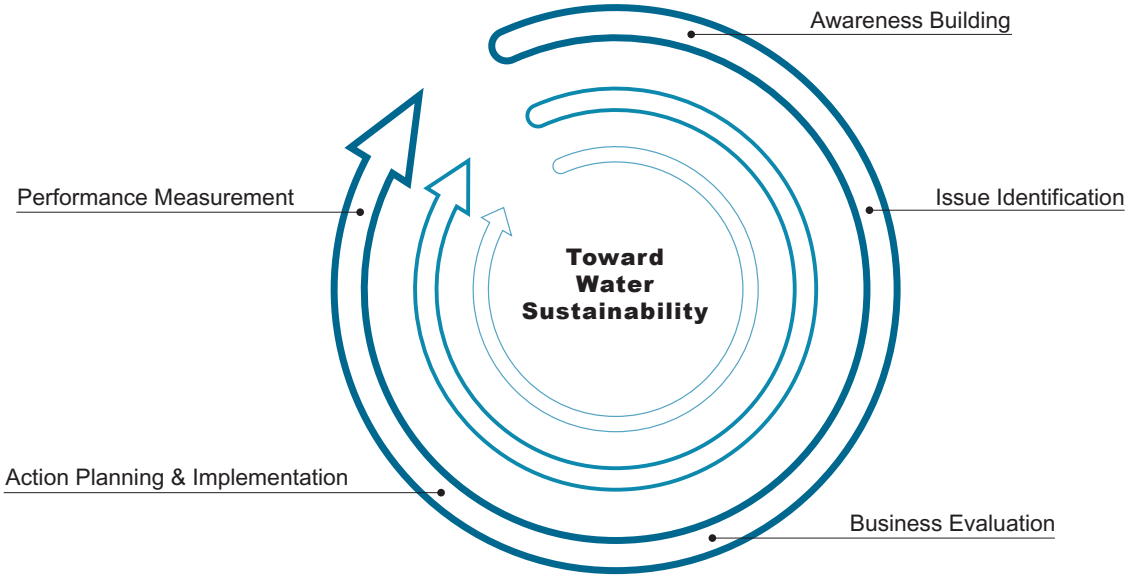
- List of common roles that various business functions can play in the development and implementation of a company water strategy.

Step 2: Identify and Implement Specific Actions to Achieve the Organization's Water-Related Goals

Actions will typically fall into two categories. First, there are actions designed to address specific water-related opportunities and risks. These actions will support key opportunities identified in Module 3. Second, there are actions designed to ensure that the organization effectively identifies, evaluates, addresses, and monitors water opportunities and risks into the future. Such actions focus on awareness building, issue identification, business evaluation, action planning and implementation, and performance measurement. For most companies, these continual improvement actions will fit well into their environmental management systems and into the Plan-Do-Check-Advance process that has been a hallmark of GEMI's tools.



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- Descriptions of the five continual improvement process areas – awareness building, issue identification, business evaluation, action planning and implementation, and performance measurement
- Matrix tool suggesting actions (supported by links to case studies and resources) that various business functions can take to foster the development of a continual improvement-based water strategy

Module 5 Outputs

Completing Module 5, organizations should have a water strategy tailored to the company's needs and circumstances. The strategy should lay the foundation of a continual improvement system to identify, evaluate, address, and monitor water-related opportunities and risks.

Module 5 Case Studies

Engaging the Organization in Water Strategy Implementation

Anheuser-Busch Inc.

High quality water is an essential ingredient throughout Anheuser-Busch's (A-B) value chain, from irrigation water for grain crops to brewing water for beer. To ensure that sufficient organizational attention focuses on water conservation and other water issues, A-B is engaging multiple parts of the organization in developing and implementing the company's water strategy.

Operations-focused solutions. Facility personnel play a major role in identifying and implementing water conservation initiatives. With corporate assistance, A-B facilities have implemented water meters and information systems to provide facility personnel with real-time information on water use throughout facility processes. A-B facilities use this information to develop a "roadmap" of water uses and flow rates, using a water balance approach. Process engineers, utility conservation engineers, and other specialists from the facility and corporate EHS use these roadmaps to identify specific water-saving opportunities. For example, in 2000, a multi-disciplinary Utilities Task Force at A-B's Williamsburg, Virginia brewery identified opportunities to save over 175 million gallons per year. A review of the facility's automated cleaning processes revealed an opportunity to reduce rinse water by 36 million gallons per year. In addition, at an employee's suggestion, bottle and can rinsing equipment in the packaging area was recalibrated, saving 24 million gallons of water annually.

Plant managers and water reliability. A-B plant managers play an essential role in assuring the long-term reliability of local water supplies. Plant managers are responsible for building relationships with local water utilities and suppliers to help ensure that local water sources are managed in a sustainable manner. A-B has developed a "water reliability survey of long-term fundamentals" to assist plant managers in working and planning with local water supply managers to maintain the health and reliability of local and regional water sources.

Corporate support. A-B established a Corporate Water Council to support and coordinate efforts across the company to address water opportunities and risks. The Council meets quarterly to discuss emerging water issues, opportunities, and the company's progress towards addressing water challenges.

Tracking Water Performance: Metering and Metrics

DuPont

DuPont began to explore potential water metrics in the mid-1990s as part of the company's growing focus on sustainability. The effort met initial internal resistance at the facility level due to "metrics fatigue" and concerns that certain metrics definitions related to water "consumption" would unfairly penalize some facilities when compared to others. Over time, EHS staff built awareness at the facility level, used examples illustrating the benefits of metrics, and made a sufficient business case for proceeding. DuPont formed a team of corporate and facility personnel, supplemented by water resource and engineering experts, to determine how to best approach water performance measurement.

The team examined water metrics developed by other companies and found total *water intake* to be the most commonly measured parameter. After significant consideration, the team opted to measure four key aspects of water use:

- Consumption of potable water—a measure of all water withdrawn from municipal potable supplies (considered 100% consumption)
- Consumption of groundwater—a measure of all water withdrawn and displaced from groundwater sources, even if returned to surfacewater (considered 100% consumption)
- Consumption of surfacewater—the "consumed" portion is the difference between the intake and outtake volumes
- Total water intake from surfacewater—a measure of total water withdrawn from surfacewaters, including water returned to surfacewater bodies and water consumed through evaporation, irrigation, or other uses

Facilities routinely enter this water data into DuPont's environmental information systems, enabling roll-up and analysis of the data by location, region, business unit, or other criteria. Under DuPont's Corporate Environmental Plan, facilities are required to develop performance goals and targets associated with these water metrics to foster improvement over time.

Challenges

Overcoming Challenges on the Path to Water Sustainability

As companies develop strategies to address water issues, they may encounter resistance due to established water management practices, perceptions, and policies at the global, national, regional, and local level. At times, corporate culture, public policy, and/or market forces may be strong enough to discourage pursuit of more sustainable water management practices and strategies. Yet, delaying may result in missed opportunities for market leadership or environmental improvement, as well as difficulty in pursuing more sustainable options later.

This section is intended to help tool users anticipate and identify such obstacles and perceived obstacles. It also offers tips and strategies for overcoming these challenges.

It is not always easy to see the benefits of investing in sustainable water activities, especially in the face of existing public policy disincentives. Taking a leadership role in your company or sector may entail risks, but you may reap important benefits by improving your relationships with critical customers, such as government regulators, shareholders, employees, community groups, or financial institutions.

Taking a leadership role in your company or sector entails risks, but you may reap benefits by improving your relationships with critical customers.

Common Misperceptions about Water Management

"The price of water does not always justify conservation activities."

With low water prices, it can be difficult to make a business case for investing in conservation projects. In some cases, direct and hidden subsidies may be present within or external to the business that mask the true costs of water. These costs can often be "surfaced" to give a more complete picture of water-related expenses at a facility or company. The price of water is not likely to be fixed (or may be fixed only for the short-term) and may rise quickly or unexpectedly in the future.

> Tips

- Conduct a water use audit (possibly in conjunction with a local utility) to understand how much water is being used, for what purposes, at your facility.
- Prioritize potential water saving activities. Look for "low hanging fruit," where a business case is easy to make.
- Consider indirect costs associated with water use, such as related maintenance of plant and equipment, electricity required for pumping, etc., in cost/benefit calculations.
- Use increasing future water prices in projections. Overall trends point to lower subsidies and/or higher prices in the future.
- Calculate other environmental and social "costs" of water use. Reducing water use may provide other benefits to the company by supporting its "license to operate" in the local community.

"If I do not use all of my water allocation this year, I will lose my water rights."

Water law in some regions of the U.S., and in many other countries, promotes "use or lose" policies for individual water rights holders. At times, using less water may result in the loss of a valuable property right.

> Tips

- Consider water bank programs that allow saved water to be used for in-stream flow in many areas, while preserving existing water rights.
- Consider leasing saved water.
- Consider selling water rights to government agencies or non-governmental organizations (NGOs) for in-stream flow, or as part of a conservation easement.
- Consider participating in programs that allow trading of ecosystem services or water quality credits.
- Collaborate with other water users to create a water conservation trust that can work with several parties to develop efficiency incentives.

"If I conserve now, my share will be reduced further in times of drought or reallocation."

During drought or other periods of reduction, water purveyors generally give no consideration for previous conservation efforts. Companies may believe they would be better prepared to respond to these events if they had maintained high levels of water use.

> Tips

- Negotiate upfront agreements with water purveyors for assuring access to adequate quantities during times of shortage in return for conservation measures.
- Evaluate a wide range of options, including alternative source identification, in preparing drought contingency plans.
- Consider activities that reduce vulnerability to supply disruptions.

"If I reduce my water use, local utilities will have to raise water rates to pay for system operations."

Because utilities generally set rates based on water usage, the high fixed costs of local water systems can create a disincentive for conservation. Conservation may result in higher rates to users to meet fixed costs. For example, after successfully encouraging conservation during a drought in Seattle, Washington in 2001, the local utility announced that it may need to increase water rates to recover lost revenue.

> Tips

- Encourage local water purveyors to search for solutions that will lower fixed costs without decreasing capacity or water quality (i.e., investing in watershed protection or demand reduction programs).
- Recognize that rate increases can result from a variety of factors/influences.
- Recognize that conservation efforts may still result in reduced total costs to the company despite rate increases.

"If I reduce my use or improve water quality, there is no guarantee that the benefits will flow to ecosystem restoration or other public purposes."

Use of shared public resources is said to result often in "the tragedy of the commons." The "tragedy" is that sharing resources creates an incentive for individuals to compete for and overuse, rather than conserve, those resources.

> Tips

- Participate in watershed groups that represent all landowners, managers, and users. Reach joint agreements about watershed protection activities.
- Consider leading by example and challenging others to contribute to watershed protection and water conservation efforts.

"The public is not ready to accept the use of recycled water."

There may still be low public understanding of the potential health effects of water reuse and recycling activities.

> Tips

- Take an incremental approach. Build on the success of other efforts. For example, many golf courses are now using recycled water for landscaping. The public seems to accept this use.
- Include local groups during the development of ideas for water reuse or recycling.
- Provide public outreach and education about use of recycled water.
- Use or develop certification systems to provide product branding benefits.

Water Trends

Awareness of global, regional, and local water trends can ensure that organizations have time to plan and act before crises arise. This section presents several important water trends. See the website (www.gemi.org/water) for more trend information and resources.

Supplies of freshwater are stretched to meet the demands of growing populations, increasing industrial development and agricultural production, and ecosystem and wildlife protection.

- Although most of the world is not running out of freshwater, a number of regions face chronic freshwater shortages
- In the future, water shortages are likely to spread due to increasing demands, unsustainable withdrawal rates, difficulty in finding new supplies, pollution and source water contamination, and changing climatic and precipitation patterns
- Water shortages impact regional security by causing human health problems and population displacement, increasing conflicts between competing users, and damaging ecosystem health
- While regulatory responses are becoming more stringent, watershed-based management approaches are expanding

I. Freshwater Supply, Quality, and Availability Trends

The world is not running out of freshwater resources, but freshwater is not uniformly distributed. A number of regions are experiencing chronic freshwater shortages.

Less than one percent of the world's freshwater is readily accessible and located in the lakes, rivers and streams that cross our continents.[1] Although

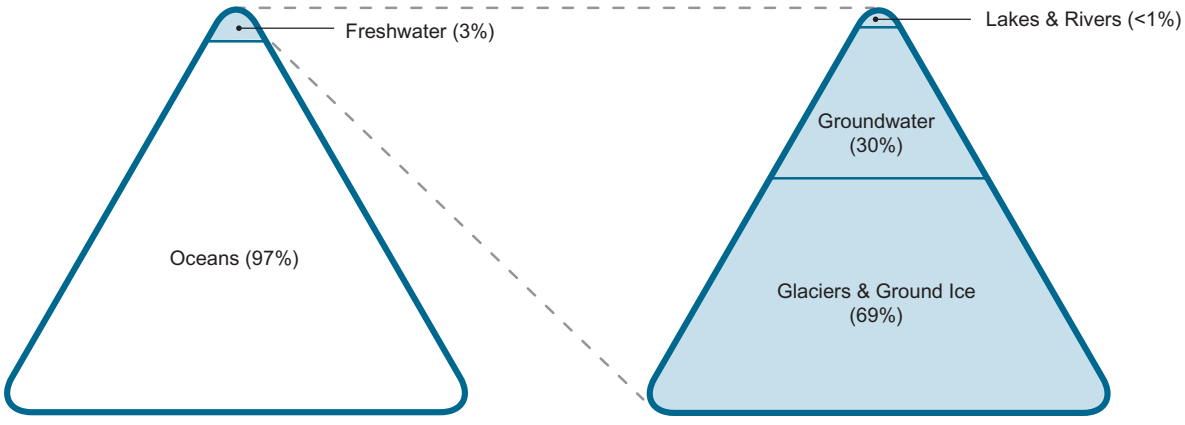
freshwater is a finite resource, the world's water cycle is constantly renewing itself. Rain and snow supply enough new water every year to inundate all of Europe under almost seven feet of water.[2] But freshwater resources are not uniformly distributed, and many regions are suffering from shortages.

The Middle East, North Africa and the Southwestern U.S., among other regions, have long been familiar with water shortages. Increasingly, shortages are occurring even in places that have access to relatively large amounts of water. China is facing severe surface and groundwater supply problems as it irrigates croplands to feed its enormous population. The Ganges River in India and the Chao Phraya River in Thailand, both of which are in monsoon regions, now experience times in the year when little or no water reaches the ocean.[3] The Pacific Northwest of the U.S., well known for its wet weather, and states from Maine to Georgia have recently experienced several summers of drought.[4]

The severity of water shortages varies greatly from place to place. Some areas face issues such as hydroelectric power shortages, decreased crop yields, and loss of species habitat, while some less developed nations confront the true crisis of insufficient water for basic human needs. Despite this range of differences, an important commonality is emerging in all global water resource issues. Shortages and conflicts are less the result of insufficient technological or infrastructure capacity for accessing new sources and more a result of water demands surpassing the availability of local freshwater resources.

Increasing human demands for water and unsustainable rates of water withdrawal are likely to worsen water shortages. Other factors also have the potential to affect long-term water availability.

40% of the world will live in water-scarce regions by 2025.[5] Factors likely to contribute to these predicted water shortages include population growth and unsustainable rates of water withdrawal. The United Nations currently estimates global annual



Accessible, Clean Freshwater Is a Small Fraction of Total Global Water Resources

population growth at 1.2%, which translates to an increase of 77 million people per year.[6]

Current data indicates that 10% of the global agricultural harvest—180 million tons of grain—is produced by depleting groundwater supplies.[7] Extensive surfacewater withdrawals for irrigation have also contributed to the dramatic shrinking of some of the world's great freshwater bodies including the Aral Sea and Lake Chad. Given that agricultural irrigation is the world's largest use of freshwater, accounting for twice as much as the industrial and domestic sectors combined, these unsustainable rates of withdrawal have already caused water shortages and will likely cause more.

Some researchers have identified potential linkages between changes in the earth's climate and water availability. This research suggests that changing precipitation patterns could lead to possible disruptions of traditional weather and run-off patterns and affect regional water supplies. Changing temperatures could also decrease the storage and subsequent slow release of moisture from snow and ice.[8]

Pollution of existing freshwater supplies exacerbates water constraints and shortages. At the same time, water management advances are providing water quality and availability improvements.

Surfacewater and groundwater pollution effectively decreases the quantity of usable freshwater. Many of the world's lakes, large rivers, and most of its estuaries have been contaminated with industrial, municipal, and agricultural runoff and effluent discharges. Contamination of surfacewater has led many regions of the world to turn to groundwater.

While most of the planet's groundwater remains pure (largely a result of the fact that there is almost 100 times as much freshwater underground than there is on the earth's surface), contaminants such as pesticides, nitrogen, petrochemicals, radioactive waste, and a variety of heavy metals increasingly threaten these supplies.[9] The pollution of groundwater aquifers is not just significant for localized groundwater users but also for surfacewater users since the base flow for major rivers such as the Mississippi, Niger, and Yangtze comes from groundwater sources.[10]

Significant progress has been made in developing technologies and best practices for conserving, purifying, recycling, and desalinating water, all actions that effectively increase freshwater availability. In the developed world, basic efficiency measures are now widely practiced in the industrial and commercial sectors and include the use of low-volume plumbing fixtures, reduction of irrigation schedules, and efficiency improvements for water-cooling technologies and equipment. Industrial dischargers generally employ best available pollution control technologies. Basic drinking water and sewage treatment are in place throughout the developed world and some developing nations. More efficient and effective technologies are gradually emerging.

While desalination is not yet cheap enough to be broadly applicable, the technology has advanced significantly, most notably in the technique of reverse osmosis (RO), which uses pressure and semi-permeable membranes to filter salt or other contaminants from water. The effectiveness of RO has increased, as has the durability and dependability of membranes used in the process.

Many areas of the world are taking advantage of improvements in wastewater reuse and reclamation technology. In Singapore, recycled and reclaimed water is emerging as an essential alternative to water from the mainland. By 2010, the island country aims to meet 20% of its water needs through reclaimed water. A new water treatment facility will have the capacity to produce "Newater" (a term coined by the Singapore Utilities Board), reclaimed water with an even higher purity than the standard potable supply.[11] In arid Namibia, wastewater-recycling technology has helped meet water needs in the capitol city of Windhoek at less than half the cost of developing new sources of supply.[12]

Expansion of freshwater supplies is increasingly costly and controversial.

In the past, as demand for water has increased, society's focus has been on addressing this demand through increases in supply. However, this solution is becoming increasingly difficult and costly and may soon be infeasible in many areas.

No longer does the drilling of additional wells sufficiently address agricultural supply issues. The area of irrigated land using water from the Ogallala Aquifer in the Western U.S. has decreased since the 1970s because of falling water tables and rising pumping costs.[13] While advanced desalination technologies have been implemented in some energy rich, water poor areas of the world such as the Middle East, overall costs remain prohibitively high in most places due to the large amounts of energy and capital required.

Large diversion and storage projects are also increasing in cost and decreasing in feasibility, especially as ecological and social costs are considered. China has long proposed the diversion of its southern rivers, such as the Yangtze, to the country's northern plains to satisfy increasing demand for irrigation water. However, the potential financial, social, and environmental costs of the project have made it very controversial. In 1991, Libya completed a $25 billion water diversion project that pipes water from desert aquifers to the coastal population centers, but these types of projects are unlikely to solve growing freshwater supply problems.[14]

II. Social and Environmental Dimensions of Water Issues

Inadequate supplies of clean freshwater contribute to a broad range of public health issues, especially in the non-industrial nations and some developing nations.

Human health can be affected by freshwater problems ranging from contamination of municipal water supply sources to pollution of water bodies used for fishing or recreation. Pathogens that cause acute illness and disease, or chemicals that can be carcinogens in high concentrations, can affect drinking water supplies. Non-industrial and developing nations face the most serious threats to human health from inadequate freshwater supplies. Various sources estimate that 1 to 1.5 billion people lack access to safe drinking water, 2 to 3 billion people lack access to proper sanitation, and 14,000 to 30,000 people die each day from water-borne illnesses.[15] These astonishing numbers represent a significant challenge for individuals, governments, and businesses in coming decades.

Drought, freshwater depletion, and floods contribute to population displacement.

Freshwater shortages, and attempts to address them through diversion and storage projects, have displaced large numbers of people. As lakes and rivers dry, people dependent on these resources are forced to move. Experts estimate that dams displaced 40 million people in the 20th century. Official records show that at least 10 million were displaced between 1960 and 1990 in China alone.[16] Floods have also contributed to significant population displacement around the globe.

Water scarcity is increasingly leading to conflict, especially in arid areas.

Violent conflict over water resources has occurred in many regions of the world, most notably in the Middle East where scarce water resources exacerbate existing religious and political tensions. Other examples of recent violent disputes over water include a Brazilian invasion of a contested dam site in Paraguay, irrigation rights disputes in India, military protection of dam construction in Slovakia, and violent water shortage protests in Bangladesh. Other examples exist of non-violent water-related conflicts that have produced protests, national and international stand-offs, and contentious debates.[17]

Even in places where water scarcity has not escalated to a cause for conflict, there is increasing public concern over water quality and quantity. In the U.S., there is considerable heated political debate over whether to regulate agricultural runoff or to mandate wetlands and endangered species protection. Partly in response, watershed and community action groups in the U.S. and abroad are becoming more involved in protecting local water resources.

40% of the world will live in water-scarce regions by 2025.[5]

Ecosystem needs for freshwater are broadly affected by human activities.

Due to the finite nature of water resources, there is a constant trade-off between meeting human and environmental freshwater needs. Water taken from a watershed for municipal drinking water supplies, for example, can affect the habitat and health of local species. Indirect impacts of human activities on ecosystem freshwater needs are common. Habitat degradation, urbanization, pollution, and introduction of foreign species can all adversely impact the ability for ecosystems to receive an adequate quantity and quality of freshwater.

As society recognizes the value of ecosystem services and natural capital, environmental needs for freshwater are receiving higher priority.

Often, and especially in times of severe shortage, human needs are given immediate priority over those of the environment. However, there is increasing recognition for the social and economic value provided by the environment and various ecosystem services. Through this recognition of value, environmental needs are receiving more attention. A 1997 report titled "The Value of the World's Ecosystem Services and Natural Capital" placed the annual value of the earth's natural

storage and purification of water at $2.3 trillion. Annual wetlands services received an even higher value of $4.7 trillion.[18] Governments, institutions, and businesses worldwide have responded by giving environmental concerns a higher priority when making key water-related decisions.

III. Freshwater Regulatory Trends

Freshwater regulations worldwide are becoming more stringent.

Worldwide, regulations addressing freshwater quality and effluent are becoming more stringent. Largely in response to concerns over the effects of water quality on public and ecosystem health, governments are pursuing a variety of regulatory approaches for reducing water pollution. Techniques include tighter discharge limits for pollutants and nutrients, technology requirements, water use restrictions, and effluent rights trading. Given the increasing pressures on many watersheds and the growing research on public and ecosystem health effects of water quality, it is likely that this trend will persist.

Jurisdictions in many countries are restructuring freshwater subsidies.

Government subsidies for freshwater have often been designed to encourage use of water resources to spur development and agricultural production. However, as shortages have increased, these subsidies have been reexamined. In some areas, subsidies have been restructured to provide incentives for conservation, efficiency, and watershed protection. The price of water, when reflective of its true cost or value, can encourage responsible use.

In Israel, much discussion has occurred over how best to regulate the use of its water resources, which historically have been heavily subsidized. Because subsidies have prevented prices from rising as supplies dwindle, one of the country's primary aquifers has been drawn down to the critical "red line" level. The country's Infrastructure Minister is now pushing for a complete phase-out of agricultural water subsidies to increase financial incentives for conservation.[19]

Regulatory efforts are increasingly focusing on watershed-based management approaches.

Watersheds vary significantly in the amount of water they produce and the types of activities they support both on-site and downstream. Many jurisdictions are turning to watershed-based water management as a way to deliver more effective, locally-tailored solutions. In the U.S., regulatory agencies are exploring watershed-based approaches to water quality protection. For example, Total Maximum Daily Load (TMDL) approaches establish discharge limits for local sources based on watershed health and assimilative capacity for pollutants. The European Union (EU) officially adopted the EU Water Framework Directive (WFD) in September 2000, which aims to improve water quality in all EU water bodies through coordinated watershed management.[20]

Moving Forward

Moving Forward

As GEMI member companies reflected on the emerging challenges facing our businesses and our communities, freshwater availability and quality surfaced prominently on the list. Clean freshwater is vital to business—and to people and ecosystems.

In areas around the world an imbalance is growing between supply and demand for clean freshwater. Supplies of freshwater are being stretched to meet the needs of growing populations, increasing industrial development and agricultural production, and ecosystems and wildlife protection. While the world is not running out of water, supplies of clean freshwater are not always in sufficient availability where and when needs arise. The challenge of meeting these needs intensifies where water sources are depleted at rates faster than replenishment and where waters are being polluted.

The collective experience of GEMI member companies indicates that the business case for strategically and sustainably addressing water challenges continues to strengthen across many business sectors and regions. We see our collective challenge as this: To manage our shared water resources, through thoughtful and collaborative efforts, to ensure the health and well being of people, ecosystems, and businesses now and into the future. To do so will require foresight and creativity.

As we move forward into the 21st century, our understanding about what it means to sustainably

"I have come to believe...that water quality and quantity issues will pose the greatest environmental challenge of the 21st century."

Governor Christine Todd Whitman, Administrator, U.S. Environmental Protection Agency[1]

Continued dialogue and collaboration will be necessary to map broad notions of water sustainability into clear concepts that can guide action and decision-making.

manage freshwater supplies will undoubtedly evolve. Continued dialogue and collaboration will be necessary to map broad notions of water sustainability into clear concepts that can guide action and decision-making. The GEMI Water Sustainability Tool can help companies take an important step forward. Each step that we take forward together will help build a healthy environment, healthy communities, and healthy companies.

Perspectives on Water Sustainability

"Sustainable Development is a very simple idea. It is about ensuring a better quality of life for everyone, now and for generations to come."

U.K. Department of the Environment, Transport, and the Regions [1]

"Water is a key to sustainable development, crucial to its social, economic and environmental dimensions. Water is life, essential for human health. Water is an economic and a social good, and should be allocated first to satisfy basic human needs. Many people regard access to drinking water and sanitation to be a human right. There is no substitute for water: without it, humans and other living organisms die, farmers cannot grow food, businesses cannot operate. Providing water security is a key dimension of poverty reduction."

International Conference on Freshwater, Bonn, 2001 [2]

"Water scarcity may be the most under appreciated global environmental challenge of our time."

World Watch Institute [3]

"Water is needed in all aspects of life. The general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of

Perspectives

ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water-related diseases."

United Nations: Agenda 21 [4]

"All human beings have an inherent right to water in quantities and of a quality necessary to meet their basic needs. This right should be protected by law. The right to water is satisfied when every person has physical and economic access to a basic water requirement at all times."

"Satisfying the standards of [the UN Declaration of Human Rights] cannot be done without water of a sufficient quantity and quality to maintain human health and well-being. Meeting a standard of living adequate for the health and well being of individuals requires the availability of a minimum amount of clean water."

Peter Gleick, President, Pacific Institute for Studies in Development, Environment, and Security [5]

"One cannot preserve the life of a place and not protect the waters that run through it. Historically, The Nature Conservancy has targeted terrestrial species through protection of the habitats that they need to survive. We have had great success on this front, owning and managing the world's largest system of private nature preserves. But our thinking and methods have evolved over time and we recognize the connection between land and water is elemental: one cannot preserve both the terrestrial and aquatic life of a place without protecting the waters that run through it."

The Nature Conservancy Freshwater Initiative [6]

"Forests are vital to this country's water supply. The largest volume and the cleanest water in the United States flows off our forested landscapes. Forests cover one-third of the continental United States but supply two-thirds of the runoff.... Water is perhaps the most under-valued and under-appreciated forest product. Watershed health and restoration should be the over-riding priority for forest management. We can leave no greater gift to our children than to leave the watersheds entrusted to our care healthier, more diverse, and more productive."

Mike Dombeck, Former U.S. Forest Service Chief [7]

"Doing more with less is the first and easiest step along the path toward water security. By using water more efficiently, we in effect create a new source of supply."

"In short, we need a water ethic – a guide to right conduct in the face of complex decisions about natural systems we do not and cannot fully understand. The essence of such an ethic is to make the protection of water ecosystems a central goal in all we do…. Living by such an ethic would mean using less whenever we can, and sharing what we have."

Sandra Postel, Director of the Global Water Policy Project [8]

Endnotes

The Business Case for Pursuing Water Sustainability: New Opportunities, New Risks

1 GEMI conducted a benchmarking survey of 27 member companies in 2001 to better understand businesses' relationship to water use, costs, risks, and trends. Wastewater discharge limits and water supply availability were identified as two primary emerging issue areas facing the companies. Please visit GEMI's website, www.gemi.org, for a summary of the benchmarking results.

Module 3: Business Opportunity Assessment

1 Vickers, A. 2001. *Handbook of Water Use and Conservation*. Amherst, MA: WaterPlow Press.
2 GEMI. 1998. *Environment: Value to Business*. Washington, D.C.
3 GEMI. 2001. *Environment: Value to the Top Line*. Washington, D.C.

Module 4: Strategic Direction and Goal Setting

1 Refer to GEMI's *Environment: Value to Business* (1998) and *Environment: Value to the Top Line* (2001) reports for guidance and case studies to assist companies in determining the value of environmental initiatives.
2 Newell, R. and Pizer, W. December 2001. *Discounting the Benefits of Climate Change Mitigation: How Much Do Uncertain Rates Increase Valuations?* Arlington, VA: Pew Center on Global Climate Change.
3 Amram, M. and Kulatilaka, N. 1999. *Real Options: Managing Strategic Investment in an Uncertain World*. Boston: Harvard Business School Press.

Water Trends

1 Postel, S.L. 1992. *Last Oasis: Facing Water Scarcity.* Worldwatch Books. New York: W.W. Norton.
2 World Business Council for Sustainable Development and United Nations Environment Program (WBCSD and UNEP). 1998. *Industry, Fresh Water and Sustainable Development*. Available at: http://www.wbcsd.org.
3 Houlder, V. "Low water: If rivers and lakes are drained further, many parts of the world may experience increased political tension, food shortages and environmental damage." *The Financial Times.* August 14, 2001. Page 14.
4 "Extended Drought Strains Resources Along East Coast." *The New York Times.* April 21, 2002.
5 World Resources Institute, United Nations Environment Programme, and the World Business Council for Sustainable Development. 2002. *Tomorrow's Markets, Global Trends and Their Implications for Business*. Paris, France.
6 United Nations Population Information Network. 2000. *World Population Prospects, The 2000 Revisions, Highlights*. Available at: http://www.un.org/popin/data.html.
7 Postel, S.L. 1999. *Pillar of Sand: Can the Irrigation Miracle Last?* Worldwatch Books. New York: W.W. Norton.
8 Pacific Institute for Studies in Development, Environment, and Security. 2000. *Water: The Potential Consequences of Climate Variability and Change*. A Report of the National Water Assessment Group.
9 Gleick, P.H. 2000. *The World's Water 2000-2001: The Biennial Report on Freshwater Resources.* Washington, D.C.: Island Press.
10 Sampat, P. "Groundwater Shock: The Polluting of the World's Major Freshwater Stores." *World Watch*. January/February 2000.
11 Kaur, S. "Water supplier has burning ambition." *The Straights Times*. September 19, 2001. Page H6.
12 Gleick 2000.
13 Postel 1999.
14 Postel 1999.
15 WBCSD and UNEP 1998; Gleick 2000; World Resources Institute, Earth Trends. Available at: http://earthtrends.wri.org/.
16 Gleick, P.H. 1998. *The World's Water 1998-1999: The Biennial Report on Freshwater Resources.* Washington, D.C.: Island Press.
17 Gleick 2000.

< Endnotes

[18] Constanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., and Paruelo, J. "The Value of the World's Ecosystem Services and Natural Capital." *Nature* 387:253-260, May 15, 1997.
[19] "The Price of Water." *The Jerusalem Post*. November 23, 1999. Page 8.
[20] "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy." *Official Journal of the European Communities*. December 22, 2000.

Moving Forward

[1] "Remarks of Governor Christine Todd Whitman, Administrator of the U.S. Environmental Protection Agency, to the Association of Metropolitan Water Agenices." Washington, D.C. March 19, 2002.

Perspectives

[1] *Opportunities for Change*. U.K Department of the Environment, Transport and the Regions. 1998.
[2] "Recomendations for Action." *Water - A Key to Sustainable Development.* International Conference on Freshwater, Bonn, 3–7 December, 2001. Also available at http://www.water-2001.de/outcome/BonnRecommendations/Bonn_Recommendations.pdf.
[3] Worldwatch Institute Home Page. http://www.worldwatch.org.
[4] *Agenda 21, the Rio Declaration on Environment and Development*. Adopted by more than 178 Governments at the United Nations Conference on Environment and Development (UNCED). Rio de Janerio, Brazil. 3–14 June, 1992. Chapter 18.2. Also available at http://www.un.org/esa/sustdev/agenda21.htm.
[5] Gleick, P.H. 2000. *The World's Water 2000-2001: The Biennial Report on Freshwater Resources.* Washington, D.C.: Island Press.
[6] The Nature Conservancy's Freshwater Initiative. *Recommended Strategies for Advancing Freshwater Conservation*. Available at: http://nature.org/wherewework/northamerica/states/pennsylvania/science/art832.html.
[7] Dombeck, Michael. "Protecting the Stuff of Life." *Wisconsin Academy Review*. Winter 2002. Pages 14–18.
[8] Postel, S.L. 1992. *Last Oasis: Facing Water Scarcity*. Worldwatch Books. New York: W.W. Norton.

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"WATER RIGHTS: WHY BUSINESSES SHOULD CARE ABOUT SCARCITY AND ACCESSABILITY"

A FOOD COMPANY'S PERSPECTIVE

By
Scott Rickman
Associate General Counsel
Del Monte Foods

I) Del Monte's Business, Water Usage and Growers

A) Our Business

Del Monte is one of the country's largest and most well known producers, distributors and marketers of premium quality, branded and private label food and pet products for the U.S. retail market. Our food brands include *Del Monte, StarKist, Contadina, S&W and College Inn* and other brand names, and our pet food and pet snacks brands include *9Lives, Kibbles 'n Bits, Pup-Peroni* and *Pounce*.

Del Monte has 17 production facilities in the United States and additional production facilities in Canada, American Samoa, Ecuador and Venezuela.

B) Water Usage, Discharge and Recycling

Food production is a "wet" industry, using high volumes of water in the production process. For example, Del Monte has three production facilities in the central valley of California for processing fruit and tomato products. These three facilities use almost 400 million gallons of water per year. Del Monte obtains most of its process water from privately owned groundwater production wells.

Most of the process water used at Del Monte's fruit and vegetable production facilities is recycled after use by land application. At Del Monte's pet products production facilities, waste water is usually discharged to the local municipality.

C) Reliance On Our Growers

Del Monte owns almost no farmland, except for small holdings used for research and development purposes. Instead, Del Monte relies on an extensive network of private growers, who rent or own their own land, to grow the produce Del Monte processes and packages.

Del Monte works with approximately 300 growers in California alone. Del Monte also works with hundreds of growers in Texas, Washington and throughout the Midwest.

II) Water Concerns

A) Water Quality

Consumer Safety. As a food processor, Del Monte is uniquely concerned about the quality of water used in its products.

Safe Drinking Water Act. Del Monte must comply with the Safe Drinking Water Act ("SDWA") or equivalent state regulations. As the U.S. EPA reduces acceptable thresholds for chemicals in drinking water, the costs of finding and treating water sources increases.

For example, new or proposed thresholds for naturally occurring chemicals, such as arsenic and radon, poses challenges for water users in areas where those chemicals are commonly found at elevated levels.

Increasing regulation of other chemicals which are not naturally occurring, but which are pervasive in certain areas, such as PCE in the central valley of California, also jeopardize water resources.

California's Proposition 65. Del Monte must also comply with Prop 65 for food products sold in California. Food is under intense scrutiny in the realm of Prop 65. Suits are currently pending relating to lead in chocolate, mercury in seafood and acrylamide in French fries. While process water is not the source of any of the chemicals in these suits, some of these chemicals are naturally occurring.

The risk of Prop 65 claims increases with every further reduction in the "acceptable level" of chemicals in drinking and process water. Unlike the risk models used by the U.S. EPA and FDA to establish acceptable levels, which typically use a 10-fold safety factor over the No Observable Effects Level ("NOEL"), Prop 65 requires a 1,000-fold safety factor.

B) Water Discharges

Del Monte Discharges. Increasing regulation of waste water discharges is obviously a fact of life for industrial dischargers.

Grower Discharges. Many people would not consider farmers as waste water dischargers. Strictly speaking, they may not be, but the U.S. EPA is focusing more closely on the problems caused by pesticide, fertilizer and sediment run-off from non-point sources such as farms. Indeed, some commentators have said that non-point sources are the largest remaining contributor to water quality impairment in the U.S. Given the economics of farming, this presents a huge challenge to those in agri-business who work with and rely on farmers.

An Overview of Water Law Issues in the U.S. & Abroad

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Why Businesses Should Care About Scarcity & Accessibility

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1. Introduction

Many world regions are running short of their most essential natural resource—water. Water is indispensable to life and to all forms of economic development. Irrigation has been central to the world's efforts to feed its soaring population. Although many regions can produce crops simply with rain, some of the world's most fertile lands require supplemental irrigation. Dependable water supplies also permit farmers to maximize their crop yield. Although only 16% of global cropland is irrigated, this land currently produces 36% of the world's food. More importantly, water is crucial to a wide variety of business enterprises, from beverage companies to computer chip manufacturers.

As the global population continues to expand, competition mounts for the limited supply of fresh water. In regions that are already short of water, growing urban populations and industrial development threaten to take water away from farming regions that must somehow feed additional people. Partly due to water shortages, both irrigated land and worldwide grain production have fallen on a per capita basis since the mid-1980s, after several decades of growth. As countries squeeze their available water supplies, periodic droughts also take a harder toll on their already thirsty populations and economies.

Water-short regions have typically turned to two solutions. First, many regions have built dams, reservoirs, and aqueducts to store and import the runoff of distant watersheds. To date, the world has erected more than 40,000 large dams (defined as dams more than 15 meters high) and millions of smaller dams. Second, regions have turned to the often vast quantities of water amassed over the millennia in underground aquifers.

Neither solution, unfortunately, is sustainable. Silt builds up and eats away at the storage capacity of most reservoirs. Because nations typically develop the best dam sites first, new water projects grow ever more technologically complex and expensive. Time, moreover, has revealed the large environmental price tag of water projects—the extinction of fish species, desertification of former wetlands, and harmful concentration of salt and other contaminants in depleted waterways. For all these reasons, new dam construction has dropped over 70% since its peak in the 1950s and 1960s.

Excessive groundwater withdrawals, in the meantime, are depleting thousands of aquifers. As the aquifers dry up (or steps are taken to save them from overuse), those who are using the groundwater will need to find alternative sources, reduce their water use, or both. In the meantime, water tables are dropping, overlying land is subsiding, and rapid pumping rates are drawing salt water and other contaminants into many aquifers.

Two questions dominate water policy at the turn of the century. Can the world's nations reverse the dewatering of surface waterways and groundwater aquifers that has accompanied traditional water solutions? And can they find alternative means of meeting the water needs of their growing populations and economies? Both questions depend on nations' ability to stimulate conservation, better allocate water among competing users, and employ new, more environmentally benign means of expanding water supplies.

This outline analyzes a few of the issues that countries confront in trying to meet growing water demand on a sustainable and environmentally benign basis. I begin by surveying the tools countries can employ to shape their population's use of water resources. I then examine in brief how water policy has evolved in the United States, the consequences of that policy, and possible reforms.

Spread over a vast and climatically varied terrain, the United States provides a useful case study for water policy. Water has long been scarce in the nation's arid Southwest, and regional shortages are now developing elsewhere. Having followed the traditional solutions of dams and groundwater mining, the United States is now awakening to the environmental, economic, and social consequences. Although the nation is making some progress toward modifying its water policies, reform has been slow and remains uncertain.

2. **Policy Constraints and Tools**

In trying to meet the water needs of their populations, governmental and private officials assume that some factors are beyond their control. Nature has bequeathed a vast imbalance in water supply among regions. Approximately 15% of the world's population lives in arid areas with average rainfall of less than 30 cm (12 inches) per year. With such meager precipitation, crops die without artificial irrigation and water is always an issue. Even normally wet regions frequently find themselves suffering through multi-year droughts. From 1989 to 1990 precipitation levels in European countries dropped by as much as 60%.

Unwilling to concede that precipitation levels are totally beyond humanity's control, some nations have seeded rain clouds and investigated other means of weather modification. Yet experiments to date have been inconclusive. While some appear to have produced short showers, results have been neither predictable nor reproducible. The experiments have also generated social and environmental concerns. Weather modification, if successful, promises not only to increase rainfall for one region, but also to reduce precipitation elsewhere and perhaps produce unknown changes in the world's overall weather system.

Precipitation levels represent only part of the water equation confronting policymakers. Equally important is population growth which, paired with precipitation levels, determine per capita water availability. Countries begin to encounter serious water shortages when yearly water availability falls below 5000 cubic meters per person. When this figure falls below 1000, water scarcity endangers agricultural and economic production and threatens the natural environment. Water experts often label these countries "water scarce." Approximately 20 countries are currently "water scarce." Experts believe that by the year 2050 another 40 countries or so will join the list, encompassing almost half of the world's population.

Continued population growth increases water needs at the same time it decreases per capita water availability. Indeed, because of increasing living standards, global water use has been growing faster than world population. To make matters worse, most nations with already low per capita supplies also suffer the fastest population growth. Experts predict that, on average, the population of water-scarce countries will double in less than 30 years, halving current per capita water availability unless new sources are identified.

Water officials indirectly influence population growth and development by regulating water use. Some regions purposefully have used water policy to limit growth. Some California communities, for example, have tried to restrict growth by declaring moratoria on new water supplies. Despite the pressure that population growth and economic development can place on water supplies, however, most water officials have shied away from a direct role in setting population or development policies. In the view of most water officials, their job is to develop policies that can meet expected population growth and economic demands, rather than shaping population growth and development to fit water availability.

Water officials can use a variety of tools in trying to meet their populations' demands within their regional water budget. Statutory restrictions, regulatory programs, and other legal rules constitute the principal means of shaping water use in most countries. Informal local norms, however, can also be an important policy tool. Tucson, Arizona, for example, reduced peak water demand during summer months through a voluntary "Beat the Peak" campaign that promotes the civic virtues of water conservation.

The price of water is another critical policy tool. Although we need a minimum amount of water for survival, most water use is discretionary and responsive to price. Economic studies of water use in the United States suggest that a 10% increase in the price of water will produce anywhere from a 2 to 14% decrease in consumption, depending on such variables as the region, type of user, and time of year. Price changes are most effective over the long run as farmers switch to less water-intensive crops or install new irrigation systems, domestic users relandscape and adopt low-flow plumbing, and industries modify their manufacturing processes.

To resolve anticipated shortages, water officials have turned frequently to engineering projects and technological innovation. Most major cities in the world import at least part of their water supply through elaborate systems of dams, reservoirs, and aqueducts. As large scale water projects have run into greater fiscal, environmental, and technological obstacles, officials have also turned their attention to an array of other engineering options designed either to increase

supply, such as desalination and reclamation, or reduce demand, such as drip irrigation and high-precision sprinkler systems.

3. **A Case Study of United States Water Policy**

a. **The United States Waterscape**

Like the world at large, the United States suffers from a considerable imbalance in water supplies. The mountain ranges of the Pacific Coast and the 100th meridian represent important divides. North of San Francisco, the coastal ranges create a "rainshadow effect," ensuring considerable precipitation for the Pacific Northwest. Historic storm patterns have also guaranteed significant rainfall to most of the nation east of the 100th meridian. By contrast, the western flatlands are parched, leading early cartographers to label the area as "The Great American Desert." Even small distances can make dramatic differences. The Puget Sound area of Washington, for example, enjoys over 40 inches of rain in an average year; only 100 miles east, over the Cascades Mountains, precipitation drops to less than nine inches.

Differences in precipitation are reflected in river variations. The four largest rivers in the United States are the Mississippi, the Columbia, the Ohio, and the St. Lawrence. The Colorado River, which dominates the Southwest's geography, ranks only 25th nationally and carries about 3% of the water found in the Mississippi.

Imbalances in supply are joined by tremendous variations in the timing of precipitation. The Northeast boasts relatively year-round precipitation and thus continuous river flows. By contrast, other regions regularly receive only a few months of precipitation, sometimes accompanied by flash flooding, followed by many months of drought during which rivers often dry up entirely. About 80% of the meager rainfall near Tucson, Arizona occurs during the summer. Virtually all of the Pacific Coast's precipitation is wedged into the period from November to April.

As early as the nineteenth century, some policymakers and scientists advocated a strategy of ecological adaptation to these differences in natural water supply. In the view of John Wesley Powell, who headed the U.S. Geological Survey from 1881 to 1894, the West should be divided into hundreds of "hydrographic basins," or watersheds, with development reflecting each watershed's natural characteristics.

Like virtually all nations, however, the United States has built cities, planted crops, and developed industries with little regard for these natural variations. Six of the nation's ten largest cities, and all ten of its fastest growing cities, rise out of the arid West. In California, the nation's most populous state,

only 3% of the natural water supply, but over 50% of the people, reside in the southernmost third of the state.

The dramatic growth of irrigated agriculture in the western United States is a prime example of the mismatch between water supply and economic development. Eastern farmers do not generally need to irrigate their crops because of the large rainfall. As a result, thermoelectric power generators, which are quite low-percentage "consumers," use the vast majority of water in the East. By contrast, irrigating farmers, who are high-percentage consumers, withdraw approximately 80% of the water in the western United States.

Unwillingness to match development with local water supplies, however, is not unique to the arid West. Many other regions of the United States, particularly along the eastern seaboard, have also knowingly outgrown their local water supplies. New York City enjoys average annual rainfall of 44 inches, but its water demands long ago surpassed its natural water supply.

For much of this century, cities and agricultural communities that faced local water constraints simply turned to distant watersheds for supplemental supplies. New York meets the needs of its seven million residents by importing over 1.5 billion gallons of water per day from watersheds up to 125 miles away. When Los Angeles first began running out of water early this century, it reached out to the Owens Valley 250 miles northeast (setting off a sometimes violent battle over water between local farmers and the city); today, the Los Angeles region also draws large quantities of water from the Colorado River, some 200 miles to the east, and from northern California rivers over 450 miles away. Most major cities in the United States, including Boston, Denver, Phoenix, and San Francisco, have adopted similar import strategies.

The national government's major water distribution program dwarfs even these efforts. In 1902, Congress started a "reclamation program" to encourage small family farming in arid regions of the West by importing and distributing needed irrigation water. Over the last 90 years, the national reclamation program has built hundreds of separate reclamation projects, involving over 300 dams and 7000 miles of canals. Although originally designed to promote small farms, the program today provides water to over 20% of all irrigated land in the West, much of it held by large corporate farms, as well as to 20 million domestic users.

b. Surface Water Policy

i. Waste & Conservation

The need for more effective water conservation is one of the most important water issues confronting the United States. Far from constraining waste, traditional United States water policy has encouraged excessive levels of water use. The nation has long promoted new

residential, agricultural, and industrial development and has perceived water as key to that growth. To encourage new development, national, state, and local governments have fostered a policy of cheap water—undercutting financial incentives to conserve water. While state law technically outlaws gross water waste, states have never vigorously looked for and proscribed overuse.

Water pricing. Few, if any, water users pay the true cost of their water. There are several reasons. First, in awarding rights to use water, states do not charge for the value of the water itself. Water is a valuable resource. When cities or farmers divert water from a stream, there is an "opportunity cost": instream flow is reduced at the expense of fish, wildlife, and the environment generally; other potential consumers, moreover, cannot use the water for domestic or commercial purposes. Yet cities or farmers pay nothing for the water they divert (other perhaps than a small permit fee). As a result, water users and distributors divert water even when some or all of the water would be economically more valuable left in the stream or used by someone else.

Second, water users do not generally pay for the environmental damage incurred in storing and distributing water. Many of the dams, reservoirs, pipelines, and aqueducts used to store, divert, and transport water have destroyed or injured valuable ecosystems. In the 1920s, for example, San Francisco flooded the Hetch Hetchy Valley—which John Muir likened in grandeur to its neighbor Yosemite—as a storage site for supplemental water supplies. Water users should, but do not, pay the cost to society of these and other environmental impacts.

The prices that cities, irrigation districts, and other water distributors charge for providing water to the ultimate consumer also promote excessive water use. A number of water distributors charge customers a flat rate no matter how much they consume. Even distributors that charge by usage spread the cost of expensive new supply projects across all consumers (which often results in only a minimal rate increase) rather than charging new water users for the true cost of their water.

The government, in addition, sometimes subsidizes the costs of collecting, storing, transporting, purifying, and distributing water. Many cities use property tax revenues to reduce their water rates. The national Bureau of Reclamation permits farmers 50 or more years to pay back, *interest free*, the costs of the irrigation projects that it builds for the farmers. National reclamation subsidies historically were substantial.

State Regulation. State law under both the riparian and prior appropriation systems theoretically prohibits the use of "unreasonable" quantities of water. State regulation of waste, however, has been

relatively ineffective for several reasons. First, state agencies and courts often have been reluctant to second-guess water users and distributors on their water needs. Where a city has decided to build a new water project, water agencies and courts have not wanted to substitute their judgment for that of elected officials. Nor have water agencies or courts historically felt themselves equipped to make independent economic and technological decisions on what conservation measures would be feasible for individual water users. To avoid making such decisions, agencies and courts historically looked to community custom to determine what degree of conservation was practicable. If a farmer was using no more water than her neighbors, agencies and courts generally did not intervene even though all the farmers in the area might have had significant conservation opportunities.

Second, states have not regularly monitored all water use. In the arid West, water uses are reviewed automatically only when a water user first applies for an appropriation permit. (Even this review is often perfunctory since few agencies have the personnel necessary to identify and ferret out possible waste. To identify at least gross levels of waste, some states set maximum agricultural "water duties" that prohibit applying more than a specified quantity of water to each irrigated acre.) After the permit is granted, agencies and courts typically reevaluate a use only if someone complains that the use is wasteful. In the East, where only a minority of states have adopted permit systems, most water uses are never automatically reviewed.

Consequences. Absent effective regulatory constraints, water subsidies have stimulated the diversion of large quantities of water for uses that do not justify the cost. The national reclamation program has been a particular source of waste. A 1989 study of 18 irrigation districts receiving national reclamation water estimated that the financial costs of providing water to 11 of the districts (not including the opportunity cost of the water and any environmental costs) outweighed the economic benefits to the farmers receiving the water. In one case, the reclamation project cost over $1,500 per acre served ever though the project's value was only about $200 per acre.

National reclamation subsidies have also encouraged irrigation of crops in the West that could be produced less expensively elsewhere in the United States. By subsidizing western irrigation water, the United States often displaces economically more efficient agriculture from the Midwest or South. As an ironic aside, many farmers long used national reclamation water to grow so-called "surplus crops" such as wheat, cotton, and rice, that the United States paid farmers elsewhere millions of dollars not to grow. In the early 1990s, almost half of all lands irrigated with national reclamation water grew surplus crops.

Water subsidies also encourage water users to divert and use *more* water than is socially optimal. Although estimates of the exact amount of such waste vary substantially, most analysts agree that there is significant opportunity for conservation. Mohamed El-Ashry of the World Bank estimates that the United States wastes half of the water it withdraws (slightly better than his estimate of 65-70% waste worldwide).

Irrigating farmers consume only a fraction of the water that they divert from the nation's waterways. Only about 75% of the water withdrawn by a typical irrigation system reaches the farm (the rest is lost to evaporation and leakage); crops, in turn, consume on average only half of the water that reaches the farm. Although most of the unused water flows back to a waterway or into an underground aquifer where it is reusable by others, significant quantities are lost to use through contamination, evaporation, or seepage into unaccessible aquifers. Farmers can economically reduce their water use through various technological improvements, including lining canals, carefully monitoring irrigation needs by computer, and switching from furrow irrigation systems to more efficient systems like drip irrigation or precision sprinklers.

Waste is not unique to agriculture. Urban water use could be cut dramatically and economically through relatively simple conservation measures. In older cities, the repair of leaking water mains can save up to a third of the public water supply. Water saving appliances, such as low flow shower heads, can readily cut indoor water by up to 20%. "Xeriscaping" of yards with drought-tolerant plants can reduce outdoor water use, which represents the largest fraction of domestic water use, by a third.

Current Reforms. Increased recognition of the need for water conservation has led to some U.S. reforms. A number of states, for example, have adopted planning laws requiring cities, irrigation districts, and other water distributors to develop conservation plans. Few of these laws, however, mandate actual conservation measures or require real water savings. Some state water agencies also have begun to police water use more carefully.

What appears to be "waste," moreover, sometimes is not. Agricultural water that is currently lost because of inefficient irrigation practices goes somewhere. If the water evaporates or is otherwise lost to others' use, the water indeed is "wasted" and conservation can increase the water supply. Yet, as already noted, most "wasted" water returns to a waterway and is used by others.

The past decade has also seen pricing reform. At the local level, a number of cities and other water suppliers with flat-rate pricing systems have begun to meter water use. A growing number of water suppliers are moving to "increasing tier" prices in which the price per unit of water increases as individual use increases. Many municipal water agencies have decreased their subsidization of water rates.

Since 1982, the United States Congress also has passed a number of bills reforming prices under the national reclamation program. Most of the bills have raised water rates that farmers must pay the national government, although the rates remain significantly less than the true cost of the water. Congress has also required some irrigation districts to use tiered prices.

Pricing reform has not been easy. Over time, water users make investment decisions based on existing water prices. Farmers purchase additional acreage or new farm equipment; domestic residents plant lawns and foliage. When water agencies threaten to eliminate subsidies and raise prices, water users object that the government is belatedly and unfairly changing policy and undercutting these investments. Beyond these equity objections, most politicians and bureaucrats are loathe to take the politically unpopular step of raising prices. Most water rates consequently remain substantially below actual water costs.

ii. **Confronting Water Scarcity in Israel**

How are other nations doing on conservation? Nations confronted by scarce water supplies often have proven capable of stretching supplies through conservation or other sustainable means, providing a model for future water policy elsewhere in the world. By anyone's definition, Israel is a water-scarce country. In 1992, its annual renewable water supply was only 330 cubic meters per capita. The comparable number in the United States is approximately 10,000 cubic meters (a 30-fold differential); average annual consumption in the United States is over 2,300 cubic meters. Israel receives virtually no rain for six months each year, and rainfall varies considerably from year to year around Israel's already low mean. Yet from 1973 to 1988, Israel's population doubled and irrigated acreage expanded by over 25%.

Israel has met the needs of an increasing population and agricultural sector largely through conservation. Israel pioneered drip irrigation in the 1960s and today uses the technique on over 50% of its irrigated land (the highest percentage in any nation other than Cyprus where over 70% of irrigated land uses drip irrigation). Holes in plastic hoses deliver the correct amount of water to each plant, eliminating potential loss through evaporation, percolation, or runoff. Drip irrigation

can be anywhere from 20 to 50% more efficient than standard sprinklers and is dramatically more efficient than the open-ditch flood irrigation systems still used in much of the world. Israeli farmers have increased their water efficiency another 10 to 30% by linking their irrigation systems to computers that detect leaks, and shut off faulty lines, and precisely adjust water application amounts for wind speed, air temperature, and soil moisture. Researchers are examining various farming techniques that could further reduce water consumption. By covering exposed soil with polyethylene, for example, farmers can reduce evaporation and increase the water efficiency of plants by raising root-zone temperatures.

Israel also is making extensive use of recycled water. Israel has achieved a high quality standard, suitable even for domestic use by taking treated effluent and letting it percolate into underground aquifers from which it is later pumped back up; the soil provides natural purification as the water passes through it. Because agriculture does not demand the same high level of quality as domestic use, the Dan Region Project also transports treated effluent from Tel Aviv and other northern cities south to farms in the Negev desert—freeing up fresh water for expanding domestic needs. Many parts of the country use dual distribution systems with farms receiving untreated storm water and some effluent, while homes receive high quality drinking water. Waste water currently constitutes 30% of Israel's agricultural water (with the percentage projected to grow to 80 percent by 2025).

Israel also has begun to look for other ways of expanding its limited natural water supply. For example, Israel uses available capacity in its groundwater aquifers to store water. Israel artificially recharges the aquifers with excess water during wet seasons and then pumps the water back up during dry periods. In 1997, Israel fired up its first major desalination plant to purify water from the Red Sea for use in the growing coastal town of Eilat. (About 60% of the world's current desalination capacity is found in the neighboring Persian Gulf region. Saudi Arabia, with over 20 plants and 30% of the global capacity, still leads the way.) Israeli farmers are also experimenting with a variety of crops that are more tolerant of salt.

Despite these various efforts, Israel could do more to promote water conservation and ensure a sustainable environment. Since Israel's completion of the National Water Carrier, which taps water from the Sea of Galilee for use as far south as the Negey desert, virtually no water has flowed into the southern Jordan River. Israel also continues to use over 15% more water than its renewable supply by overdrafting its underground aquifers. The overdrafting has permitted salt water to invade Israel's coastal aquifer, one of it two principal groundwater aquifers. Israel encourages excessive water use in some sectors and areas by

subsidizing water deliveries to stimulate agricultural production and the settlement of new territories.

c. Depletion of Waterways

i. United States waterways

The United States also has done a poor job of protecting its rivers from depletion, particularly in the West where water demand long ago outstripped most local supplies. Until recently, state water agencies did not weigh the value of instream flows in deciding whether to permit diversions. Under the prior appropriation doctrine, moreover, people interested in preserving instream flow for fishing, environmental, or other purposes were not permitted to "appropriate" water themselves for use in the stream. Western states wanted to encourage development and rewarded only those who planned to divert water for offstream consumption.

As a result, hundreds of western waterways are totally drained of water for some or all of the year. Water users reduce other waterways to mere trickles. The Colorado River, which dominates the southwestern waterscape, seldom reaches its mouth in the Gulf of California; in most years, it peters out in a saline pond almost 15 miles from its natural destination.

The principal costs of depleted waterways are environmental. Low water flows, along with deteriorated quality, are currently threatening over one-third of all fish species in the United States. Depletion of waterways has led to the total extinction of some fish species such as the Truckee River cutthroat trout.

As scientists have learned more about the harmful effects of depleted streamflows, policymakers have begun to enact measures to protect existing instream flows. In one of the earliest reforms, most western states authorized their water agencies to consider environmental, aesthetic, and recreational impacts before permitting new appropriations from a river. Several western states have also authorized their environmental or wildlife agencies to reserve instream flows, preventing others from appropriating and diverting the water for offstream consumption. A number of states, and the national government, have adopted scenic river legislation proscribing or limiting new appropriations from rivers designated as having special aesthetic or recreational value.

National environmental legislation now provides the greatest protection for instream flows. Under section 404 of the Clean Water Act, no one can excavate or fill a waterway without obtaining a permit from the

U.S. Army Corps of Engineers. Although section 404 grew out of a century-old statute designed to protect navigability, it now plays a number of other important roles. Section 404 is the principal national tool for regulating the filling and development of wetlands. And because almost all major water diversions require some excavation or filling of a waterway, section 404 also serves as an important constraint on new water projects.

Before issuing a permit in connection with a planned water diversion, the Army Corps of Engineers must determine that the water project will not have "an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas." The Corps must follow guidelines developed by the national Environmental Protection Agency (EPA), and the EPA can veto any permit that it believes should not be issued. Under the national Endangered Species Act, moreover, the Corps cannot issue a permit if the planned water diversion would "jeopardize the continued existence" of an endangered species or "result in the destruction or adverse modification" of the species' critical habitat.

These measures, powerful as they may prove to be in avoiding further depletion of our waterways, unfortunately do nothing to restore the thousands of already depleted waterways. Here progress has been slower because restoration requires water users to reduce their current diversions. Proposals to reduce existing diversions directly threaten current water users and generate stronger political opposition than efforts to limit new diversions. Because the United States Constitution prohibits the government from taking private property without paying compensation, current water users also argue that the government cannot unilaterally order reductions in existing diversions unless they are willing to pay for the water.

Some progress has been made. A few state courts have reduced water diversions through innovative application of long standing legal doctrines. The law contains a fair amount of flexibility and, spurred by new needs, courts can often remold or reinterpret the law to meet the needs. An example is the "public trust" doctrine. Courts have long held that states, upon formation, receive title to lands beneath navigable waterways in "trust" for the public. Although states can sometimes convey these lands to private owners, the public trust still applies in most cases and limits what the private owners can do with the lands. In *National Audubon Society v. Superior Court*, the California Supreme Court held that the public trust doctrine also extends to the water itself and imposes on the state "a duty of continuing supervision" over use of the water. If at any time the state concludes that the environmental impact of

a diversion outweighs its value, the state can order the water user to cut back or entirely stop the diversion.

Environmental laws have also forced some reductions in current diversions. Diversions can violate national and state water quality laws by increasing the concentration of existing contaminants or encouraging salt water intrusion into coastal estuaries. Diversions can also violate national and state endangered species laws by threatening the continued existence of native fish species.

ii. **Salt Lakes**

The *National Audubon* case, which focused on Mono Lake in the United States, is an example of a worldwide problem – the shrinkage of salt lakes. Lakes fall into two categories—freshwater lakes, and salt or saline lakes. Freshwater lakes, such as the Great Lakes of North America, drain to the sea and contain less than 3 grams of salt per liter. By contrast, salt lakes are sinks with no outlet to the sea; as a result, salt accumulates. The salinity of salt lakes almost always exceeds 3 grams per liter and can sometimes surpass 300 grams per liter. (For comparison, ocean water contains about 35 grams.) Many of the world's most famous lakes, including the world's largest (the Caspian Sea) and its lowest (the Dead Sea), are salt lakes. Salt lakes together account for almost half of the total volume of all inland surface waters.

Salt lakes are far more sensitive to both natural and manmade change than freshwater lakes. In salt lakes, inflows are delicately balanced with outputs from evaporation and seepage into underground aquifers. If water diversions reduce inflows into salt lakes, the lakes will shrink and grow even saltier—threatening the local ecosystem. Most of the world's principal salt lakes, including the Dead Sea and Lake Corangamite (the largest permanent lake in Australia), currently are shrinking.

The best known example is the Aral Sea in Russian Central Asia, which was once the fourth largest inland lake in the world and approximately the size of Lake Huron. Two north-flowing rivers, the Amu Darya and Syr Darya, historically drained into the Aral Sea. Until the latter part of this century, the Aral Sea, also known as the blue sea, covered 64,000 square kilometers and was home to thriving fishing, trapping, and lumber industries. In the early 1950s, fishermen harvested 50,000 tons of fish per year, which were canned in coastal cities.

The former Soviet Union, however, recognized the potential for producing massive quantities of cotton on lands neighboring the Aral Sea. Obsessed with becoming cotton independent, the Soviet Union made it the

"patriotic duty" of Central Asians to grow cotton and, by 1937, was exporting cotton. To grow the cotton, however, the Soviet Union diverted most of the flows of the Amu Darya and Syr Darya. Water planners recognized that the diversions would lead to the shrinkage of the Aral Sea, but believed that the environmental consequences would be minor.

The water planners were wrong. The Aral Sea has shrunk to about a third of its original size, splitting into two lakes with a large desert chasm in between. As deltas and islands that once supported hundreds of species have disappeared, 135 wildlife species and 50% of all bird species have also disappeared. The lake's salt content has tripled to approximately 30 grams per liter, and 20 of 24 indigenous fish species have become extinct. Commercial fishing ended in 1981, and many former fishing villages are now marooned in the middle of a desert. Winds pick up the salts and other particulates from the exposed lake bed, leading to increased emphysema and other respiratory ailments. The shrinking of the Aral Sea also has impacted the local climate. Evaporation from the sea used to deflect cold northern winds in the winter and provide rain and shade in the summer. Today, the average temperature in the winter is approximately 2º C colder, and the average summer temperature comparably warmer, than before.

Saving the Aral Sea will be difficult. Conservation measures, such as lining irrigation canals, installing drainage systems, and improving irrigation methods, could substantially reduce water use. But local officials argue that, given the weak local economy and growing population, any water saved should go toward growing more food rather into the Aral Sea. Even if the conserved water was dedicated to the Aral Sea, the lake probably would continue to shrink. Current restoration efforts thus are focused on stabilizing and making small improvements to the local environment. The United Nations, for example, is funding the creation of "green belts" that will shield particularly sensitive areas from the Aral dust. In the meantime, the Aral Sea continues to shrink and is expected to stabilize at about a third of its current size.

Mono Lake provides a valuable contrast. The second largest lake in California, Mono Lake sits on the eastern side of the Sierra Nevada escarpment near Yosemite National Park and has sometimes been called the "Dead Sea of California." Mark Twain, who wrote of Mono Lake in *Roughing It*, observed that "Half a dozen little mountain brooks [actually five] flow into Mono Lake, but not a stream of any kind flows out of it. It neither rises nor falls, apparently, and what it does with its surplus water is a dark and bloody mystery." The lake's most notable feature is its "tufa towers," limestone-like stalagmites that form over freshwater springs in the lake bed.

In 1941, California granted Los Angeles the right to divert water from the streams that feed Mono Lake and transport the water 250 miles to meet the needs of Los Angeles' growing population. By 1982, the lake level had dropped by 20 m (or 45 feet), its surface area had shrunk by one third, and its salinity had nearly doubled from 48 to 90 grams per liter. As the lake shrank, one of its two principal islands became a peninsula, exposing roosting gulls to coyotes and other predators. Trout fisheries in the feeder streams all but disappeared.

A coalition of environmentalists and sports fishermen sued to reduce Los Angeles' diversions, arguing that the diversions violated the public trust doctrine and various environmental laws. As noted in the text, the California Supreme Court ruled in favor of the coalition in 1983. Acting to implement the court's decision, the California State Water Resources Control Board in 1994 prohibited Los Angeles from diverting any water from the feeder streams until Mono Lake rises 17 feet. Although the Board initially believed that 20 years might elapse before this goal is achieved, high amounts of rainfall raised the lake level six feet by the middle of 1997. Los Angeles also will ultimately spend more than $10 million trying to restore the habitat of the lake and its environs.

d. **Meeting Growing Urban Needs**

With water supplies already pressed in many regions, meeting the demands of rapidly growing urban and suburban populations and their associated economies looms as another critical issue. Cities traditionally adopted "supply solutions" to water shortages. Taking the level of demand as unchangeable, cities built large projects, such as San Francisco's Hetch-Hetchy reservoir, to import water from distant watersheds. As discussed earlier, most cities now are addressing prospective shortfalls also from a demand side. Although far more could be done to reduce urban demand, particularly through the pricing of water, however, many cities will still need to find sources of additional water.

A number of cities are experimenting with technological solutions such as desalination or recycling. By the end of the 20th century, local governments in California will have built more than a dozen desalination plants. Yet, the plants will be small and largely experimental. Despite potential promise, desalination of sea water remains expensive because of the large amounts of power needed to drive the process. Desalination also presents a number of environmental concerns, including disposal of saline waste, air pollution from the needed energy production, and destruction of coastal vistas by large desalination plants and power facilities.

A less expensive option is to recycle waste water. St. Petersburg, Florida, was the first city in the world to recycle all of its water. The city distributes fresh water for drinking and household use, and makes recycled water available (at only

70% the fresh-water prices) for irrigation of parks, golf courses, and lawns, and for a variety of other outdoor uses. A growing number of other cities, including Los Angeles, Denver, Tucson, and El Paso, hope to use recycled water to meet up to 20% of their local needs by early in this century. The future of recycling will depend on the ability to further reduce its cost (which is already competitive with major new water projects) and reduce psychological barriers to the use of recycled water. The greatest promise for recycled water lies in using it for agriculture, which could free up fresh water for domestic use.

Many western cities see transfers of water from agricultural to urban areas as the best solution to their water needs. Because agriculture currently accounts for almost 85% of all water consumption in the United States, and an even higher percentage in the West, even small reductions in agricultural water use can provide sizable increases for urban areas. If Arizona farmers reduced their current consumption by just 5%, the freed-up water could support the domestic needs of 1.5 million people (over half the current population of the state). As discussed earlier, economic studies suggest that far greater levels of agricultural conservation are cost justified.

Given the opportunities for trade, one would expect farmers to conserve and sell water to cities and other urban water suppliers. Western water law, however, historically frowned on market transactions in water. Since states did not charge water users to divert water, water officials did not believe that users should be able to profit by selling the water to someone else. Water officials also feared that people might "speculate" in water by appropriating far more than needed, with an eye toward marketing it. Ten western states banned water transfers.

Although all ten states now have repealed the bans, the law still presents significant obstacles to market transfers. Ironically, the anti-waste provisions of western water law pose a hurdle to the conservation and sale of irrigation water. The very act of conserving water suggests that the farmer may have been wasting and thus not have been entitled to the saved water. According to some courts, farmers and other water users cannot use or sell conserved water; instead, the conserved water reverts to the state and is available for new appropriation.

A number of western states, as well as the national government, have enacted legislation to overcome barriers to water transfers. California, for example, has explicitly authorized the sale or lease of conserved water. Oregon permits water users to submit "conservation plans"; if approved by the state water agency, users can then sell 75% of the conserved water (the remainder must return to the river as a form of environmental tax).

The prospect of active water markets has generated considerable fear within rural agricultural communities. The communities fear that cities and other urban water agencies will pay farmers not only to conserve water but also to

fallow their fields. Water is economically far more valuable in urban use than on many farms; with active water markets, farmers may often find it more profitable to close up shop and sell their water than to continue farming. Many policy analysts believe that this is how the market should operate. Water should not remain permanently tied to marginally profitable farms when it could be used more valuably elsewhere.

The rural communities at risk, however, argue that water transfers will impose economic, public, environmental, and social costs on local residents that the nation should not require them to bear. Farm closings can generate unemployment and reduce business in support industries. Closings can also decrease local tax revenues, requiring a curtailment of public services. In some areas, the fallowing of fields can lead to dust storms and local desertification. Many communities fear that farm closings will have a snowball effect where the problems created by initial closings will encourage other farms to close and businesses to leave, increasing the local impacts and leading to yet more farms and businesses closing.

Many states try to protect agricultural communities against such harm. States, for example, often authorize water boards to prohibit transfers that might injure local economies or otherwise damage the "public interest." While protecting agricultural communities, however, such restrictions also limit the ability of the marketplace to help meet shifting demands.

As water markets develop, a growing number of businesses also might decide to purchase water directly from farmers and other current users rather than relying on the uncertainties, and sometimes high cost and restrictions, of public water supplies. In the 1990s, a number of large businesses either purchased water on the market for their operations or considered doing so. Such direct purchases, however, can be controversial. Not only do such purchases raise the issues discussed above, but other local water users sometimes object that companies are trying to avoid sharing in either the cost of public water systems or water reductions during droughts and other periods of water shortage.

e. Groundwater Policy

i. United States groundwater use

Groundwater use has grown dramatically in the United States over the last century and today constitutes approximately 25% of all freshwater use. Irrigated agriculture is the largest consumer of groundwater, using about 70% of the total. A number of factors have helped produce growth in groundwater use. The advent of cheap rural electricity and new technology has made groundwater economically competitive with surface supplies. Dwindling surface supplies also have forced growing cities and agricultural belts to search for water underground.

Where a region has outgrown its renewable water supply, it can still meet its water demand by "mining" fossil water in local aquifers. Many regions of the United States are doing exactly that. In the West, agricultural users mine nearly 25% of all aquifers. Nationally, recharge averages approximately 60 billion gallons per day, an encouraging figure until one realizes that water users are extracting almost 75 billion.

Mining aquifers, however, is at best only a temporary solution to unmet water demands. The fossil water will ultimately run out, leaving the areas that have grown reliant on it with the need to either find alternative supplies or dramatically reduce their water use. The Ogallala (or "High Plains") Aquifer, which underlies large portions of Kansas, Nebraska, Texas, and four other states, is probably the largest underground body of fresh water in the world. Yet it has virtually no recharge, due partly to the low precipitation in the region, but due more to an impervious layer that forms a watertight cover over most of the aquifer. Local residents turned to the Ogallala several decades ago to support agricultural and residential growth and now are quickly draining it dry. With water levels falling three feet every year in some areas, most of the aquifer could be effectively depleted within several more decades, leaving an estimated five million acres of farmland without water.

Even before an aquifer runs dry, groundwater mining can impose severe economic and environmental costs. As an aquifer is mined, its water table drops. Water users must pump the groundwater greater distances, increasing both pump and electricity costs. (Water users seldom deplete an aquifer of all its water. Long before this occurs, water tables drop to a level where pumping is no longer economical.) Lower water tables already have taken a sizable toll. Although total groundwater use has increased in the United States since 1975, spiraling pumping costs have led to an actual decline in the quantities used by farmers, who often cannot afford the same costs as municipal and industrial users.

If an aquifer consists of poorly consolidated materials (like sand or gravel), overlying land can subside. The Shipping Channel area of Houston, Texas dropped 6 inches per year in the late 1960s and early 1970s (resulting in millions of dollars in property damage). Overlying flora that rely on a high water table can perish, leading to desertification of the surface. Natural springs can dry up, threatening species reliant on their flow. Finally, dropping pressure levels can lead to destructive groundwater contamination. Mining of coastal aquifers frequently leads to salt water intrusion from the ocean. In other areas, groundwater mining has accelerated the spread of existing contaminants or drawn in polluted drainage water and other impurities.

None of this means that groundwater mining should be totally outlawed. Fossil water is a valuable economic resource, and the benefits from a limited degree of mining can outweigh the associated costs. Groundwater mining must be carefully regulated, however, to ensure net benefits.

Most states long tolerated groundwater mining, no matter what the costs. Eastern states originally employed a rule of "absolute ownership" that entitled land owners to withdraw as much groundwater as they wanted from underlying aquifers. This set the stage for a tragedy of the commons in which individual landowners saw little reason to limit their withdrawals. Landowners did not have to bear any damage their withdrawals caused others by, for example, lowering the water table. Individually, moreover, no landowner could eliminate an overdraft; if one landowner voluntarily stopped pumping, others would still continue.

As groundwater mining has become a more serious problem, a growing number of states have taken at least some steps to regulate pumping. Yet reform has again been slow. Except when faced by a critical and immediate problem such as salt water intrusion, farmers and cities generally have been unwilling to give up any of the groundwater on which they have grown reliant. Even in the midst of a crisis, disagreements over how to cure existing groundwater problems and who should bear the burden of groundwater reduction have often derailed reform efforts or led to ineffective compromises.

Environmental laws again have sometimes stepped into policy vacuums. When extraction of water from the Edwards Aquifer near San Antonio, Texas, threatened endangered fish species in the aquifer and in waterways fed by the aquifer, for example, a federal court ordered the state and local users to reduce water withdrawals. Texas responded by forming the Edwards Aquifer Authority to regulate groundwater pumping and restrict total withdrawals.

ii. **Global groundwater depletion**

Overdrafting of groundwater aquifers is a global problem. Mexico City is depleting the groundwater aquifer that lies beneath it twice as fast as nature is replenishing it. As a result, the land on which the city is built is subsiding at the rate of approximately 6 cm annually (or about a foot every five years). Some parts of the city are dropping at rates up to three times this decline. In Mexico City's historic center, the ground has dropped 9 cm (almost 30 feet) this century, leaving churches and palaces leaning precariously.

China also is seriously overdrafting its groundwater. As a result of local pumping, China's most populous city, Shanghai, has been sinking by approximately 10 mm annually (or 1 foot every 30 years) since the mid-1980s. Subsidence has been more severe in other coastal cities, causing pipes to break and houses, bridges, and other structures to collapse; coastal subsidence also has threatened increased flooding from local rivers. With the nation's capital also overdrafting its local aquifer, the land underlying Beijing has sunk more than 60 cm (or approximately 2-1/2 feet) since the middle of the century and is continuing to sink at a rate of up to 2 cm per year (approximately 1 foot every 15 years). Groundwater tables are dropping by about 1 m every year, increasing the cost of pumping water for surface use. Northern China's second largest city, Tianjin, has sustained serious building damage from subsidence rates over four times those of Beijing.

One can cite examples of groundwater overdrafting virtually everywhere in the world that major population or agricultural centers are found. Tokyo is sinking. Water tables are dropping rapidly in important agricultural regions of India, forcing the abandonment of thousands of wells and threatening the regions' long-term sustainability. Overpumping in the western Indian state of Gujarat has led to salt water intrusion and contamination of local drinking water supplies. The Middle East faces particularly dire groundwater problems. Hydrologists believe that Bahrain will exhaust its groundwater aquifer early in the 21st century. At the current rate of pumpage, Saudi Arabia's groundwater supply probably will last from 25 to 100 years, with most estimates centering around 50 years.

In the face of dropping groundwater tables, surface subsidence, and even salt water intrusion, many governments do nothing. Most of the major options, from importing alternative supplies to regulating groundwater withdrawals, will either raise water costs or require significant conservation and thus will be unpopular with local populations. Faced with the choice of political criticism or the status quo, many officials choose the status quo.

Of the options for addressing the problems, most countries opt for finding alternative sources of supply. Some import water from distant watersheds for direct distribution to the population or for artificially recharging the aquifer. By itself, importation of new water supplies is only a short-term solution. Mexico City now supplies approximately a third of its water by importing water over 150 kilometers (or 90 miles) from distant provinces. Yet as the city has continued to grow by half a million people per year, groundwater overdrafting has continued apace as described earlier. Water importation projects, moreover, often damage the environmental—replacing one set of water problems with another.

A number of countries, including China, have begun to restrict the amount of water that can be withdrawn from overpumped aquifers. Unless wells are registered and metered, however, restrictions cannot be enforced. And regulation of individual aquifers often simply increases pumping from neighboring aquifers. In 1997, Chinese officials reported that new Shanghai restrictions had led local industries to obtain water from neighboring provinces where restrictions were fewer.

Long-term solutions to groundwater overdrafting will require areas with dropping water tables not only to limit groundwater pumping, but to conserve water or otherwise stretch their limited supplies. Mexico City finally has begun to encourage conservation by raising water rates, replacing conventional toilets with low-flow alternatives, and running an educational campaign. A number of countries with severe groundwater problems, including China and Saudi Arabia, have begun to treat effluent both as a replacement for groundwater and to recharge depleted aquifers.

Even these measures, however, ultimately will be ineffective unless population growth is brought under control. Mexico City's population is expanding by more than half a million people every year. The population of Saudi Arabia is likely to double in 20 years. Even with conservation and recycling, high growth rates inevitably will increase water demand and place pressure on local groundwater resources.

