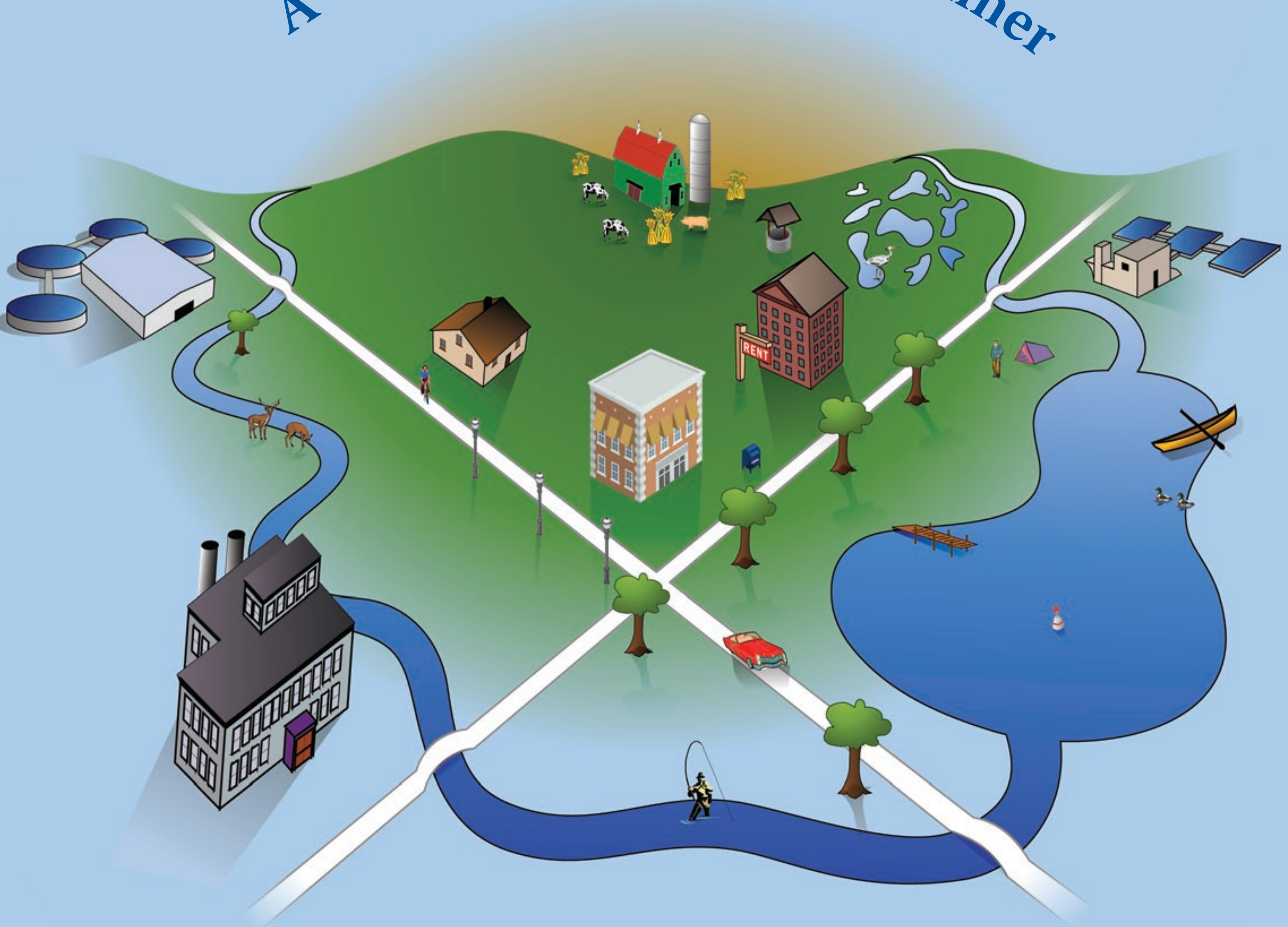
# Collecting the Drops: A Water Sustainability Planner




Global Environmental Management Initiative

GEMI®

## ABOUT THE GLOBAL ENVIRONMENTAL MANAGEMENT INITIATIVE (GEMI)

The Global Environmental Management Initiative (GEMI) is a non-profit organization of leading companies dedicated to fostering environmental, health and safety excellence and corporate citizenship 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 this 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.



### GEMI Member Companies

## PREFACE

January 2007

Each year, more users are successfully making the business case for the sustainable use of water. Today's business climate is significantly different than that of even five years ago. The high cost of energy combined with intense global market pressures has placed many businesses in a challenging position. Through all of these changes, the issue of water continues to be one of the most complex sustainability topics. The resource is plentiful, but is not geographically distributed in the places of need or of the quality needed. Businesses, communities and ecosystems all depend on fresh water to prosper. The first GEMI water tool, *Connecting the Drops Towards Creative Water Strategies: A Water Sustainability Tool*, was created to establish a link between water sustainability issues and the business case. The tool was created to help companies better understand an organization's relationship to water and to assist in making a business case, while gauging opportunities and risks.

The signals of the challenges faced by water users come in all forms. Some are faint, some pronounced. All of them must be understood and balanced for a company to create a forward looking strategy that can be implemented. As more companies understand the critical link between sustainability and the contributions from each of the signals, they implement programs to balance their needs and supplies with those around them. Converting the concept of sustainable water strategy into actionable plans at a site or unit level is a challenge.

GEMI's Water Sustainability Work Group developed this tool, ***Collecting the Drops: A Water Sustainability Planner***, to complement other GEMI tools. This tool is intended to guide the user through the process of taking a corporate sustainability strategy and converting it into a site or unit strategy for water. ***Collecting the Drops: A Water Sustainability Planner*** is not a Code of Conduct for companies. It is not designed to suggest that companies must be actively engaged in all of the module assessments. The three areas of focus, or Modules, will assist users in understanding water use and impacts, water risk assessment and provide case examples of techniques that GEMI member companies have used. This information is then combined with simple engineering estimates and tools to give the user an overall risk assessment output that is unique for their unit.

***Collecting the Drops: A Water Sustainability Planner*** has been designed to provide users with a clear picture of where they could focus their actions on a unit level to support both local and global sustainability efforts. As the ancient proverb says, "Enough pails of earth — a mountain. Enough pails of water — a river." ***Collecting the Drops: A Water Sustainability Planner*** will allow all users to collect the drops and fill a pail. With enough pails we can make a large impact on the global environment and our corporate citizenship efforts.

Karl Fennessey
The Dow Chemical Company

Paul Halberstadt
ConAgra Foods

Harry Ott
The Coca-Cola Company



*Collecting the Drops: A Water Sustainability Planner*

## ACKNOWLEDGEMENTS

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### Contributing GEMI Water Sustainability Work Group members include:

Brenda Abke, The Scotts Company
Robert Accarino, Abbott Laboratories
Marcio Amazonas, The Coca-Cola Company
Audrey Bamberger, Anheuser-Busch, Inc.
Maurice Bechard, JohnsonDiversey, Inc.
Paul Bowen, The Coca-Cola Company
Brad Burke, Southern Company
Mark Chatelain, Johnson Controls, Inc.
Soma Chengalur, Eastman Kodak Company
Stan Christian, Motorola, Inc.
Ric Coleman, Carnival Corporation & PLC
Al Collins, Occidental Petroleum Corporation
Tyler Dutton, Tyson Foods, Inc.
Doug Finan, GlaxoSmithKline
Al Forte, Pfizer Inc
Don Gebhardt, Ashland Inc.
Elizabeth Girardi Schoen, Pfizer Inc
Eric Grates, The Dow Chemical Company
Angela Grooms, Duke Energy
Debbie Hammond, Abbott Laboratories
Mark Hause, DuPont
Mitch Jackson, FedEx
Bryan Jacob, The Coca-Cola Company
Jack Kace, Roche
Jim Kearney, Bristol-Myers Squibb Company
Kelly Kline, Smithfield Foods, Inc.
William Lechner, The Scotts Company
Jimmy Mardis, Tyson Foods, Inc.
Phil McAndrew, Kraft Foods, Inc.
Paul McNulty, Kraft Foods, Inc.
Keith Miller, 3M
Dean Miracle, Southern Company
Tim Mohin, Intel Corporation
Leslie Montgomery, Southern Company
Neil Parke, Eli Lilly & Company
Krish Ravishankar, Occidental Petroleum Corporation
Ted Reichelt, Intel Corporation
Jeff Seabright, The Coca-Cola Company
Jeff Smith, Abbott Laboratories
Lindell Sneed, Abbott Laboratories
John Stier, Anheuser-Busch, Inc.
Jim Thomas, Novartis Corporation (Gerber)
Robin Tollett, The Procter & Gamble Company
David Trindell, Roche
Hannah Valmont, Koch Industries, Inc.
Bruce Wallington, Merck & Co. Inc.
Terry Welch, The Dow Chemical Company
Carl Wirdak, Occidental Petroleum Corporation

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## EXECUTIVE SUMMARY

Business risk and opportunity assessments have evolved to include analyses of water use, impact of use and "license to operate" considerations. These assessments are used to create short- and long-term water sustainability strategies. ***Collecting the Drops: A Water Sustainability Planner*** is a tool segregated into three Modules that guides a facility user through: the process of assessing the facility's specific water uses/needs in comparison to the availability of water in the region; the impacts these operations pose on the available water resources; and the identification of factors that may pose a risk on the operation's ability to produce. Case examples of how GEMI members have identified opportunities to efficiently manage water resources are also provided.

There are several factors that, when all summed up, form an operation's relationship to water. These factors can include such items as: the quality and quantity of water available for use, the cost of water, environmental sensitivities of the region, current/projected community development and the adequacy of the current infrastructure.

Regions throughout the world are experiencing significant water shortages. Population shifts to coastal regions, smaller towns and cities adjacent to large cities have stressed existing suburban infrastructure and required agencies to impose further restrictions or cost sharing with users. However, growth can occur without further stress on water resources and there are several cases of sustainable growth in water "limited" areas. In parallel, the cost of water has increased, and will likely continue to increase around the world driven by demand for high quality water and limits on the resources. Water conservation efforts have been imposed in many areas throughout the world and require groundwater and surface water use allocation permits.

This document and the associated web site (**www.gemi.org/waterplanner**) have been developed to provide facility staff or operating division staff the tools and guidance to perform an assessment of their facility's water use and the impacts on the local or regional water supply. Guidance and individual programs are provided to assist the user in understanding the wide range of considerations that may apply. Also included are case examples of how GEMI members have engaged internal and external stakeholders in dialogue and generated actions to promote overall water supply resource management and conservation. Although ***Collecting the Drops: A Water Sustainability Planner*** is self-standing, facility users are encouraged to review the following GEMI tools for the purpose of understanding the considerations that could be taken into account when evaluating sustainability drivers: *Connecting the Drops Towards Creative Water Strategies: A Water Sustainability Tool; Exploring Pathways to a Sustainable Enterprise: SD Planner™;* and *Transparency: A Path to Public Trust*.

The user is encouraged to consider and evaluate the overall use of water and the impact of the operations on the regional water supply by using the three Modules of this tool.

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**Module I — Facility Water Use and Impact Assessment Program:** includes guidance, examples and programs the facility user can use to: assess the relationship to water by developing a water block flow diagram and performing a water balance; develop an understanding of water use and disposition and; assess quality of the water supply in comparison to water quality requirements of the facility operations. These steps will provide a more comprehensive understanding of the facility's relationship to water.

**Module 2 — Water Management Risk Assessment Program:** is a questionnaire that includes key questions to assess: a facility's sensitivity to external changes in water supply availability; the probability of water supply and water quality changes; business sensitivity to regulatory or policy changes and the changes due to community development. This module requires input from the user to answer general questions as well as specific vulnerability/risk questions on a sliding scale. Questions have been organized and presented in six risk categories including: watershed; supply reliability; efficiency; compliance; supply economics; and social context. The Risk Assessment Program tabulates the average risk score for each risk category based on the user input. The program also lists the results on a highest to lowest risk basis and provides links to relevant information and case examples provided by GEMI members.

**Module 3 — Case Examples and Reference Links:** is a database of case examples provided by GEMI members from a wide range of industry sectors on how to manage water wisely. This module includes reference links that provide specific water-related information. The user can search this module to identify case examples that may apply to your facility to improve overall water resource management performance within the facility and in the community. In addition, examples have been provided that outline methods to improve overall water efficiency of specific operating equipment.

This tool has been designed so that the information generated from the assessments can be used to create short- and long-term water sustainability strategies, develop action plans and perform actions to improve water resource management within the operation and community.

## INTRODUCTION

***Collecting the Drops: A Water Sustainability Planner*** is segregated into three modules that guide a facility user through the process of assessing the:

- Facility's relationship to water on a local and regional basis
- Identification of specific challenges and opportunities
- Identification of public, community and social considerations that could be taken into account

The facility user can then develop a strategic water management program from which the facility can address risks and move forward with opportunities identified.

This tool provides a process by which a facility user, regardless of location, can assess the specific situation with regard to water resources. It provides a list of considerations that need to be taken into account to assess specific water uses/needs, impacts on the existing available resources and the resulting opportunities and risks. The modules/programs assist the facility user in assessing the many circumstances that can affect the:

- Adequacy and quality of the supply
- Impact of the facility on the local water supply and water quality
- Need for communication to increase awareness and community involvement to manage water resources wisely

### Module 1 — Facility Water Use and Impact Assessment Program

This module is the first step in identifying overall facility water uses and impacts posed by the operations. It includes guidance for preparing a facility water block flow diagram and a Water Balance Program. Together, these elements will assist the user in developing data and generating an understanding of the facility's usage of water, the water losses and final wastewater discharge. This information can be entered into the Water Balance Program that calculates percent closure of the balance and the remaining volume of water unaccounted for. It also provides guidance for acceptable margins of error based on percentage versus average volume of water used. In addition, this information will be required to answer water-related risk questions in Module 2. Several links to information are included for easy reference, such as water engineering calculations and "rules of thumb" as examples.

## Module 2 — Water Management Risk Assessment Program

This module is a web-based interactive program in the form of a Water Management Risk Assessment Questionnaire that requires input of facility water considerations and input for levels of risk. The water-related risk questions are organized and presented in six risk categories. It generates a table of risks in descending order that the facility user has indicated based on the responses. It is important to note that opportunities are frequently derived from risks that have been identified during this process. Several case examples of methods to mitigate risk and implement opportunities are provided through links in this module.

## Module 3 — Case Examples and Reference Links

This module is a reference program that helps the facility user identify case examples and links to reference information that could be applied in specific operations to use water more efficiently, to reduce water use and to promote conservation. Reference information has been included for the purpose of providing examples of operational methods to efficiently utilize water, to engage stakeholders and promote sustainability of water resources. Links to case examples are provided throughout the program to assist the facility user with the identification of methods that can be employed to manage water resources. The facility user is also encouraged to review definitions and information included in the References Tab on the web site, **www.gemi.org/waterplanner** for the purpose of understanding the terms utilized throughout this document.

## MODULE 1 — FACILITY WATER USE AND IMPACT ASSESSMENT PROGRAM

**Discussion of Water Program Content and Key Considerations**

The facility user may want to consider and evaluate the operations' overall use of water and the impact on the regional water supply. This module is provided to assist with the preparation of a water block flow diagram and perform a simple water balance that will provide an approximation of overall use and disposition.

> **Note:** Much of the information generated through this process will be requested as input to the water management risk questionnaire in Module 2.

**Module Purpose and Approach**

The purpose of Module 1 is to guide the user through the tasks required to assess the facility's relationship to water by:

- Developing a water block flow diagram using the guidance and example schematic provided
- Utilizing the Water Balance Program to develop an understanding of water use and disposition
- Performing an analysis of water supply quality in comparison to process quality requirements to assess if opportunities exist for water management improvements such as recycling or reuse of the streams

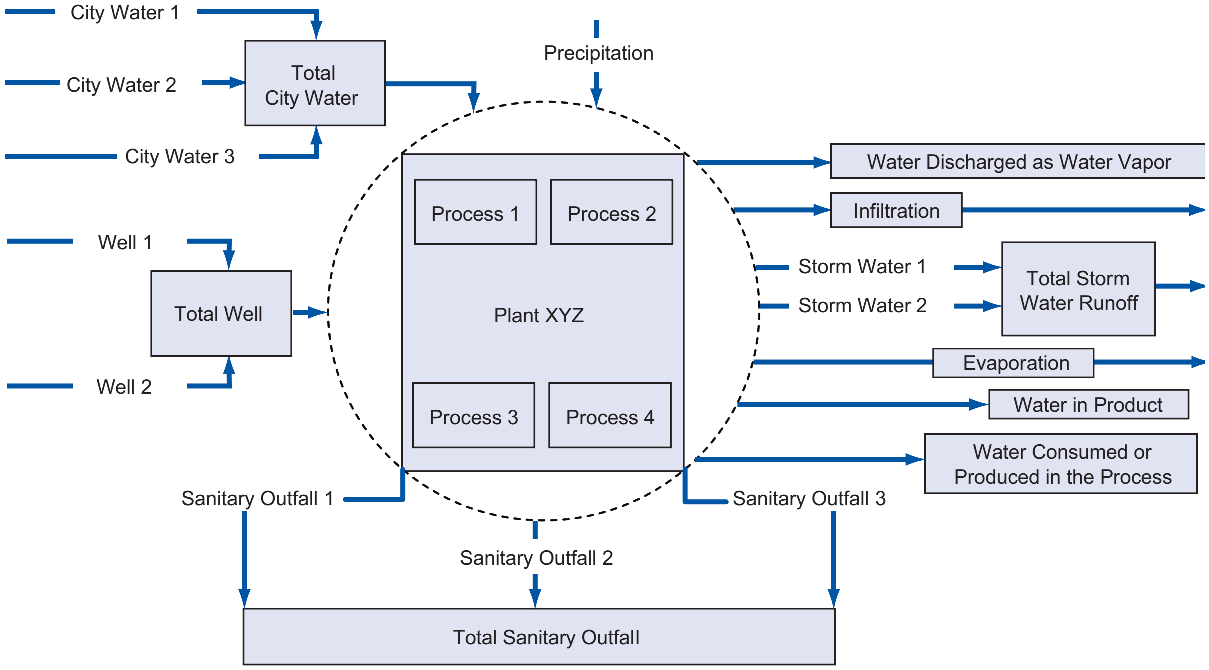
These steps will provide a more comprehensive understanding of the relationship to water.

**Water Block Flow Diagram and Water Balance Program**

The facility user should be prepared to invest time to understand water supply including the quality and quantity used, losses of water to air, losses to land, water retained in the product and the final disposition of the water once used (water discharged). A simple flow diagram can be prepared by linking the water supply to each location where water is used. The process unit can be the entire facility, a building containing several production processes, a particular production process, the utilities area or specific unit operations (e.g., the cooling towers). The process unit could also be defined as a type of usage such as sanitary usage (i.e., the water consumed by facility employees, used in toilets, showers and in food preparation).

After defining a process unit, the user can draw an imaginary dotted line around the process unit and identify and ultimately quantify the water inputs, water losses (to air, land and to product) and wastewater discharge. Lines should connect to each block (labeled with the name of the water-using process) and should include information of total water flow per unit time and water quality. A water balance case example, flow calculations and rules of thumb are provided as links in Module 1 for use during the preparation of the water flow diagram. Once completed, the combination of process steps (boxes) and flows (lines), from supply through final process prior to discharge, represents the facility's comprehensive water flow diagram. Figure 1 represents a Sample Water Flow Diagram.

**Figure 1. Sample Water Flow Diagram**




The next step is developing a simple water balance by assessing the total water used (inputs) minus the volume of overall losses in production and wastewater discharged (outputs). A simple Water Balance Program is provided for this purpose.

## General Water Balance Calculation

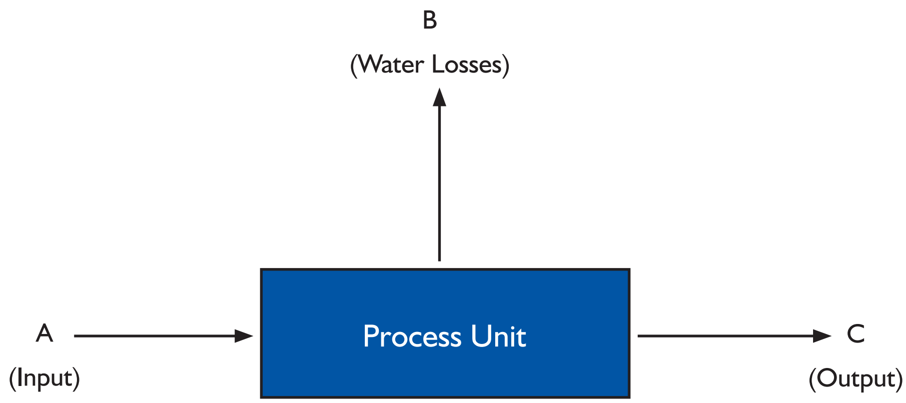
A water balance is an inventory of the water in a system. The purpose of developing a water balance is to prioritize the major water uses in the facility where potential water conservation and reuse opportunities could exist based on process water quality requirements. After the user has prepared a water flow diagram, the next step is to perform a facility wide water balance. The facility water balance is often a simple exercise because raw water and wastewater flows are commonly metered. Subtract the total water supplied to the facility from the total wastewater discharged from the facility. The remainder is the amount of water that is lost to air through evaporation, to the land through irrigation, leaks or retained in the product. The next step for the user is to perform a water balance for each water use to account for facility losses. Prepare separate diagrams for utilities, production, sanitary, irrigation and all other uses. A link to a hypothetical water balance case example is provided for reference in Module 1.

Water systems can be very complex and can have a number of water inputs, losses and outputs to wastewater or recycle/reuse. Facilities generally do not have separate water meters covering these operations. The facility engineer is called on to estimate water uses in the various areas. This is commonly done by a combination of methods including engineering calculations/factors, process knowledge and the installation of water meters and/or wastewater measuring devices. Some common estimating tools are provided later in this module.

A Block Flow Diagram is very important when developing the water balance. A simple spreadsheet can be used for more complex systems using multiple inputs, losses and outputs. Figure 2 provides a basic schematic that can be used for calculating a water balance:

**Figure 2. Sample Block Flow Diagram**

Typical Process/Facility Water Balance Calculation




**VARIABLE DEFINITIONS: A - (B + C) = Balance or Discrepancy**
A: Input is Process/Facility Water Supply
B: Water Losses (e.g., to air, land and product)
C: Output is Wastewater Discharge

**Water Balance Program**

The Water Balance Program includes three spreadsheets that require inputs for water supplied, process/facility losses and total volumes discharged or returned. The program calculates a result based on user input that will indicate a complete balance or a discrepancy (water unaccounted for). The program also provides a percent closure result. Acceptable margins of error based on discrepancy percentage versus average volume of water used are provided. The water balance is an important step to obtain sufficient information about water usage and assess if opportunities exist to reduce, reuse or recycle water. Table 1 represents a Water Inventory Calculation.

| Table 1. Water Inventory Calculation | | | | |
|---|---|---|---|---|
| **Input** | **-** | **Total Losses** | **=** | **Output** |
| Process/ Facility Water Supply | | Water that is consumed (i.e., added to the product, removed by chemical reaction, evaporated or lost from the system) | | Process/Sanitary wastewater and water that leaves the process unit |

A water-related engineering calculation and reference information link is provided in Module 1. Water-related calculations and "rules of thumb" are included in this module to assist with the water balance activity. Table 2 provides examples of the water-related calculations and "rules of thumb" that are provided for reference and use in the Calculation Tab on the web tool.

| Table 2. Examples of Water-Related Calculations and "Rules of Thumb" | |
|---|---|
| **Miscellaneous Calculations** | |
| Fluid Flow Fundamentals | Q = Area x Velocity |
| Hydraulic Horsepower | $\frac{\text{Head (ft) x Flowrate (gpm)}}{3956}$ |
| Irrigation Usage | Number of sprinkler heads x the flow capacity per head (i.e., 2.5 gpm x the duration [minutes] of water application) |
| **"Rules of Thumb"** | |
| Sanitary Usage in a Production Facility | 10-25 gallons per person per shift |
| Slab Washing | 5 gallons per minute for each hose |
| One Drip per Second | 10,000 liters per year or 2,642 gallons per year |
| Water Flow Estimation | Using a bucket and stopwatch |

As the user begins to identify key water uses, consider the broad range of areas where your company may be connected to water; how it is used (e.g., cooling, process cleaning); and how much is used. The next step is to create a list of individual water uses and the estimated volume of use such as sanitary (employee bathrooms, showers and lunchrooms); lawn/landscape maintenance; process steps; sanitation of equipment; etc. Please refer to the hypothetical water balance case example on the web site in Module 1 that is presented as an example of what may be developed to define facility water usage and use the Water Balance Program to compare water use versus water returned.

There are a number of areas where water is used at facilities. Table 3 provides examples of where water is commonly used and is provided as a starting point for the user to examine all the water demands at any facility.

| Table 3. Key Water Uses |
|---|
| • Irrigation of crops<br>• Irrigation of lawns, green areas, plants, shrubs and trees<br>• Cleaning of raw materials<br>• Cleaning of process equipment, storage vessels, process piping, floors, walls and work spaces<br>• Cleaning during or following maintenance of parts, equipment, facilities, vehicles, etc.<br>• Cleaning following or during waste handling<br>• Sanitation of process equipment<br>• Consumption by people and/or animals<br>• Food preparation, dish washing, cafeteria operations<br>• Raw material in production process (e.g., as an ingredient in a beverage or pharmaceutical product or manufacturing input)<br>• Cooling including non-contact cooling water, as quench water for a reaction, as cooling tower makeup and to lubricate a pump seal<br>• Power generation (e.g., hydropower, thermal, nuclear) for heating and as boiler feed water<br>• Fire suppression<br>• During quality assurance laboratory activities<br>• Pollution control equipment (e.g., in a scrubber, in a condenser for cooling, for cleaning of wastewater treatment process unit)<br>• In other utilities areas such as input to a water treatment process to produce higher quality water (e.g., a softener, a reverse osmosis unit) to produce steam, to quench boiler blow down<br>• Movement/transportation of materials or goods (e.g., water slurry, ballast water, feed supply to produce higher quality water)<br>• Air conditioning or cooling |

Each operation has specific water quality requirements for each use at its facility. The facility user is encouraged to define all of its water uses and their related water quality requirements. The user can then analyze the water quality discharged from each specific process where water is used and assess the opportunities to recycle and reuse this water. This can be done when the discharge quality matches the quality requirements in another area of the operation.

# MODULE 2 — WATER MANAGEMENT RISK ASSESSMENT

**Module Purpose and Approach**

This module outlines key questions relating to assessing your facility's sensitivity to external changes in water supply availability, the probability of water supply and water quality changes, business sensitivity to regulatory or policy changes and the changes due to community development. The user can consider the water source information previously reviewed in Module 1 to assess the likelihood of changes that could occur based on the sensitivity of the watershed. This may be linked to the vulnerability of the water source(s) that are relied upon. For example, an aquifer that is being rapidly depleted or contaminated would likely be vulnerable to changes or response actions, such as water allocation restrictions 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.

If the business sensitivity to changing water impact requirements is high, this can create a strong business case for conducting research and development and investment in creative, cost-effective options to eliminate the water impact. Tool users can assess the likelihood that one or more of the drivers for change will affect the business in the near future. By analyzing sensitivity to external changes associated with water-related impacts, the facility user can make a qualitative assessment of the business "significance" of this impact.

The Water Management Risk Assessment Program provided in ***Collecting the Drops: A Water Sustainability Planner*** identifies the factors that need to be addressed if they apply to the operation through a series of questions.

**Usage Notes:**

This program requires input from the facility user to answer general questions as well as specific vulnerability/risk questions. Water use and impact questions have been organized and presented in the following six risk categories:

- Watershed
- Supply Reliability
- Efficiency
- Compliance
- Supply Economics
- Social Context

For each stage, the user will want to consider not only the needs of the facility but the needs of the entire community that share the local water supply.

A downloadable file that represents the complete questionnaire is provided on the web site in Module 2. Printing a copy of the questionnaire may assist the user in reviewing the questions and identifying the specific information that will require time to gather.

Table 4 provides an example of the risk questions contained in the questionnaire and an example of the results that would be generated based on the question responses. The user may choose to complete the entire questionnaire or sections that are of interest.

**Table 4. Sample of Questionnaire Inputs**

**Questionnaire:**
**Watershed 2 of 7**

1. Enter the name of the watershed that the facility relies on for its water supply. This would be the watershed that the water is withdrawn from by the supplier or through private withdrawals from groundwater or surface water.

   **Type answer here:**

   Aquifer

2. There are several ways that water is withdrawn from the watershed. Water is withdrawn from surface water (rivers and streams) from groundwater through production wells or through the collection and use of precipitation. Please enter the sources of water withdrawn from the watershed by the supplier or privately owned water supply system (surface water, groundwater, precipitation).

   **Type answer here:**

   Groundwater

3. What is the average annual rainfall at your facility? Using your internet browser, type in "average annual rainfall" for your facility location. Another link that has reference information is http://www.worldclimate.com.

   **Type answer here:**

   9 inches per year

4. What is the available water per person per year (m3/person/year)? Review information related to your specific watershed by using the following links:
   http://multimedia.wri.org/watersheds_2003/index.html;
   http://waterdata.usgs.gov.

   Please compare the figure for your watershed to the following thresholds to define scarcity.
   Risk Criteria

   ☐ 1 = > 10,000 to 20,000 cubic meters per person per year
   ☐ 2 = > 5,000 to 10,000 cubic meters per person per year
   ☐ 3 = > 2,000 to 5,000 cubic meters per person per year
   ☐ 4 = 1,000 to 2,000 cubic meters per person per year
   ☐ 5 = < 1,000 cubic meters per person per year

   **Importance:** 3 **(1-5, 1=lowest, 5=highest)**

Table 5 is an example of the results which includes a list of the general questions and responses given, the average risk ranking for the risk category answered and a summary of the highest risks to lowest risks in descending order. Table 5 provides the risk score entered, the question number the score relates to and a link to GEMI member case examples that may prove helpful to the user in identifying options for reducing risk.

**Table 5. Sample Results of Questionnaire**

**Collecting the Drops:**
**Evaluation**

**Watershed**

General Information

1. **Enter watershed that facility relies on for its water supply.**
   *Aquifer*

2. **What are the sources of water from the watershed withdrawn by the supplier or privately owned water supply system (surface water, groundwater, recycled)?**
   *Groundwater*

3. **What is the average annual rainfall at your facility? Using your internet browser, type in "average annual rainfall" for your facility location.**
   *9 inches per year*

**Average Ranking 4**

| Risk Level | Question Number | Relevant Information |
|---|---|---|
| 5 | 7 | GEMI Member Case Example |
| 4 | 6 | GEMI Member Case Example |
| 4 | 8 | GEMI Member Case Example |
| 4 | 5 | GEMI Member Case Example |
| 3 | 4 | GEMI Member Case Example |

## MODULE 3 — CASE EXAMPLES AND REFERENCE LINKS

**Module Purpose and Approach**

This module provides a database of case examples provided by GEMI members that have been used in a wide range of industry sectors to manage water wisely. It also contains reference links that provide specific water-related information. This module can be used to identify case examples that may apply to your facility with the intent to improve overall water resource management within the facility and in the community. In addition, examples have been provided that outline methods to improve overall efficiency of specific operating equipment.

The user is encouraged to review the operations, scan through the available case examples and referenced information, and identify potential new opportunities where these examples can be applied.

**Module Guidance**

Figure 3 represents the Community Map found on the web site that is segregated into three sectors: Industry, Community and Natural Resources. The user can mouse over and click the sector of interest and access case examples that relate to that sector.

**Figure 3. Community Map**

In addition to the case example links provided within the three sectors of the Community Map, the case examples can be accessed by categories that were generated to further assist the user. Table 6 represents a list of case example categories that are contained in the database.

| **Table 6. List of Case Example Categories in the Database** |
|---|
| Advocacy Management Techniques (link to GEMI's *Transparency: A Path to Public Trust*) |
| Community Outreach |
| Development Impact |
| External Stakeholder Discussion Guidelines (link to GEMI's *Transparency: A Path to Public Trust*) |
| Global Awareness and Education |
| High Purity Water Systems |
| Housekeeping |
| Innovative Water Conservation Approaches |
| Innovative Water Reuse/Recycle Approaches |
| Metrics (link to *GEMI Metrics Navigator*) |
| NGO Interaction Guidance (link to GEMI's *Transparency: A Path to Public Trust*) |
| Pretreatment |
| Risk Avoidance |
| Waste Reduction/Minimization |
| Wastewater Treatment Systems |
| Water Access |
| Water Management Operational Practices |
| Water Quality Standards |
| Water Quantity/Allocations |
| Water Treatment Systems |
| Watershed Management/Reclamation |
| Zero Discharge |

Module 3 also includes a list of links to reference web sites that GEMI members have found useful during the development of water management programs. The following represents some examples of the reference web site links:

- Global Water Partnership (**www.gwpforum.org**)
- Global Water Challenge (**www.globalwaterchallenge.org**)
- The World Bank Group (**www.worldbank.org**)
- United Nations Development Programme (**http://hdr.undp.org/hdr2006/**)
- United Nations Economic and Social Development (**www.un.org/esa/**)

## REFERENCE SECTION

The References Tab includes definitions and descriptions that clarify the use of terms in the document.

### Definitions

Predominant sources of fresh water are surface water and ground water, with desalinized and treated wastewater as important sub-categorical sources. Saline water may also be suitable for some direct uses. Terms used to describe water use are:

- **Beneficial Consumption** — The amount of water bound into products or crops; or transpired during crop production. It is considered beneficial since it is inherently part of an economic good for social benefit.
- **Conservation** — Water conservation is a permanent or temporary reduction in water use or losses, achieved through changes in the structural process, institutional, educational or economic means. Permanent conservation is meant to lower overall use. Temporary conservation is part of a suite of tools to deal with the risk of temporary shortages. To be meaningful, it must be analyzed in terms of beneficial end effects. For instance, conserving withdrawals while increasing consumptive use (i.e., closed system vs. evaporative cooling) may be unwise. Beneficial conservation is that where economic, environmental and social benefits exceed the costs.
- **Consumption** — The portion of withdrawn water evaporated, transpired or bound into products or crops. Note that this term is often used by water utilities (and their customers) to describe water delivered and billed to the user (including return flow) — a different concept based on water sales.
- **Conveyance Loss** — The amount of water lost in transit to point of use or from point of release to return point.
- **Delivery** — The amount of water delivered to the point of use.
- **Grey Water** — Water discharged from a process use that may be considered for recycle/reuse.
- **Gross Water Use** — Includes withdrawals, reclaimed wastewater and recirculated water.
- **Return Flow** — The amount of water returned to surface or ground water after release from the point of use. The quality, quantity, temperature and point of return to a watershed or aquifer compared to pre-withdrawal conditions are important elements of sustainability evaluation.
- **Scarcity** — On a global basis, the United Nations and other organizations such as the World Resources Institute (WRI) provide the following thresholds to define scarcity:
    - Extremely low <1,000 cubic meters per person per year
    - Very low 1,000 to 2,000 cubic meters per person per year
    - Low >2,000 to 5,000 cubic meters per person per year
    - Medium >5,000 to 10,000 cubic meters per person per year
    - High >10,000 to 20,000 cubic meters per person per year
    - Very high >20,000 cubic meters per person per year
- **Withdrawal** — The amount of water taken from a surface or ground water source, which may be fresh or saline.

## General Water Rate Considerations

For water pricing, there are two broad categories of water availability: self-supplied and purchased. With regard to self-supplied water, permits and fees related to resource use and return may be applied. Contracts and agreements for volume of storage or flow entitlement, similar to U.S. water rights administration, may also be applicable. With respect to purchased water, in general, the principle of full direct cost recovery in establishing rates might be assumed. This is consistent with European Union (EU) Directives and World Bank Policies. An important consideration, often overlooked in past rate setting practice, is the capture of all costs. Development grants and loans as well as long-term contracts for water storage or availability at subsidized rates and low cost water rights systems can lead to setting rates too low ignoring long-term replacement and development costs. While economic theory for production may support pricing consistent with short-run costs, economic efficiency for investment and long-term capacity calls for pricing based on long-term costs (see Marginal below). Pricing for efficiency is becoming more broadly accepted. In addition, full costs for social and environmental impacts and necessary mitigation for sustainability could be included with direct costs for future rate setting, contracts and governmental agreements. Resource depletion and sustainability effects charges may also be expected to become more common in the future.

The primary purpose of a rate structure is to generate revenue to cover utilities costs; however, rate structure may also be used to allocate costs among users and user groups and to provide incentives to customers to adopt beneficial water use patterns. Water rate setting can be a variable and complex process depending upon not only good asset management principles, but also rate of return and environmental costs. In addition, flat rates or service charges independent of quantity of water used are still encountered in some systems. Fire service, public use and building capacity are also built into some utility costs. Basic water rate structures include the following, sometimes in variation and combination:

- **Decreasing Block** — A rate per unit decrease in stepped blocks as use decreases. A structure designed to encourage greater use (sales).
- **Excess Use Charge** — A possible, but not often encountered charge or fee that might be part of drought contingency plans or other unique conditions.
- **Increasing Block** — A rate per unit increase in stepped blocks as use increases. A structure designed to foster efficient use.
- **Marginal** — A change in cost per unit increase in quantity, which may be an increase or a decrease. It is an economic concept basic to selecting a rate, but often not applied literally. Costs may often be decreasing in the short term, but increasing in the long term with the need for new supplies and improvement.
- **Peak Load Pricing** — A means to reflect higher costs inherent to maintaining extra supply and delivery capacity to meet peak load demands which can vary daily, weekly and seasonally.
- **Seasonal Pricing** — A simple variation in rate structure to reflect predictable heavy use seasons, such as summer exterior household use, which could also be reflected as a summer surcharge applied over some normalized base use.
- **Uniform** — A rate where the amount paid per unit of water remains the same for each unit used.

## Governance and Regulation Inputs

The social/cultural/political setting for water management manifests itself through a variety of governance forms, regulations and regulating institutions. Water management for flow-related water uses such as flood control, hydropower, navigation, recreation, fish and wildlife are often different and separate from public, commercial, industrial and wastewater institutions. The sophistication and ability to manage interfaces between responsibilities for various water uses is greater and accomplished with more certainty in developed countries. These countries might also be expected to have quantity and quality environmental permitting regulations with well-functioning enforcement institutions. In developed countries, a trend toward Integrated Water Resource Management (IWRM) to manage total water resources on a regional or watershed basis is clear. However, the degree of centralization versus fragmentation of both government and private sector responsibilities is variable and affected by the existence and form of regulatory and enforcement institutions. In developing countries, enforcement capability and longevity of decisions may contribute to uncertainty and could be considered.

## Risk and Uncertainty

Risk related to a social/cultural/political setting is generally surrounded by larger degrees of uncertainty than hydrologic risk and not easily subject to mathematical analysis. Yet the approach set forth in Module 2 relies on the experience of the user to subjectively estimate a probability to aid decision making. Therefore, it will be important in this process not to be either too optimistic or too pessimistic. Very sensitive factors with surrounding uncertainties could be identified in order to focus attention on methods to circumvent, reduce or apply appropriate solutions to high priority risks.

The array of factors to which an estimated risk will be assigned can be assessed in order to:

- Apply different corporate analytical and management skills to the risks as appropriate to the decision
- Develop a complete list of Good Management Practices (GMPs)
- Focus attention on highest priority areas
- Array watershed level issues such as sustainable supply, treatment of contaminants, regulatory and supply constraints

In some cases, community awareness programs may be more effective when pressure on a watershed is derived from quality or quantity issues related to run-off, homeowner irrigation or other community impacts.

## Water Use and Sustainability

The term sustainability, although widely used, is often not precisely defined. For purposes of this discussion, it is presumed to be a concept related to using water to meet present needs without sacrificing ability to meet future needs. It also means using renewable water sources in a way that minimizes long-term environmental, ecological and social effects. Risks to water availability and use can be calculated as probabilities related to the hydrologic cycle (frequency of floods and droughts) or technological reliability in making trade-off decisions to meet future needs. Uncertainty is a lack of sufficient information to calculate and assess probabilities and may often relate to institutional, governance and market conditions as well as environmental settings. The goal of risk analysis is to produce good planning and design for sustainable use of water and minimizing uncertainty of shortage. Demand for water, as opposed to "need," is an economic term where cost and relevant pricing mechanisms are applied to available water, often restraining expressions of "need."

Water may be used in two ways:

- **Instream Use:** is use that does not require withdrawal or diversion from a surface water source, but is used within the water source itself. It includes purposes such as hydroelectric generation, navigation, minimum flows for fish, wildlife and ecosystem health, recreation and water quality.

- **Offstream Use:** is water withdrawn or diverted from surface (or ground) sources and used for industrial, commercial, irrigation, livestock, mining, thermoelectric power, domestic and public supplies and other similar uses.

# CONCLUSION

Water management is a complex issue for any organization. This tool, along with GEMI's other tools, is meant to assist users along their journey to use water sustainably. While the tool does not cover every detail needed, it covers many of the areas that GEMI member companies consider crucial.

The user is encouraged to generate a water sustainability strategy for their operation, set goals and measure progress in meeting those goals. Please visit the GEMI web site (**www.gemi.org/waterplanner**) to evaluate your relationship to water.


**www.gemi.org/waterplanner**

## Reader Notes:

***Business helping business improve environmental, health & safety performance, shareholder value and corporate citizenship.***

GEMI®


**Global Environmental Management Initiative**
**1155 Fifteenth Street, NW, Suite 500**
**Washington, DC 20005**

**Phone:** 202-296-7449 **Fax:** 202-296-7442 **E-mail:** info@gemi.org
www.gemi.org



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