

# Guideline for Development of Effective Water Sharing Agreements

This document uses both the  
International System of Units (SI)  
and customary units



Documents

Document Sharing



Provided by IHS

Licensee=University of Texas Revised Sub Account/5620

No reproduction or networking permitted without license from IHS , 10/04/2014 00:24:27 MDT



Full document details: ASCE 60-12 2013

**American Society of Civil Engineers**

# **Guideline for Development of Effective Water Sharing Agreements**

This document uses both the International System of Units (SI) and customary units.



**ENVIRONMENTAL &  
WATER RESOURCES  
INSTITUTE**

**Published by the American Society of Civil Engineers**



**Documents**  
Document Sharing Hub

## Library of Congress Cataloging-in-Publication Data

Guidelines for development of effective water sharing agreements / American Society of Civil Engineers.

p. cm. — (ASCE standard)

“ASCE/EWRI 60-12.”

“This document uses both the International System of Units (SI) and customary units.”

Includes bibliographical references and index.

ISBN 978-0-7844-1230-5 (pbk. : alk. paper) — ISBN 978-0-7844-7691-8 (ebook)

1. Water—Law and legislation. 2. Water rights (International law) 3. Water resources development—Law and legislation. I. American Society of Civil Engineers.

K3496.G85 2012

346.04'691—dc23

2012013748

Published by American Society of Civil Engineers

1801 Alexander Bell Drive

Reston, Virginia 20191

[www.asce.org/pubs](http://www.asce.org/pubs)

This standard was developed by a consensus standards development process which has been accredited by the American National Standards Institute (ANSI). Accreditation by ANSI, a voluntary accreditation body representing public and private sector standards development organizations in the United States and abroad, signifies that the standards development process used by ASCE has met the ANSI requirements for openness, balance, consensus, and due process.

While ASCE's process is designed to promote standards that reflect a fair and reasoned consensus among all interested participants, while preserving the public health, safety, and welfare that is paramount to its mission, it has not made an independent assessment of and does not warrant the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed herein. ASCE does not intend, nor should anyone interpret, ASCE's standards to replace the sound judgment of a competent professional, having knowledge and experience in the appropriate field(s) of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the contents of this standard.

ASCE has no authority to enforce compliance with its standards and does not undertake to certify products for compliance or to render any professional services to any person or entity.

ASCE disclaims any and all liability for any personal injury, property damage, financial loss, or other damages of any nature whatsoever, including without limitation any direct, indirect, special, exemplary, or consequential damages, resulting from any person's use of, or reliance on, this standard. Any individual who relies on this standard assumes full responsibility for such use.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

*Photocopies and permissions.* Permission to photocopy or reproduce material from ASCE publications can be obtained by sending an e-mail to [permissions@asce.org](mailto:permissions@asce.org) or by locating a title in ASCE's online database (<http://cedb.asce.org>) and using the “Permission to Reuse” link.

Copyright © 2013 by the American Society of Civil Engineers.

All Rights Reserved.

ISBN 978-0-7844-1230-5 (paper)

ISBN 978-0-7844-7691-8 (e-book)

Manufactured in the United States of America.

18 17 16 15 14 13

1 2 3 4 5

# STANDARDS

In 2006, the Board of Direction approved the revision to the ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by the Society. All such standards are developed by a consensus standards process managed by the Society's Codes and Standards Committee (CSC). The consensus process includes balloting by a balanced standards committee made up of Society members and nonmembers, balloting by the membership of the Society as a whole, and balloting by the public. All standards are updated or reaffirmed by the same process at intervals not exceeding five years.

The following standards have been issued:

- ANSI/ASCE 1-82 N-725 Guideline for Design and Analysis of Nuclear Safety Related Earth Structures
- ASCE/EWRI 2-06 Measurement of Oxygen Transfer in Clean Water
- ANSI/ASCE 3-91 Standard for the Structural Design of Composite Slabs and ANSI/ASCE 9-91 Standard Practice for the Construction and Inspection of Composite Slabs
- ASCE 4-98 Seismic Analysis of Safety-Related Nuclear Structures
- Building Code Requirements for Masonry Structures (ACI 530-02/ASCE 5-02/TMS 402-02) and Specifications for Masonry Structures (ACI 530.1-02/ASCE 6-02/TMS 602-02)
- ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures
- SEI/ASCE 8-02 Standard Specification for the Design of Cold-Formed Stainless Steel Structural Members
- ANSI/ASCE 9-91 listed with ASCE 3-91
- ASCE 10-97 Design of Latticed Steel Transmission Structures
- SEI/ASCE 11-99 Guideline for Structural Condition Assessment of Existing Buildings
- ASCE/EWRI 12-05 Guideline for the Design of Urban Subsurface Drainage
- ASCE/EWRI 13-05 Standard Guidelines for Installation of Urban Subsurface Drainage
- ASCE/EWRI 14-05 Standard Guidelines for Operation and Maintenance of Urban Subsurface Drainage
- ASCE 15-98 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)
- ASCE 16-95 Standard for Load Resistance Factor Design (LRFD) of Engineered Wood Construction
- ASCE 17-96 Air-Supported Structures
- ASCE 18-96 Standard Guidelines for In-Process Oxygen Transfer Testing
- ASCE 19-10 Structural Applications of Steel Cables for Buildings
- ASCE 20-96 Standard Guidelines for the Design and Installation of Pile Foundations
- ANSI/ASCE/T&DI 21-05 Automated People Mover Standards—Part 1
- ANSI/ASCE/T&DI 21.2-08 Automated People Mover Standards—Part 2
- ANSI/ASCE/T&DI 21.3-08 Automated People Mover Standards—Part 3
- ANSI/ASCE/T&DI 21.4-08 Automated People Mover Standards—Part 4
- SEI/ASCE 23-97 Specification for Structural Steel Beams with Web Openings
- ASCE/SEI 24-05 Flood Resistant Design and Construction
- ASCE/SEI 25-06 Earthquake-Actuated Automatic Gas Shutoff Devices
- ASCE 26-97 Standard Practice for Design of Buried Precast Concrete Box Sections
- ASCE 27-00 Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
- ASCE 28-00 Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction
- ASCE/SEI/SFPE 29-05 Standard Calculation Methods for Structural Fire Protection
- SEI/ASCE 30-00 Guideline for Condition Assessment of the Building Envelope
- SEI/ASCE 31-03 Seismic Evaluation of Existing Buildings
- SEI/ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations
- EWRI/ASCE 33-09 Comprehensive Transboundary International Water Quality Management Agreement
- EWRI/ASCE 34-01 Standard Guidelines for Artificial Recharge of Ground Water
- EWRI/ASCE 35-01 Guidelines for Quality Assurance of Installed Fine-Pore Aeration Equipment
- CI/ASCE 36-01 Standard Construction Guidelines for Microtunneling
- SEI/ASCE 37-02 Design Loads on Structures during Construction
- CI/ASCE 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data
- EWRI/ASCE 39-03 Standard Practice for the Design and Operation of Hail Suppression Projects
- ASCE/EWRI 40-03 Regulated Riparian Model Water Code
- ASCE/SEI 41-06 Seismic Rehabilitation of Existing Buildings
- ASCE/EWRI 42-04 Standard Practice for the Design and Operation of Precipitation Enhancement Projects
- ASCE/SEI 43-05 Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities
- ASCE/EWRI 44-05 Standard Practice for the Design and Operation of Supercooled Fog Dispersal Projects
- ASCE/EWRI 45-05 Standard Guidelines for the Design of Urban Stormwater Systems
- ASCE/EWRI 46-05 Standard Guidelines for the Installation of Urban Stormwater Systems
- ASCE/EWRI 47-05 Standard Guidelines for the Operation and Maintenance of Urban Stormwater Systems
- ASCE/SEI 48-11 Design of Steel Transmission Pole Structures
- ASCE/SEI 49-07 Wind Tunnel Testing for Buildings and Other Structures
- ASCE/EWRI 50-08 Standard Guideline for Fitting Saturated Hydraulic Conductivity Using Probability Density Functions
- ASCE/EWRI 51-08 Standard Guideline for Calculating the Effective Saturated Hydraulic Conductivity
- ASCE/SEI 52-10 Design of Fiberglass-Reinforced Plastic (FRP) Stacks
- ASCE/G-I 53-10 Compaction Grouting Consensus Guide
- ASCE/EWRI 54-10 Standard Guideline for Geostatistical Estimation and Block-Averaging of Homogeneous and Isotropic Saturated Hydraulic Conductivity



ASCE/SEI 55-10 Tensile Membrane Structures  
ANSI/ASCE/EWRI 56-10 Guidelines for the Physical Security  
of Water Utilities  
ANSI/ASCE/EWRI 57-10 Guidelines for the Physical Security  
of Wastewater/Stormwater Utilities

ASCE/T&DI/ICPI 58-10 Structural Design of Interlocking Con-  
crete Pavement for Municipal Streets and Roadways  
ASCE/SEI 59-11 Blast Protection of Buildings  
ASCE/EWRI 60-12 Guidelines for Development of Effective  
Water Sharing Agreements

# CONTENTS

|                                                                             |            |
|-----------------------------------------------------------------------------|------------|
| FOREWORD . . . . .                                                          | Page<br>ix |
| PREFACE . . . . .                                                           | xi         |
| ACKNOWLEDGMENTS . . . . .                                                   | xiii       |
| 1 The Foundation for Effective Water Sharing . . . . .                      | 1          |
| 1.1 Purpose and Scope of the Standard Guideline . . . . .                   | 1          |
| 1.2 Distinctive Characteristics of Water. . . . .                           | 1          |
| 1.3 Guiding Principles for Effective Water Sharing . . . . .                | 2          |
| 1.3.1 Coordination and Cooperation . . . . .                                | 2          |
| 1.3.2 Interdisciplinary Analysis . . . . .                                  | 2          |
| 1.3.3 Watershed and River Basin Planning . . . . .                          | 2          |
| 1.3.4 Adaptive Management . . . . .                                         | 2          |
| 1.4 Goals and Objectives of Water Sharing Agreements . . . . .              | 3          |
| 1.4.1 Existing Demands and Usage. . . . .                                   | 3          |
| 1.4.2 Future Demands and Usage. . . . .                                     | 3          |
| 1.4.3 Quality of Water Allocated . . . . .                                  | 3          |
| 1.4.4 Sustainable Management . . . . .                                      | 3          |
| 1.5 Summary. . . . .                                                        | 3          |
| 2 Water Sharing across Political Boundaries . . . . .                       | 5          |
| 2.1 Obstacles to Effective Water Sharing . . . . .                          | 5          |
| 2.1.1 Agreement across Political Boundaries. . . . .                        | 5          |
| 2.1.2 Conflicting Internal Water Rights. . . . .                            | 5          |
| 2.1.3 Conflicting Internal Water Policies . . . . .                         | 6          |
| 2.1.4 Incomplete Knowledge of Water Resource Availability . . . . .         | 7          |
| 2.1.5 Incomplete Knowledge of the Water Resource Demands . . . . .          | 7          |
| 2.1.6 Conflicting Internal Economic Policies. . . . .                       | 7          |
| 2.2 Negotiating Obstacles Leading to an Agreement . . . . .                 | 8          |
| 2.2.1 Obligation to Cooperate and Negotiate in Good Faith . . . . .         | 8          |
| 2.2.2 Obligation to Prevent Unreasonable Harm to Other Parties . . . . .    | 8          |
| 2.2.3 Commitment to the Equitable Utilization of the Shared Water . . . . . | 8          |
| 2.2.4 Commitment to the Values of Water Resource Sustainability . . . . .   | 8          |
| 2.2.5 Obligation to Exchange Adequate Data with the Other Parties . . . . . | 9          |
| 2.3 The International Law of Transboundary Water Sharing . . . . .          | 9          |
| 2.3.1 Substantiating International Legal Norms . . . . .                    | 9          |
| 2.3.2 Legal Norms of Water Sharing . . . . .                                | 9          |
| 2.3.3 Legal Evolution of Shared Water Agreements . . . . .                  | 9          |
| 2.4 Summary. . . . .                                                        | 12         |
| 3 Resource Assessments . . . . .                                            | 13         |
| 3.1 Geographical and Political Boundaries . . . . .                         | 13         |
| 3.2 Assessment of Water Laws and Policies . . . . .                         | 13         |
| 3.2.1 Water Rights. . . . .                                                 | 14         |
| 3.2.2 Water Policies . . . . .                                              | 15         |
| 3.3 Assessment of Water Resources. . . . .                                  | 16         |
| 3.3.1 Data Collection and Uncertainty . . . . .                             | 16         |
| 3.3.2 Water Supply . . . . .                                                | 16         |
| 3.3.3 Underground and Atmospheric Water Supply . . . . .                    | 17         |
| 3.3.4 Quality of Water Supply . . . . .                                     | 18         |
| 3.3.5 Water Supply Augmentation . . . . .                                   | 18         |

|            |                                                                              |    |
|------------|------------------------------------------------------------------------------|----|
| 3.4        | Assessment of Water Demands . . . . .                                        | 20 |
| 3.5        | Summary. . . . .                                                             | 20 |
| 4          | Administration of Agreements. . . . .                                        | 21 |
| 4.1        | The Challenge . . . . .                                                      | 21 |
| 4.2        | The Historical Record of International Water Sharing Institutions. . . . .   | 21 |
| 4.2.1      | Coordination and Cooperation Agreements. . . . .                             | 21 |
| 4.2.2      | Comprehensive Agreements. . . . .                                            | 21 |
| 4.2.3      | Analysis . . . . .                                                           | 22 |
| 4.3        | The Historical Record of U.S. Water Sharing Institutions . . . . .           | 22 |
| 4.3.1      | Interstate Compacts . . . . .                                                | 22 |
| 4.3.2      | Federal–Interstate Compacts . . . . .                                        | 23 |
| 4.3.3      | Federal Administration of Shared Waters. . . . .                             | 23 |
| 4.3.4      | Title II River Basin Planning Commissions . . . . .                          | 24 |
| 4.4        | Organizational Design Principles . . . . .                                   | 24 |
| 4.4.1      | Interdisciplinary Analysis . . . . .                                         | 24 |
| 4.4.2      | Legal Basis . . . . .                                                        | 24 |
| 4.4.3      | Political Validity and Equitable Participation. . . . .                      | 25 |
| 4.4.4      | Financial Viability. . . . .                                                 | 25 |
| 4.4.5      | Implementation and Enforcement Competence. . . . .                           | 25 |
| 4.4.6      | Stakeholder Involvement . . . . .                                            | 25 |
| 4.4.7      | Adaptability . . . . .                                                       | 25 |
| 4.5        | Choices in Institutional Design . . . . .                                    | 25 |
| 4.5.1      | Purpose and Objectives . . . . .                                             | 25 |
| 4.5.2      | Rules of Decision . . . . .                                                  | 25 |
| 4.5.3      | Powers and Duties. . . . .                                                   | 25 |
| 4.5.4      | Accountability and Responsiveness. . . . .                                   | 26 |
| 4.5.5      | Compliance . . . . .                                                         | 26 |
| 4.5.6      | Dispute Resolution . . . . .                                                 | 26 |
| 4.6        | Summary. . . . .                                                             | 26 |
| 5          | Water Allocation Strategies . . . . .                                        | 29 |
| 5.1        | Strategies for Water Allocation . . . . .                                    | 29 |
| 5.1.1      | Surface Water . . . . .                                                      | 29 |
| 5.1.2      | Underground Water . . . . .                                                  | 30 |
| 5.1.3      | Atmospheric Water . . . . .                                                  | 31 |
| 5.1.4      | Integrating Surface, Underground, and Atmospheric Water Allocation . . . . . | 31 |
| 5.1.5      | Allocating Water Resulting from Supply Augmentation . . . . .                | 31 |
| 5.2        | Adaptive Management. . . . .                                                 | 32 |
| 5.3        | Summary. . . . .                                                             | 32 |
| 6          | Model Water Sharing Agreements. . . . .                                      | 35 |
| 6.1        | Purpose and Scope of Models. . . . .                                         | 35 |
| Appendix A | Model Water Sharing Agreement A (Coordination and Cooperation) . . . . .     | 37 |
| A.1        | Article 1A: Declaration of Policies and Purposes . . . . .                   | 37 |
| A.2        | Article 2A: General . . . . .                                                | 39 |
| A.3        | Article 3A: Administration . . . . .                                         | 41 |
| A.4        | Article 4A: Coordination of Water Issues. . . . .                            | 47 |
| A.5        | Article 5A: Dispute Resolution (Optional) . . . . .                          | 48 |
| A.6        | Signatures . . . . .                                                         | 49 |
| Appendix B | Model Water Sharing Agreement B (Limited Purpose). . . . .                   | 51 |
| B.1        | Article 1B: Declaration of Policies and Purposes. . . . .                    | 51 |
| B.2        | Article 2B: General . . . . .                                                | 53 |
| B.3        | Article 3B: Administration . . . . .                                         | 56 |
| B.4        | Article 4B: Equitable and Reasonable Use of Water . . . . .                  | 58 |
| B.5        | Article 5B: Dispute Resolution (Optional) . . . . .                          | 61 |
| B.6        | Signatures . . . . .                                                         | 62 |
| B.7        | Allocation Alternatives . . . . .                                            | 62 |

|                      |                                                           |     |
|----------------------|-----------------------------------------------------------|-----|
| Appendix C           | Model Water Sharing Agreement C (Comprehensive) . . . . . | 65  |
| C.1                  | Article 1C: Declaration of Policies and Purposes. . . . . | 65  |
| C.2                  | Article 2C: General . . . . .                             | 68  |
| C.3                  | Article 3C: Administration . . . . .                      | 73  |
| C.4                  | Article 4C: Comprehensive Water Management . . . . .      | 82  |
| C.5                  | Article 5C: Financing . . . . .                           | 96  |
| C.6                  | Article 6C: Dispute Resolution . . . . .                  | 96  |
| C.7                  | Signatures . . . . .                                      | 100 |
| C.8                  | Financing (Example) . . . . .                             | 100 |
| C.9                  | Arbitral Panel (Optional) . . . . .                       | 102 |
| GLOSSARY . . . . .   |                                                           | 105 |
| REFERENCES . . . . . |                                                           | 107 |
| INDEX . . . . .      |                                                           | 115 |

*This page intentionally left blank*

10/04/2014 00:24:27 MDT

## FOREWORD

The Board of Direction approved revisions to the ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by ASCE. All such standards are developed by a consensus standards process managed by the ASCE Codes and Standards Committee (CSC). The consensus process includes balloting by a balanced standards committee, and reviewing during a public comment period. All standards are updated or reaffirmed by the same process at intervals between five and ten years. Requests for formal interpretations shall be processed in accordance with Section 7 of ASCE Rules for Standards Committees, which are available at [www.asce.org](http://www.asce.org). Errata, addenda, supplements, and interpretations, if any, for this standard can also be found at [www.asce.org](http://www.asce.org).

The form of this Standard Guideline reflects the goals of the Water Regulatory Standards Committee (WRSC) of the Environmental and Water Resources Institute (EWRI) of ASCE. The provisions of this document are written in permissive language and, as such, offer to the user a series of options or instructions but do not prescribe a specific course of action. Significant judgment is left to the user of this document.

Three model water sharing agreements are included in this Standard Guideline in Appendixes A, B, and C. Although the general format the appendixes follows *The Chicago Manual of Style*, imbedded within these model agreements is the format commonly used today in the drafting of proposed uniform state laws. This format, developed under the auspices of the National Conference of Commissioners of Uniform Laws, has been accepted as the format for the ASCE Model Water Codes documents (ASCE 2004a; Dellapenna 2007a). The format of the sections and subsections of each model agreement consists of statutory language in boldface that a legislature could enact with or without change. This statutory language is followed by a

commentary section that describes the purpose and scope of the statutory provisions. Cross-references to other provisions in the specific agreement follow. The section or subsection is closed by a paragraph listing other interstate and international water sharing agreements that contain similar provisions.

Each section of each agreement is optional. Authorities may, however, enact the bulk of the agreement yet delete or change any particular section. Nonetheless, the WRSC made an effort to create a complete, comprehensive, and well-integrated contract between the parties capable of effectively managing shared water. The WRSC has concluded that almost every section of each agreement is necessary to achieve that goal. Some sections apply, however, only to water sharing compacts within the United States, others only to an international agreement. Others are specifically denominated optional in any jurisdiction, which indicates that the drafters consider that these sections might not be necessary or appropriate to the needs of the specific situation. A coherent and workable agreement would still result were all of the optional sections omitted. This Standard Guideline refers to current ASCE Policy Statements and to certain common references. ASCE Policy Statements normally are updated every three years and should be consulted for changes that may have occurred ([www.asce.org/pressroom/news/policy.cfm](http://www.asce.org/pressroom/news/policy.cfm)).

This standard has been prepared in accordance with recognized engineering principles and should not be used without the user's competent knowledge for a given application. The publication of this standard by ASCE is not intended to warrant that the information contained herein is suitable for any general or specific use, and ASCE takes no position respecting the validity of patent rights. The user is advised that the determination of patent rights or risk of infringement is entirely his or her own responsibility.

*This page intentionally left blank*

## PREFACE

The Model Water Code Project of the American Society of Civil Engineers (ASCE) was initiated in 1990 under the leadership of Ray Jay Davis of the Brigham Young University School of Law. The purpose of the project was to develop model statutory provisions intended for adoption by state governments for allocating water rights among competing interests and for resolving quantitative conflicts over water (Dellapenna 1997b).

After Davis retired from Brigham Young University in 1995, the project continued under the leadership of Joseph W. Dellapenna of the Villanova University School of Law. In 1997, ASCE published *The Regulated Riparian Model Water Code* (Dellapenna 1997b). In 2001, the code was accepted as EWRI/ASCE Standard 40-03.

Early in the project formulation and development process, the ASCE Water Laws Committee recognized that effective water allocation and management required planning and regulation by water basins. Because most basins are shared by two or more political entities and their independent legal jurisdictions (e.g., states or nations), the committee recognized the need for a companion agreement or compact to manage the waters flowing across or along the boundary between separate legal jurisdictions.

When two or more independent governments share a common water resource, the timing and magnitude of the respective individual uses can be continual sources of conflict. Water scarcity is evident throughout much of the western United States, and the use of shared water resources is often a major source of legal and political conflict. The interstate and international conflicts over the allocation of the waters of the Colorado River began early in the twentieth century and have still not been totally resolved. However, the problem is not limited to the western states. Even when water is relatively plentiful, the increasing demand for water from shared resources is growing as the population expands, dramatically increasing the needs for public water supply. This problem has been graphically shown by the recent dispute among Florida, Alabama, and Georgia over allocation of the waters of the Apalachicola–Chattahoochee–Flint River Basin. The problem is pervasive, since few river basins in the continental United States are contained within a single state's boundaries (Dellapenna 2002b; Draper 2002a, 2006).

The problem is magnified in the international arena. There are more than 250 major rivers shared between and among two or more nations. These international river basins cover almost one half of the total land surface of the globe. More than 50 rivers are shared by three or more nations, and the Danube is shared by 13 riparian countries. International river basins sustain more than 40% of the world's population. Almost 25% of the world's population lives in the Earth's semiarid and arid zones, where scarcity of water is often acute. Therefore, the potential for conflict is enormous (Draper 2002a, 2006; *The Transboundary Freshwater Dispute Database* 2012).

Among others, protracted conflict over shared waters exists among Turkey, Iraq, and Syria in the Tigris–Euphrates basin; between Jordan and Israel regarding the opposite bank sharing of the Jordan River; and among nations in the Nile River Basin. The Ganges River is a source of dispute between India and Bangladesh. Armed conflict has occurred between Ecuador and Peru over the Cenepa River. The breakup of the Soviet Union has caused conflict between former members, especially in the

arid regions east of the Caspian Sea. Seven active transboundary water disputes currently exist in Africa; six in Europe and Asia; and at least five in the Americas (Dellapenna 2001a; Draper 2002a, 2006).

The need for effective cooperation among riparian countries has greatly expanded because of the growing demand for water in various international basins and the increasingly harmful effects of activities in upstream countries. Although some form of interstate compact covers most of the shared river basins in the United States, many were drafted in the first half of the twentieth century. These agreements were often one-dimensional and limited in scope, oriented to specific problems rather than holistic management of the basin's water. It can be argued that many of these interstate water compacts are inadequate to resolution of the more complex water sharing issues that will develop in the twenty-first century (Draper 2002a, 2006).

Water resource experts now recognize that the shared use of water resources is most effective when management is on the river basin level and when management of the shared resource is comprehensive and multidimensional. Internationally, the problems are more acute. More than a third of the 200 international river basins are not covered by any international agreement, and only some 30 have truly cooperative institutional arrangements. Therefore, a significant need exists for guidance and procedures that can facilitate the development of agreements that can provide a basis for effective and efficient water sharing between autonomous political entities (Draper 2002a, 2006; *The Transboundary Freshwater Dispute Database* 2012).

The creation of this Standard Guideline proceeded in two stages. First, three model water sharing agreements were published (Draper 2002a). The model agreements were then followed by a second report that provided a narrative description of suggested guidelines to be used in choosing the model agreement that might best serve as the basis of the specific water sharing agreement to be created by the parties (Draper 2006).

Although water scarcity and the increasing competition for water suggest that comprehensive management of a shared river basin is appropriate, a significant challenge to overcome is the prevailing tendency for governments at all levels to resist outside control over and interference with their internal affairs and those decisions that affect economic growth or quality of life. Each government or legally competent authority subject to the agreement, whether it is a nation-state, a state within a federal system, or a tribal entity within a national federal system, normally wants to maintain authority over the people, places, assets, and natural resources within its political boundaries. Local control is the operative word.

Strong incentives are required for a government to relinquish control of resources within its jurisdiction. Early in the process, the committee recognized that the degree to which the parties were willing to relinquish such control over water resources in or adjacent to their jurisdiction depended on the hydrologic, geographic, and political situation involved in the shared water dispute. In some situations, the parties might be willing to relinquish considerable autonomy in the search for efficient water management. In other situations, the parties may insist on maintaining control of the waters within their boundaries and may be content to coordinate water management activities in some manner (Draper 2002a). Therefore, the committee chose to

develop three distinct model transboundary agreements to serve as a framework for individual agreements, each of which is based on how much control the parties might be willing to cede.

In 2002, model water sharing agreements were published as *Model Water Sharing Agreements for the 21st Century* (Draper 2002b). This publication provided three separate model agreements that may be used to provide a framework around which an agreement could be formed. It was recognized, however, that the model agreements alone would not provide sufficient guidelines to the drafters of a water sharing agreement. Because an effective agreement to share water involves a complex amalgamation of data and information, a narrative discussion was required that detailed for the drafters of a real-world water sharing agreement the research and procedures leading to the decision to use one of the model agreements as a basis for their specific agreement.

In 2006, a narrative analysis of the development of model agreements was published as the EWRI/ASCE *Sharing Water in Times of Scarcity* (Draper 2006). This publication provided guidelines to enable integration of the multiple aspects of the water resource through an analysis that synthesizes the disciplines of science, engineering, technology, economics, and law. The document sought to ensure that all pertinent factors are considered in the development of an agreement so that the agreement accommodates the physical realities of the shared resource along with the different political systems, cultures, and/or water use customs of the particular water basin.

This Standard Guideline has merged and refined these two Shared Use of Transboundary Water Resources publications (Draper 2002a, 2006). The scope of this Standard Guideline includes application for international agreements, interstate

compacts, and state-tribal agreements for regulating water resources along or across political boundaries. This Standard Guideline is used to apply to any sharing of waters between independent political governments. This Standard Guideline considers a variety of issues that influence the development of interstate and/or international water sharing agreements. This publication provides guidance to enable integration of the multiple aspects of the water resource through an analysis that synthesizes the disciplines of science, engineering, technology, economics, and law. The document seeks to ensure that all pertinent factors are considered in the development of an agreement so that the agreement accommodates the physical realities of the shared resource along with the different political systems, cultures, and/or water use customs of the particular water basin.

This Standard Guideline forms a bridge between the theory and the practice of effective shared water management. It provides a process that all states and/or nations can use when creating or modifying a transboundary water sharing agreement. This process includes an assessment of the various factors influenced by the shared water use, to include correlating the geographic and political issues surrounding utilization of the water resource, inventorying the sources and uses of the water resource, analyzing the ecological impact of the transboundary use, and examining its effect on economic growth and quality of life of the various constituents. This Standard Guideline presents the various alternatives available for allocation of water among the parties, with special emphasis on extreme events (e.g., droughts or floods). The alternatives include allocation methods for surface water, underground water, and atmospheric waters. Finally, different choices for the administrative apparatus that is to supervise implementation are provided.

## ACKNOWLEDGMENTS

The American Society of Civil Engineers acknowledges the work of the Water Regulatory Standards Committee (WRSC) of the Standards Development Council (SDC) of the Environmental and Water Resources Institute (EWRI). The WRSC consists of individuals from many backgrounds, including consulting engineering, law, research, the construction industry, education, government, design, and private practice. Work on this Standard Guideline material began in 1995 with the formation of the Shared Use of Transboundary Water Resources (SUTWR) Task Committee and incorporates information developed by the EWRI Laws & Institutions Committees of the American Society of Civil Engineers. Two SUTWR committee reports provide the foundation for this Standard Guideline: *Model Water Sharing Agreements for the 21st Century* (Draper 2002b) and *Sharing Water in Times of Scarcity* (Draper 2006). This Standard Guideline was prepared through the consensus standards process by balloting in compliance with rules as administered by the Codes and Standard Committee of the American Society of Civil Engineers. Those individuals who served on the Water Regulatory Standards Committee were

Robert H. Abrams, J.D., Aff.M.ASCE  
Fadi Georges Comair, Ph.D., M.ASCE  
Richard H. Cox  
William E. Cox, Ph.D., M.ASCE  
Ron Cummings, Ph.D.  
Matthew D. Davis, S.M.ASCE  
Joseph W. Dellapenna, J.D., LL.M., Aff.M.ASCE (WRSC  
Chair)  
Henry Reirden Derr, P.E., M.ASCE  
Stephen E. Draper, Ph.D., P.E., J.D., M.ASCE (Principal  
Author; Corresponding Editor)  
Christopher Estes  
Shou Shan Fan, Ph.D., M.ASCE  
Harald D. Frederiksen, P.E., D.WRE, F.ASCE  
Marshall Goulding  
Ken C. Hall, P.E.

Steven C. Harris, P.E., M.ASCE  
Kris G. Kauffman, P.E., M.ASCE  
Conrad G. Keyes, Jr., Ph.D., P.E., L.S., D.WRE, Hon.M.ASCE  
Olen Paul Matthews, Ph.D., J.D.  
Nathaniel Dehass McClure, P.E., D.WRE, F.ASCE  
Zachary L. McCormick  
Donald M. Phelps, P.E., D.WRE, M.ASCE  
Phyllis Saarinen  
Gerald Sehlke, P.E., D.WRE, Aff.M.ASCE  
Hal D. Simpson, P.E., D.WRE  
Kenneth Stern, P.E.  
C. Wesley Strickland, J.D., Aff.M.ASCE  
Gregory K. Sullivan, P.E., M.ASCE  
R. Peter Terrebonne, Ph.D.  
R. Timothy Weston, J.D.  
Kenneth R. Wright, P.E., L.S., Dist.M.ASCE

*This page intentionally left blank*

## CHAPTER 1

# THE FOUNDATION FOR EFFECTIVE WATER SHARING

Economic growth and prosperity and improved quality of life require adequate supplies of high-quality water on a regular and sustained basis. This requirement means that the utilization of shared waters must be carefully and systematically coordinated among or between the parties sharing the waters. In 2007, 268 transboundary river basins were identified worldwide. These basins cover almost two-thirds of the global landmass. Forty percent (40%) of the world's population depends on these shared river basins for the water they need (International Network of Basin Organizations 2002; Sea River 2002; Draper 2007b). Of the 71 rivers in the continental United States (excluding Alaska and Hawaii) that are more than 565 km (350 mi) long, only six are not shared by one or more states and/or countries. Of more than 90,000 river km (55,800 river mi), less than 7% are not shared (Pearson Education 2002; Draper 2002b, 2007b). More than 90% of the population in the continental United States depends on waters shared with other states (Draper 2002b, 2007b).

### 1.1 PURPOSE AND SCOPE OF THE STANDARD GUIDELINE

An effective agreement can facilitate adequate planning, conservation, utilization, development, management, and control of water resources on a water basin basis, in a manner that is reasonable and equitable under the circumstances and that causes no significant harm to most other parties. A key challenge for the parties is to make more efficient and productive use of water and to reshape the water policies of the individual parties to better respond to periods of water shortages (Postel 1996; Draper 2002b, 2007b).

This document provides guidance to be used in the formulation of water sharing agreements between and among governments so that they may meet the challenge of devising an effective and equitable water sharing agreement. The Standard Guideline seeks to limit potential conflict while providing an appropriate balance among efficient use of the water resource for existing economic purposes, preserving the common water resource for future needs, and promoting the protection of the environment. The procedures focus on the process of creating or modifying a transboundary water sharing agreement to ensure that the parties include all pertinent factors in their negotiations.

Although this Standard Guideline has been developed predominately using the U.S. experience with transboundary water sharing, a number of international agreements were analyzed to gain an appreciation for other experiences. Consequently, this Standard Guideline has broad application for use in international agreements, interstate compacts, or state-tribal agreements for regulatory purposes along or across intergovernmental boundaries. The Standard Guideline can apply to any sharing of waters between autonomous political entities. As presented, this Standard Guideline can be applied to a variety of circumstances involving shared water. Only those sections appropriate to the

particular situation and conditions need be applied (Draper 2006). The need for careful analysis of the situation and conditions that influence those sections that may apply is especially relevant when an international agreement is being developed because the hydropolitical conditions may be greatly aggravated by significant sociocultural issues. This complication may be further aggravated by the lack of an appropriate legal forum and institutions necessary to adequately ensure compliance.

The following ASCE/EWRI Standards are incorporated in this Standard Guideline and provide additional guidance when and where required:

- ASCE/EWRI Standard 33-09, *Comprehensive Transboundary Water Quality Management Agreement* (2009c);
- ASCE/EWRI Standard 34-01, *Standard Guidelines for Artificial Recharge of Ground Water* (2001);
- ASCE/EWRI Standard 42-04, *Standard Practice for the Design and Operation of Precipitation Enhancement Projects* (2004b); and
- ASCE/EWRI Standard 40-03, *Regulated Riparian Model Water Code* (2004a).

### 1.2 DISTINCTIVE CHARACTERISTICS OF WATER

In setting the framework for sharing water resources, it is appropriate to briefly discuss several special characteristics of the natural resource water. Water is central to the survival of life itself, and without it plant and animal life would be impossible. Water is a central component of the Earth's systems, providing important controls on the world's weather and climate. Water is also central to our economic well-being because it supports rain-fed and irrigated agriculture, forestry, navigation, waste processing, and hydroelectricity (Vörösmarty 2002). Recreation and tourism are other primary uses supported by water, especially in developed countries.

Water, unlike oil or gold, is a shared, mobile, and public resource that is used and reused for different purposes as it moves through the hydrologic cycle. Before its capture by withdrawal or diversion, a claim of exclusive ownership is difficult to sustain. Water is different from other natural resources because different users use the same water repeatedly as the water travels downstream, as in the case of surface water, or downgradient, as in the case of underground water aquifers. A case in point is Atlanta, Georgia, which withdraws most of its reliable water supply from the Chattahoochee River, consumes a portion of the water, and returns the rest of the water to the river for use by downstream users such as Lagrange or Columbus, Georgia, and even cities in Alabama and Florida (Draper 2002a, 2004, 2007b). This use and reuse is the essence of riparian law, the fundamental law theory upon which shared water use historically has been based (Draper 2006, 2007b).

It is often said that water is renewable, but the term can be misleading. Surface water and some underground water moving

through aquifers like the Floridan in the southeastern United States are renewable in the sense that most water moves through the hydrologic cycle as one form or another of water (Draper 2007b). Other water, especially underground water in so-called fossil aquifers like the Ogallala in the midwest United States, is not quickly renewable (Opie 2000).

What is important from a sustainability perspective is how much of the water used by the various demands is actually renewable and available for reuse. Some analysts have concluded that globally, water availability has declined by half during the past 25 years because of population growth and drier trends in the climate (Shiklomanov 1998; Zalewski 2002). River runoff in Africa has reportedly declined by about one-third in the past 10 years, and runoff in South America has shown a significant increase (Georgeyewsky 1998). A significant decrease in precipitation has been observed since the mid-20th century in North Africa, Southeast Asia, Indonesia, and Australia. When looked at from a global perspective of the hydrologic cycle, the liquid form of  $H_2O$  is renewable. When considering water available to meet demands at a certain time and place, it is not necessarily renewable (Draper 2006, 2007b).

### 1.3 GUIDING PRINCIPLES FOR EFFECTIVE WATER SHARING

The uniqueness of each basin and its riparian states indicates that a universal set of principles should be fairly general (Wolf 1999). However, efficient and effective transboundary water sharing should be based on four guiding principles: coordination and cooperation, interdisciplinary analysis, watershed and river basin planning, and adaptive management (Draper 2006).

**1.3.1 Coordination and Cooperation.** A nation normally enters into any international agreement from a position of self-interest. In the negotiations, each party seeks the rights and authority critical to certain political, economic, or social objectives while ceding less critical rights and authority to the other nations. While accepting this fact, all parties have a duty to cooperate and negotiate in good faith. This principle is the foundation of international law, and it applies in all relations between governments or legally competent authorities subject to the agreement (Draper 1997). The parties should agree to cooperate and consult with the other parties to the agreement in their development and utilization of the water and related resources of the waters shared by the parties. Coordination and cooperation are essential to ensure effective and efficient use of those waters while minimizing harm to other parties. Additionally, the parties should agree to cooperate on the basis of equality and territorial integrity in the utilization and protection of the shared water resources. They should conduct themselves with an absence of malice and deceit, and with no intention to seek unconscionable advantage. Coordination and cooperation include the need for good faith implementation (Draper 2002b).

**1.3.2 Interdisciplinary Analysis.** The development of effective and efficient transboundary water sharing is a multifaceted challenge (Kenney and Lord 1994, Draper 2001). Although necessarily based on water science, i.e., knowledge of the quantity, quality, and timing of the available water supplies, the development of effective water sharing agreements is predicated on an adequate interdisciplinary analysis of water science, engineering, technology, law, and economics (Draper 2001; Jackson et al. 2001; Dellapenna and Draper 2002b).

A social component exists that should not be ignored (Fitch 2003; Levy et al. 2003). This social component relates to the cultural and noneconomic needs and wants that transcend the

economic factors of society. These needs and wants would include, for example, guaranteeing that each human being, regardless of circumstances or economic efficiency, has at least 70 L of clean water daily. It might include protection of source water that is considered sacred to native populations. Many agreements initially neglect the social aspects involved in water allocation and discover that this neglect can delay or even prevent effective implementation and/or enforcement of the agreement (Draper 2007b).

In addition, this development should include an analysis of the water available for allocation to the various existing and known future water demands, to include economic growth, public health, navigation, water-based recreation, and environmental and ecological protection. Finally, the effective and efficient utilization of water requires integration of surface and underground water sharing, as well as consideration of water quantity and water quality. The potential effect of climate change should be included (Draper 2006, 2007b).

**1.3.3 Watershed and River Basin Planning.** Planning and management on a watershed or river basin basis, rather than artificial political boundaries, should be the foundation principle for water planning (Barlow and Clarke 2002). Watersheds are the natural spatial unit for predicting future water supply and water demands, at least as they relate to the use and reuse of water as it flows downstream (Jackson et al. 2001). The reality of political boundaries and the desire for authority and control should be respected wherever possible, but water planning and management must be based on the watershed or river basin. Watershed planning and management should include three essential components. The first component is maintaining hydrologic integrity within a regional framework. The second component is developing a multijurisdictional management structure that coordinates water planning and land use planning. The third component is the use of regional–national–state–local partnerships, as well as private–public partnerships, in the planning and management of water resources (Draper 2001, 2002a).

**1.3.4 Adaptive Management.** Water resource management should be based on the best information available, but it should be flexible enough to accommodate change and complexity since natural systems are inherently variable, patchy, and complex (Sophocleous 1998). In broad terms, adaptive management is “a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs (Bennet and Lawrence 2002). Adaptive management requires deliberate evaluation of resource management activities and active response to what is learned (Sando 2002). In essence, adaptive management can be described as “learning by doing” (Lee and Lawrence 1986). An adaptive agreement is designed from the outset to recognize that clearly formulated hypotheses about the behavior of hydrologic systems may be changed by human use (Lee 1993).

For an agreement on water sharing to be effective, it should be able to adapt to potential changes in site-specific circumstances that may develop within the time period the agreement is in effect (Bernauer 2001). The provisions in the agreement should be sufficiently adaptable to allow them to evolve over time and to respond to changes in the climatic, hydrologic, economic, social, and even political conditions (Eaux partagées 2002; Fitch 2003). The agreement should be able to accommodate unexpected changes in water source availability that may result from extreme events, such as prolonged droughts and climate change. Likewise, the agreement should be able to accommodate changes in the demand for water that may arise from changes in the economic foundation of one or more of the

parties or from sociological or political changes in the value assigned to particular water demands. As with any water management policy, the provisions and rules within a water sharing agreement can best be developed and implemented by retaining and encouraging innovation and diversity (U.S. Advisory Commission on Intergovernmental Relations 1991).

## 1.4 GOALS AND OBJECTIVES OF WATER SHARING AGREEMENTS

The goal of water sharing agreements is to create a legal framework between the parties to establish the guiding principles of effecting water sharing, which is essential to sustaining economic growth and prosperity while enhancing the quality of life for the citizens of the parties. Quality of life requires a strong economy, good public health and safety, good recreational opportunities, and well-managed natural resources. All of these factors depend on adequate supplies of clean water (Draper 2001; McCain 2005).

Any water sharing agreement should clearly state its objectives and should consider meeting the needs of both existing and future demands and uses. The procedures to reach the agreement should include emphasis on integrated management and recognition of the economic value of water. A means of stakeholder participation in decision making is essential, as are means of providing access to water services for the poorest users. Institutionalizing an ecosystem approach and integrating private sector contribution should be developed (World Bank 1998; Eaux partagées 2002).

**1.4.1 Existing Demands and Usage.** The primary short-term objective of a water sharing agreement should highlight meeting existing demands and uses while maintaining reasonable environmental and ecological protection. Essentially the agreement should provide for water use during “normal” years but also provide risk management for extreme conditions, droughts or floods, and allocate water among existing uses in times of water shortages (McCormick 1994b; Draper 1997, 2001). An essential objective for the agreement, for both the short term and the long term, is equity among users (Eheart 2002).

**1.4.2 Future Demands and Usage.** The primary long-term objective should highlight meeting the needs of future demands and uses while meeting the long-term needs of the ecosystem. The agreement should be structured to ensure the availability of sufficient quantities of quality water for future growth as planned or predicted by all the parties involved in the agreement. The parties should avoid provisions that may favor existing uses at the expense of new, higher value uses (Draper 1997, 2001).

**1.4.3 Quality of Water Allocated.** The quality of the water that is allocated is as important as the quantity of water allocated. Poor quality water imposes risks that the parties should consider. First, there is the health risk to the population that uses the water for domestic purposes. Second, if the available water will not meet the standards for certain beneficial uses, there is the risk that economic growth will be impaired. Finally, there is the risk that quality degradation will have a severe impact on the ecology of the basin, resulting in the loss of long-term sustainability. Integration of water quality and quantity is essential (Draper 2002a). Riparian and aquatic ecosystems provide critical benefits for human, plant, and animal life, including improving water quality, reducing erosion and sediment losses, providing habitat (more than 75% of the animal species in arid regions require riparian habitat), creating recreation benefits and other amenities for growing populations, and providing flood control benefits

(Hirji and Ibrenk 2001). AGENDA 21 from the *United Nations Conference on Environment and Development* held in Rio de Janeiro, Brazil, 1992, obligated all signatories to develop a water and sustainable development program (Ahlander 1994). The *UN Convention on the Law of the Non-Navigational Uses of International Watercourses*, United Nations Document A/51/869 (1997), establishes the criterion that “(w)atercourse States shall, individually and, where appropriate, jointly, protect and preserve the ecosystems of international watercourses.”

Surface and underground water may be degraded by a variety of factors. Major problems affecting the quality of these water resources arise, for instance, from inadequate domestic sewage treatment, inadequate controls on the discharge of industrial waste and effluent, the diversion of waters resulting in insufficient water to assimilate waste, the loss and destruction of catchment areas, the improper siting of industrial plants, deforestation, and poor agricultural practices that cause leaching or runoff of nutrients and pesticides. Excessive interbasin transfer may affect the quantity of water available for waste assimilation downstream of the transfer (Draper 2002b). Transboundary water sharing should include effective plans and programs that reduce or eliminate, or at least minimize, the possible sources of water quality degradation. (ASCE 2009c).

**1.4.4 Sustainable Management.** Water resources should be managed in a sustainable manner so that current and future generations will have access to adequate supplies of high-quality water that supports both human needs and natural systems (Fort 1998; Eheart 2002; Georgia Joint Comprehensive Water Plan Study Committee 2002). This sustainability criterion expands the scope of water sharing beyond economic efficiency to encompass fairness to future generations as well (Tietenberg 1998). However, sustainability is a difficult concept to define, and no consensus on a definition has developed (Fort 1998). Strict interpretation of the philosophy of sustainability may deny the needs and abilities of humans to make rational choices for their immediate and long-term future.

In this light, this document defines water resource sustainability as the reasonable and beneficial use of water that avoids wasting resources and ensures reasonable protection of the environment while meeting the needs of future generations.

Sustainable outcomes for water use include the requirement that minimum water supply is guaranteed to all humans to maintain human health. Although the human minimum water needs vary according to the aridity of the region under analysis, an absolute minimum has been determined to be 50 L per day (Gleick 1996). “In November 2002, the United Nations Committee on Economic, Social and Cultural Rights affirmed that access to adequate amounts of clean water for personal and domestic uses is a fundamental human right of all people” (United Nations 2002, 2010).

The agreement should provide sufficient water to restore and maintain the health, services, and functions of ecosystems. Specific amounts vary, depending on climatic and other conditions, and flexible, adaptive management is essential. The agreement’s provisions should be structured to facilitate human actions in the shared water resources that do not impair the long-term renewable freshwater stocks and flows (Hirji and Ibrenk 2001; ASCE 2009c).

## 1.5 SUMMARY

This Standard Guideline is to be used in the formulation of efficient and effective water sharing agreements between and among governments. The guideline is intended for use in

international agreements, interstate compacts, or state-tribal agreements for regulatory purposes along or across intergovernmental boundaries. The guideline may apply to any sharing of waters between autonomous political entities.

Four guiding principles underlie the formulation and development of the final agreement (Draper 2006):

- (1) Negotiations should be conducted with a commitment to coordination and cooperation,
- (2) An interdisciplinary approach to water allocation among the parties should be used to overcome the inherent obstacles facing effective water sharing,
- (3) The agreement should provide for management on the basis of watershed and river basins, and
- (4) Adaptive management and flexible provisions should be included in the agreement.

The goal of water sharing among the parties should be to sustain economic growth and prosperity while enhancing the quality of life for the citizens of the parties. The water sharing agreement should create a legal framework that clearly states its objectives, and writers of the agreement should consider meeting the needs of both existing and future demands and uses. The procedures to reach the agreement include the following (Draper 2006):

- Emphasize integrated management,
- Recognize water's economic value,
- Enable stakeholder participation in decision making,
- Provide access to water services for the poorest users,
- Provide a systematic ecosystem approach,
- Integrate the private sector contribution, and
- Consider the needs of future generations.

## CHAPTER 2

# WATER SHARING ACROSS POLITICAL BOUNDARIES

Two factors are essential to develop a viable water sharing agreement across political boundaries. First, at the beginning of the formulation process, the parties should understand and analyze major obstacles facing such an agreement on effective water sharing. Second, the parties should approach the negotiation of obstacles leading to the agreement with an understanding and commitment to certain norms of conduct critical to fair and honest negotiation between parties to the agreement. Finally, an effective agreement for water sharing depends on an understanding of national and international water law, and the relationship of one with the other.

### 2.1 OBSTACLES TO EFFECTIVE WATER SHARING

The nature of water resource sharing by different political entities results in a number of significant obstacles to effective water sharing. The reluctance to give up dominion and control over the natural resources within the political boundaries of the parties to another party is a significant obstacle. Other obstacles include conflicts in the internal water laws and policies of the parties that make the shared goals of the agreement difficult to reach. An incomplete knowledge of the water resource availability and demand within the shared basin, as well as conflicts between the internal economic policies of the parties, may hamper an agreement between or among the parties (Clarke 1993, Draper 2001).

**2.1.1 Agreement across Political Boundaries.** Whether a party to the negotiations to share water is a nation-state or a state or tribal entity within a federal system, the sovereign party will normally claim the exclusive rights to all natural resources within its boundaries, including ownership of the water resources. When a government enters into an interstate or international agreement, it does so primarily from a position of self-interest (Draper 1997; Albert 2000). Water sharing requires each party to relinquish a part of its control and dominion over water that may be under its control and dominion to some degree. In negotiations, each party will seek to retain control over those rights and authorities that are critical to their political, economic, or social objectives while ceding to the other sovereign parties rights and authorities that may be less important to their primary objectives. This inherent friction underlies all negotiations. How much authority is relinquished determines the scope and possibly the effectiveness of the agreement (Eaux partagées 2002).

The political boundaries that exist between the governments present significant obstacles since water basin boundaries seldom coincide with political boundaries (Dellapenna 1994; Libiszewski 1995; World Bank 1998; Wolf 2001; Draper 2002b; Puri and Arnold 2002; Vörösmarty 2002; Matthews and St. Germain 2007). Rights to use water within a particular shared watershed or aquifer, with few exceptions, differ according to the water laws of the particular party in which the withdrawal occurs. It is a question of jurisdiction, “who has the responsibility and

authority to regulate water withdrawal and use?” (Kenney and Lord 1994; McCormick 1994b).

With surface water, the conflict over shared use may arise because the upstream party’s water policies and consumptive use may adversely affect the water available for use by the downstream party (Kenney and Lord 1994). For example, Nile River water use by Sudan has significant adverse effects on water use by Egypt (Dellapenna 1997b; ASCE 2004a). Because surface water often marks the boundary between political entities, the conflict may arise from the different water uses on opposite banks by adjacent states. Differing water uses by Israel and Jordan are illustrative (See *Treaty of Peace between the State of Israel and the Hashemite Kingdom of Jordan* 1994). Differing cultures and their concepts of water and its use can be an obstacle to the spirit of cooperation and trust so necessary to an effective agreement. Although the Israeli–Palestinian conflict has many causes, the inherent difference between the two culture’s views of water and its allocation provides another obstacle to peace (Dellapenna 1994, 1997a; Hassoun 1998). Water is now acknowledged as a major limiting factor in the socioeconomic development of a world with a rapidly expanding population (Sibanda 2002).

Within the United States, this same conflict exists, although arguably to a lesser degree. Three elements of control and dominion clash under the constitutional powers of the federal, state, and tribal governments. Under federalism, the states maintain control over inland waters, with some important exceptions (*Kansas v. Colorado* 1902, 1907; Kenney and Lord 1994; Gelt 1997). These important exceptions include limitations imposed directly or by implication in specific legislation, such as the Endangered Species Act, 16 U.S.C. §§ 1531 et seq. (ESA) and the Clean Water Act, 33 U.S.C. §§ 1251 et seq. (CWA), limitations or obligations imposed by interstate compacts, interstate allocations established pursuant to U.S. Supreme Court decisions, and certain other doctrines established by the U.S. Supreme Court. Such doctrines include federal reserved water rights that adhere to federal lands in the west, federal control over navigability, and federal supremacy regarding federal waterpower projects.

Indian reservations also may assert dominion and control over certain waters as a result (*Arizona v. California* 1963). Thus the elements of dominion and control that obstruct effective and efficient water sharing on the international scene often obstruct effective and efficient water sharing between the states, between a state and a tribe, or even between two or more states and the federal government.

**2.1.2 Conflicting Internal Water Rights.** An essential requirement for economic progress is the availability of sufficient quantities of high-quality water (Draper 2001, 2002a, 2002b). Adequate supplies of water for stakeholders within the political jurisdiction are normally controlled through a legal system of water rights that allocates water. The laws usually are structured

to provide a balance between providing water rights to uses that are efficient and beneficial, or at least not wasteful, while still providing legal certainty or predictability and security of tenure to those holding the water rights. Often, however, the water laws of the parties have developed differently and, consequently, conflict (Sanchez 1997; U.S. House of Representatives 1998; Grant 2001). The problem is exacerbated for laws that allocate underground water. Different laws for the allocation of surface and underground water present an issue that exists for both intra- and interjurisdictional water management (Kenney and Lord 1994).

Vested water rights within the territorial borders of the various political parties may be a source of conflict. This complication may inhibit both the development and execution of a water sharing agreement. The internal water laws of one of the parties may vest or otherwise provide to private parties legal rights to water, including private property rights. Such legal rights to water may prevent or otherwise impede the party's ability to fulfill the terms of the agreement. Within the United States, the property right associated with water varies considerably from state to state (Beck 2001; Dellapenna and Draper 2002b, c).

Consequently, different rights granted to the same source of water may result in inefficient and ineffective allocation of the water, to the detriment of all parties. The right granted by the different parties to withdraw from the same aquifer may differ, as may the rights granted to withdraw from the same surface water source. The parties may have different requirements for return flows and different standards for minimum instream flow requirements (Evans and England 1995). To prevent ineffectiveness of water allocation, all parties that have an interest in a water source should either agree on certain water-related issues or at least understand the existence of these issues to accommodate them within the framework of the agreement. These issues include determining how the parties to the agreement grant the right to use water from a specific source, the amount of water each party allocates under normal conditions from that source, and the amount of water allocated from that source during droughts (Draper 2006).

**2.1.3 Conflicting Internal Water Policies.** An obstacle to effective water sharing agreements may develop from differences in the water policies of the individual governments. A government's water policy should be distinguished from its water rights or water laws. Water policy is founded on the interrelationship of water law, science, engineering, technology, and economics (Draper 2001, 2002a, b, d, e). Water-related policies and programs of individual governments usually have specific objectives, often oriented to economic efficiency of water use in relation to economic plans and needs. Often the result is single-purpose laws and programs that fail to account for the interrelationship among surface, underground, and atmospheric water; quality and quantity of water allocated; and other water rights needs, such as instream flow rights (Vlachos 1997). The political influence of specific stakeholder groups may be a source of severe distortion in laws and regulations (Zusman 1997). A significant obstacle to effective water sharing arises when one party institutes a policy of private water markets while the other does not. Also, drought management and reservoir release policies of the upstream party may conflict with downstream water availability. Finally, one party's policy on interbasin diversions can have serious effects on the water available to the other party (Sherk 2000).

Separate and distinct political units within a government often make water policy independently of other policy-making entities within that same government, hindering effective water sharing agreements (Kenney and Lord 1994). In the United States, dif-

ferences between and among the laws, policies, and procedures of federal and state water quality and water allocation agencies exist that undermine effective water laws and policies (Rogers 1993). More than 20 subcommittees of Congress and more than 20 federal agencies have overlapping mandates and conflicting policies, each supported by separate constituencies. The laws promulgated to implement these policies are themselves fragmented and distinct. Any agreement should acknowledge and provide resolution mechanisms for these conflicts (Postel 1996).

Scientists, economists, and legal scholars have long advocated the integrated and conjunctive management of all water resources within a watershed and river basin. After all, the hydrologic cycle is an integrated whole, and courts or administrative agencies should not segregate the parts of a mobile resource that nature integrates. Water-based activities physically affect each other and should be managed comprehensively if they are to be managed properly. On the other hand, activities related to various parts of the hydrologic cycle do have varying characteristics, including varying degrees of effects upon other uses related to other parts of the hydrologic cycle (Dellapenna 2001b).

Minimum flow policies and policies concerning interbasin transfer can have substantial consequences on the effectiveness of an agreement (Draper 2002a; Eheart 2002). There may be conflict because one party wishes to reserve from allocation and consumptive use the waters necessary for the preservation of the protected biological, chemical, or physical integrities of water sources and may insist on a mechanism to further protect instream flows. The other party may have a policy that the instream flow be maintained at a lower level only for purposes of wastewater assimilation (Draper 2002a). In other cases, a party may insist that the instream flow mimic the natural cycle of spring floods and summer low flows to sustain the biological integrity of the stream (Christensen 1996; Glennon 2002). Transferring water for use outside its basin of origin with little or no return flow to the basin of origin might pose similar problems to the basin of origin as are likely to arise in interstate transfers even when both the basin of origin and the basin of use are within a single state (Draper 2002d). Similarly, significant consumptive uses (such as the incorporation of water in a product or evaporation through cooling systems) may impose substantial downstream outcomes similar to out-of-basin transfers (Draper 2006).

Until recently, water sharing agreements have primarily been concerned with surface water sources. Now, however, with newer water withdrawal technologies and with the exponential growth in the demand for water of the past several decades, underground water has emerged as a critical regional, national, and transnational resource. The sharing of aquifers and the hydrologic interconnections between surface water and groundwater sources is increasingly becoming the focus of conflict (Dellapenna 2001a).

A significant challenge to reaching an effective agreement may arise from the different standards the parties apply to consumptive use, reuse, and conservation. Increased consumptive use can have a dramatic effect on the water available to downstream users, as can reallocation by a party from older "lower value" uses that may be less consumptive to newer "higher value" uses that have greater consumption of the water withdrawn (Draper 2002e). Water reuse policies can assist or hinder downstream users. If the reuse is structured to ensure that water available to downstream users remains unchanged or even increased, reuse policies can greatly assist the parties in reaching agreement. On the other hand, if the reuse policies can result in less water available downstream, they can greatly impede the parties from reaching an agreement. Finally, as discussed earlier, the introduction of water markets by one party can result in

increased water scarcity for the other party, especially when interbasin transfers occur or the new water user engages in significantly greater consumptive use and the other party is downstream (Postel 1993).

**2.1.4 Incomplete Knowledge of Water Resource Availability.** Incomplete knowledge of the waters subject to the agreement is a significant obstacle to effective water sharing (Patino-Gomez et al. 2007). Effective agreements are predicated on a detailed knowledge of the quantity of water available for use and the quality of that water available for specific uses (Fort 1998). Incomplete knowledge, however, may arise from uncertainties regarding geologic matters (such as a relationship between underground water aquifer areas and surface water basins), data that are limited by the time frames for which information was collected, and uncertainties regarding prediction of future hydrologic conditions and technological developments (Patino-Gomez et al. 2007). Although incomplete knowledge hinders the agreement's effective allocation of water to the respective parties, a more significant effect is that an agreement does not adequately cover all water needs, especially during extreme events (Draper 2006).

A water sharing agreement usually focuses on allocation of water under average hydrologic conditions, as well as that allocated under drought conditions. Developing an effective agreement requires accurate and precise knowledge of these conditions as well as flood conditions. Otherwise, the result may be significant disputes over the terms of an agreement, significantly impairing the agreement's usefulness for the parties (Berman and Wihbey 1999; ASCE 2004a, 2009c; Dellapenna 2007a).

Lack of knowledge about underground water availability is especially prevalent (Hillel 1994; Tsur 1995). The hydrologic characteristics of some aquifers may be unknown, as is the case in many areas of the developing world. Substantial data gaps exist on the condition of different underground water basins, extraction amounts, current pumping practices, and recharge rates (Gleick 1998).

The question of the reliability of past hydrologic records may be a significant problem. Even what appear to be long-duration records (say the past 50 or 100 years) may not be representative of the cycles of hydrologic variation. Human-made changes in flow conditions (from storage, diversions, and changes to impervious surfaces) may skew the reliability of historic data (Draper 2006; Draper and Kundell 2007).

The uncertainty of climate change presents an equal uncertainty when the historical record may become unreliable as global warming changes precipitation patterns, volumes of snowpack, and the timing of spring thaws (Draper and Kundell 2007). ASCE has recognized the possible effect of climate change, publishing *ASCE Policy Statement 360* (ASCE 2010a):

Climate change could pose a potentially serious impact on world wide water resources, energy production and use, agriculture, forestry, coastal development and resources, flood control, and public infrastructure. Examples include:

- \*Alterations to the hydrologic patterns for multi-purpose water resource projects, of particular concern to civil engineers working in the hydroelectric industry and water supply utilities, where reservoir storage capacity may need to be increased;

- \*Climate extremes, such as floods and droughts, and other significant variations in hydrologic patterns that may necessitate changes or additions to flood control infrastructure to provide adequate public safety and performance;

- \*Changes in frequency and strength of tropical storms that will require changes in coastal protection systems;

- \*Changes in ocean levels that will require adaptation of coastal infrastructure, including ports; and

\*Changes in permafrost conditions that require retrofitting existing foundations and alterations to foundation design.

Such impacts could require modified agricultural practices and measures to deal with rising sea levels, water supply and quality, threats to critical infrastructure facilities, and the potential for the outbreak of disease.

#### Rationale

Civil engineers are responsible for design and maintenance of infrastructure projects that facilitate economic development and protect human health, welfare, and the environment. Climate change may result in significant impacts to this infrastructure. Civil engineers and government policy makers must work together to anticipate and plan for these impacts.

**2.1.5 Incomplete Knowledge of the Water Resource Demands.** An effective agreement requires a comprehensive understanding of the existing requirement for water, as well as projected requirements. Sound water policy planning requires a comprehensive, coordinated, and reliable source for water-related data and current reliable information (Georgia Joint Comprehensive Water Plan Study Committee 2002). The information needed includes data on water requirements that may be gathered by local, state, and national government, as well as academic institutions, the private sector, and other organizations (Draper 2001). The agreement's purpose should be to allocate the available water between and among the political parties themselves. The parties can effectively accomplish this objective only when the water requirements within the individual party's internal boundaries are known. These water requirements are often described as needs or demands (Draper 2006). Within each jurisdiction, the available water use should be divided among various, and often conflicting, uses, such as agricultural and municipal demand, waste assimilation and recreational uses, environmental protection and industrial demand, and navigation demand and hydropower. Each jurisdiction should balance its requirements with the needs of the other jurisdictions and with the available quantity of sufficient quality water for each use. Finally, an imperfect knowledge of the withdrawal amounts affecting the sustainability of the water resource may cause a non-replenished loss of water that reduces water availability, thus effectively nullifying the agreement at some future date (Nebraska Department of Natural Resources 1983; Gleick 2000b; Sherk 2000). A significant problem of inadequate knowledge of the requirements for water is especially prevalent in the agriculture sector for a variety of reasons. Even in the United States, precise knowledge of agricultural use is lacking because metering and annual reporting are not required of many irrigation users (Cummings et al. 2001b). Such knowledge is critical because agricultural use accounts for approximately two-thirds of global water use (Postel 1993). Domestic use is normally consolidated in the category of municipal use. Information on industrial and commercial water use is incomplete at best (Gleick 2002b).

**2.1.6 Conflicting Internal Economic Policies.** Autonomous economic policies among governments may hamper effective water sharing agreements. Different governments have different plans and priorities when balancing economic growth and the sustainability of water resources. Economic policy may be fragmented as to the means of promoting water policy effectiveness, with one government allocating according to the common law (Georgia Chamber of Commerce 2002), another allocating on the basis of codified water law and regulation (Dellapenna 2000), and a third using a free-market approach (Cummings et al. 2002) to economic planning and water use prioritization (Draper 2004). Policies regarding environmental and ecological protection and their relationship with economic growth are also a source of

conflict that a water sharing agreement should accommodate (Espland 1998; Draper 2001, 2004).

## 2.2 NEGOTIATING OBSTACLES LEADING TO AN AGREEMENT

Certain principles of negotiations and management are essential for the development and implementation of a viable water sharing agreement. These principles are equally necessary for the agreement's ongoing effectiveness. A number of significant principles should form the framework of the agreement. They include an obligation to cooperate and negotiate in good faith, an obligation to prevent unreasonable harm to other parties, a commitment to the equitable utilization of the shared water, a commitment to the values of water resource sustainability, and an obligation to exchange all available data with the other parties (Caponera 1995; Hey 1995; Draper 1997; Albert 2000; Dellapenna 2001a).

**2.2.1 Obligation to Cooperate and Negotiate in Good Faith.** Normally, a government negotiates an interstate or international agreement on the basis of self-interest (Draper 1997; Albert 2000). In the negotiations, each party seeks the rights and authorities critical to certain political, economic, or social objectives while ceding less critical rights and authorities to the other governments or to an international or interstate institution. This inherent friction underlies all negotiations. While accepting this fact, however, all governments have a duty to cooperate and negotiate in good faith (United Nations 1997). This principle is the foundation of international law, and it applies in all relations between parties to the agreement. All parties are expected to conduct themselves with an absence of malice and with no intention to seek unconscionable advantage or otherwise be deceitful. This obligation is a critical foundation for water sharing agreements (Kliot et al. 1998). A commitment by all parties is essential (German Foundation for International Development 1998).

Reaching an effective and efficient agreement to share a water resource means that the parties should begin the negotiations with some forethought. Water sharing requires each party to relinquish a part of its control and dominion. How much authority and control is relinquished determines the scope and possibly the effectiveness of the agreement (Eaux partagées 2002). Self-interest may be a guiding factor in many negotiations, but such a position is not conducive to reaching an effective and efficient agreement (Draper 2006).

In most water sharing cases, the purpose should be to find a way of accommodating the interests of all parties who share in the common resource—to find rules, water development investments, and other sharing arrangements that allow the legitimate needs and desires of the respective parties to be achieved. Good agreements focus on the parties' interests rather than on a particular position. Defining a problem in terms of positions means that one party will lose the dispute. When a problem is defined in term of the parties' underlying interests, it may be possible to negotiate a solution that satisfies both parties' interests (Fisher and Ury 1983).

**2.2.2 Obligation to Prevent Unreasonable Harm to Other Parties.** The duty to prevent unreasonable harm requires that water allocation and use by one riparian party cannot unreasonably harm the allocation and use by other riparian parties (Kroes 1997). The duty may be best explained by drawing an analogy to the riparian doctrine of reasonable use. Under U.S. common law, this doctrine restricts water withdrawal by a riparian owner to those circumstances in which the withdrawal was for reasonable use. The withdrawal could not unreasonably harm another

riparian owner. The balancing of certain factors determines reasonable use. Such factors may include the purpose of the use; the suitability of the use to the water resource; the economic value of the use; the social value of the use; the extent and amount of harm the water use causes; the practicability of avoiding the harm; the protection of existing uses; the availability of alternative sources; and the equity, or justice, of requiring the user causing the harm to bear the cost of remediation measures (Dellapenna 2001b).

Degradation of the quality of water resulting from inadequate treatment of domestic and industrial wastewater, from urban storm water runoff, or from combined sewer outflows may cause unreasonable harm. Other examples of causation of unreasonable harm include the overuse of pesticides and fertilizers on suburban lawns and/or agricultural lands. Harm may also be caused by water use by one party that reduces the amount of water available for use by other parties, or by water use by one party that causes the flooding of other parties. The water sharing agreement should describe the general standards for reasonable, beneficial use and specifically exclude certain uses or certain laws and regulations that may result in unreasonable harm to others (Draper 2006).

**2.2.3 Commitment to the Equitable Utilization of the Shared Water.** A fundamental aspect of transboundary water use is the mutual recognition of each party's rights to equitably share in the beneficial use of the transboundary water. At the international level, beneficial use of transboundary waters is determined according to the doctrine of Equitable Utilization (United Nations 1997; ILA 2004). In addition, many decisions from the U.S. Supreme Court in the exercise of its original jurisdiction over suits between states have decreed equitable apportionment of their shared waters. This doctrine requires governments to use transboundary water resources in a manner that is reasonable and ensures equity for all riparian parties. Certain factors are relevant to reasonable and equitable use. The weight to be given to each factor is to be determined by its importance in comparison with that of other factors. Such factors may include the geographic, hydrographic, hydrologic, climatic, environmental, ecologic, and other factors of a natural character and the social and economic needs of the governments concerned. The effects of the use or uses of the water resources by one riparian party on other riparian parties and existing and potential uses of the water resources may be considered. Other factors in the analysis could include conservation, protection, development, economy of use of the water resources, and the cost of measures taken to that effect. The availability of alternatives to a particular planned or existing use could also be relevant (Dellapenna 2001b).

**2.2.4 Commitment to the Values of Water Resource Sustainability.** Sustainability is a complex concept with as many definitions as there are settings and advocates (Hirji and Ibrenk 2001). It has been suggested that development is sustainable if "it meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland 1987). In its strictest sense, water resource sustainability requires that withdrawal and consumption of specific waters be limited in quantity to their long-term natural replenishment and that return flows be of a quality that does not adversely affect other uses of the same resource. Such a philosophy would ensure that sufficient quantities of high-quality water are available for human consumption and economic purposes far into the future (Fort 1998). However, this definition may be considered impracticable for a number of reasons. It has been suggested that an accurate measurement and quantification of sustainability is generally not

possible because of limited knowledge about long-term response of natural systems. Additionally, such a philosophy does not take into account technological advances, such as economically viable desalination, that may reclaim water for additional use. The philosophy suffers from vagueness in that the geographical scope of water resource sustainability is normally not defined. It has been suggested that the philosophy of sustainability in its strictest sense denies the needs and abilities of people to make the rational choices for their immediate and long-term future (Beck 2001). These definitions also ignore ecological and social needs.

ASCE has developed the following *Policy Statement 418* (ASCE 2010b) to describe “sustainable development”:

... sustainable development is the challenge of meeting human needs for natural resources, industrial products, energy, food, transportation, shelter, and effective waste management while conserving and protecting environmental quality and the natural resource base essential for future development.

**2.2.5 Obligation to Exchange Adequate Data with the Other Parties.** Sound management of transboundary waters requires compilation of a comprehensive database (Eheart 2002). A successful transboundary water sharing program requires the combined expertise and analytical ability of experts in hydrology, hydrogeology, water resources engineering, ecology, economics, and other scientific and technological disciplines, as well as water law and policy (Draper 2002a). Effective scientific and technological analysis requires, in turn, accurate and precise information about the climate and hydrology. Water project operations should be documented. An understanding of wastewater discharge and water quality monitoring is important. Knowledge of water development plans is critical, as are water demands for consumptive uses. Water policies and programs that affect water quantity and/or quality should be well documented (Draper 2006).

To develop a useful agreement and to make it work, each party should provide the necessary data and information in an accurate and understandable form. Normally, management on a watershed basis is preferable (Draper 2002b). To be adequate, data provided by each party should provide a comprehensive view of the water resource under consideration. Data concerning water use and activities affecting both the quality and quantity of water are also essential to understanding existing resource conditions. However, data collected independently by several parties generally possess varying degrees of incompatibility that may limit full integration of the data. The willingness of all parties to adopt a common approach to minimize such problems is a basic need to facilitate transboundary management. The parties should also consider providing mechanisms within the agreement for modification, in the event that the underlying data prove inaccurate or conditions change significantly (Draper 2006).

## 2.3 THE INTERNATIONAL LAW OF TRANSBOUNDARY WATER SHARING

Most of the principles cited earlier are recognized as the obligations of governments when water sharing is an issue. It is important for the parties to reach an agreement to recognize the legal duties imposed upon them by international law and to conduct themselves accordingly in any negotiations involving sharing of water that crosses international boundaries (Draper 2006).

**2.3.1 Substantiating International Legal Norms.** International law demands that nations, in their relationships with other nations, conduct themselves according to specific standards of conduct, or legal norms. Nation-states rarely openly or directly

defy generally accepted principles of international law but rather rely on those principles in their diplomatic exchanges (McCaffrey 1993). A nation not following these legal norms may be ostracized and sanctions of one sort or another may be imposed. However, the specific international legal norms are not as easy to ascertain as are the legal duties and obligations imposed by national laws (Draper 2006).

International law differs fundamentally from national (domestic) law. The domestic laws of any government derive from a variety of sources. These sources can include a written constitution, civil codes or statutes, common law (judge-made law), religious law, tradition, and administrative regulations. The citizens are obliged to follow these laws. These sources of law do not exist in the international arena. The basic characteristic of international law is that it is consensual. A nation usually consents to a rule only if it is in the country’s best interests in terms of the long-term benefits outweighing the long-term costs. An example is the 1921 *Convention and Statute on the Regime of Navigable Waterways of International Concern* (the Barcelona Convention). That convention obliged “each riparian State . . . to refrain from all measures to prejudice the navigability of the (international) waterway, or reduce the facilities for navigation.” This obligation was clearly in the trading interest of the different parties to the convention, and a large number of nations signed the convention (Draper 2006).

Article 38(1) of the *Statute of the International Court of Justice* (1989) describes how that court determines international legal obligations:

The Court, whose function is to decide in accordance with international law such disputes as are submitted to it, shall apply:

- a. International conventions, whether general or particular, establishing rules expressly recognized by the contesting states;
- b. International custom, as evidence of a general practice accepted as law;
- c. The general principles of law recognized by civilized nations;
- d. Judicial decisions and the teachings of the most highly qualified publicists of the various nations, as subsidiary means for the determination of rules of law.

**2.3.2 Legal Norms of Water Sharing.** Some obligations may readily be described as international norms, as defined in the *Statute of the International Court of Justice* (1989). To cooperate and negotiate in good faith is an international legal obligation expected of all nations. A number of different international treaties, conventions, and resolutions substantiate this premise. This obligation is applicable to a wide range of areas and is not limited to transboundary water sharing. The other duties cannot be satisfied without the willingness of the parties to cooperate and act in good faith efforts. The duty to prevent unreasonable harm is also an international norm that can be substantiated by a number of international documents (Draper 2006).

Other principles, however, rely on international custom and the writings of highly qualified publicists. The United Nations’ International Law Commission is an eminent example of one means of determining customary law. The commission and other legal scholars have declared the international law of water sharing to include two other obligations: (1) the duty of equitable utilization of the shared water and (2) the obligation to exchange all available data with the other parties. Enforcement of these legal norms can, of course, be problematic (Overseas Development Institute 2001; Draper 2006).

**2.3.3 Legal Evolution of Shared Water Agreements.** Water sharing agreements between or among governments create a legal structure for the legally competent authority in which they are drafted. Internationally the agreement itself creates the legal structure, while in the context of the United States, the U.S.

Constitution provides the necessary legal structure. A review of both U.S. and international law is appropriate for an understanding of the applicability of the model codes and the extent to which their modification may be necessary (Draper 2006).

Within the United States, the federal-state partnership established by the U.S. Constitution provides a stable legal relationship between the states upon which interstate conflict resolution may be based. Three levels of authority arise under the constitutional powers of the federal, state, and tribal governments. Under federalism, the states maintain authority over inland waters unless Congress has preempted them through the exercise of its powers or a direct command of the Constitution. Examples include legislation, such as the Clean Water Act (CWA 1987) and the Endangered Species Act (ESA 1982), and certain legal doctrines established by the courts. Such legislation and doctrines include federal reserved water rights that attach to federal lands in the west, federal control over navigability, and federal supremacy for federal waterpower projects. Independently of the states, Indian tribes also may assert authority over certain waters as the result of the treaties the various tribes entered into with the United States. Thus, under some conditions, the state controls use of waters within its boundaries. Under other conditions, an Indian tribe may control certain waters within a state. Finally, under still other conditions, the federal government may control certain waters within a state. Added to this “brew,” the use of the waters within one state may significantly affect the quality or quantity of waters within another state. Inevitably, conflicts over use of the water develop. Significantly, the Constitution provides a mechanism for conflict resolution, and a forum for final conflict resolution exists in the U.S. Supreme Court (Draper 2002a, d, 2006).

There are three significant methods of resolving interstate water allocation disputes: (1) interstate water apportionment compacts, (2) acts of Congress, and (3) U.S. Supreme Court original jurisdiction suits between the states. The first method is an agreement between the states to allocate or manage the shared waters. The three model water sharing agreements presented in (Draper 2002b) relate primarily to the first method, interstate water apportionment compacts. The second method is an allocation of interstate waters by congressional action. There has been but one instance of this method of transboundary water sharing, the *Boulder Canyon Project Act* (1928). In this act, Congress authorized construction of the massive Hoover Dam on the lower main stem of the Colorado River and allocation of the waters of the lower basin, predicated on ratification of the *Colorado River Compact* (1928) (McDonald 1997). In the *Truckee-Carson-Pyramid Lake Water Rights Settlement Act* (1990), Congress “authorized the federal purse” to help resolve water rights allocation disputes (Grant 2001). Other methods for Congress to affect interstate water allocation exist. Federally authorized water projects, and the resulting contracts for delivery of water to users, can result in a de facto apportionment; an example is the apportioning of water stored in federal dams on the North Platte River (Grant 2001).

The third method of resolving interstate water allocation disputes is adjudication before the U.S. Supreme Court. It is important that the drafters of an interstate compact understand these original jurisdiction suits between the states because any interstate dispute that is not resolved by compact or act of Congress would be resolved by the court, likely based on the principles of equitable apportionment. This situation creates a baseline against which each party measures what it is asked to give up under the compact (Draper 2006).

The basis of the equitable apportionment doctrine is that interstate waters should be apportioned by balancing equities. Equity

(or “fairness,” as opposed to “equality”) is achieved by balancing the stake (or value) each party may have in utilizing the shared resource (Grant 2001). The factors to be analyzed to determine a “fair” allocation of water between or among the parties include (Draper 2006):

1. Physical and climatic conditions;
2. The consumptive use of water;
3. The character and rate of return flows;
4. The extent of established uses and economies built on them;
5. The availability of storage water;
6. The practical effect of wasteful uses on the downstream area; and
7. Damage to upstream areas compared to the benefits to downstream areas if limitations were to be imposed on the former.

However, there is no requirement that an interstate compact be based on the principles of equitable apportionment, and the states can apportion waters in any manner or through any procedure the party states choose. Once approved by Congress, the compact becomes federal law, according to the terms of the compact. Should a dispute arise over interpretation of the compact and the matter be referred to the Supreme Court for resolution, it is doubtful the principles of equitable apportionment would be applied unless the compact explicitly stated that such principles formed the basis of the compact. The Supreme Court has stated that “courts have no power to substitute their own notions of an ‘equitable apportionment’ for the apportionment chosen by Congress” (*Arizona v. California* 1963). Because “congressional consent transforms an interstate compact . . . into a law of the United States, . . . no court may order relief inconsistent with its expressed terms” (*Texas v. New Mexico* 1983). Additionally, it should be noted that, to date, no state has sued for apportionment of a water source to which that state is not riparian (Grant 2001).

Within the international arena, the problems with effective conflict resolution are magnified for two reasons. First, no forum for final conflict resolution of water disputes exists in relation to water sharing conflicts. The United Nations, the World Court, and the World Trade Organization (WTO) provide forums for conflict resolution in some subject matters and under certain conditions, but no forum for conclusive judgment for conflicts involving water sharing exists. Secondly, no clear standards exist in customary international law that relate to transboundary water sharing (Draper 2006).

Under long-standing customary international law, a state had the exclusive rights to natural resources within its boundaries. This customary rule of international law does not apply to water within political boundaries. Although no definitive international treaty or agreement has been ratified on a worldwide basis to change the rule of absolute sovereignty, customary international law clearly embraces the rules of equitable utilization and no significant harm. The *Helsinki Rules on the Uses of the Waters of International Rivers* (1966) crystallized the consensus that each co-riparian state is entitled to “a reasonable and equitable share in the beneficial use of the waters of an international drainage basin.” Since 1966, a variety of other sources of international law have elaborated on this view. The 1972 Stockholm Declaration articulated the view that states have “the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.” However, a companion declaration in this 1972 declaration also articulated the need to protect “the sovereign right [of states] to exploit their own

resources pursuant to their own environmental policies” without articulating how to coordinate these rules.

The *Treaty for Amazonian Cooperation* (1978) proclaims “that the exclusive use and utilization of natural resources inside their own territory is a right inherent to the states’ sovereignty and that its exercise will not be subject to restrictions other than those imposed by international law.” The standards of international law were not described, however. The 1992 United Nations *Convention on the Protection and Use of Transboundary Watercourses and International Lakes* declared that the parties “shall take all appropriate measures to prevent, control and reduce any transboundary impact . . . (and) ensure that transboundary waters are used in a reasonable and equitable way, taking into particular account their transboundary character, in the case of activities which cause or are likely to cause transboundary impact.” Oriented to European transboundary water quality, this convention calls for “sustainable water-resources management” but does not discuss allocation of water (Draper 2006).

In 1992, the United Nations Commission on Sustainable Development reiterated the right to exploit internal resources but also emphasized the obligation not to cause transboundary harm (*Report of the United Nations Conference on Environment and Development* 1992). This report, published as Agenda 21, stated to the Secretary-General that

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies and have the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or areas beyond the limits of national jurisdiction.

Clearly, without a definitive international treaty, signed and ratified by a significant number of the world’s powers, current customary law concerning the nonnavigational use of international watercourses is still ambiguous, providing two governing principles (equitable utilization and no significant harm) that often in practice contradict each other. The *Convention on the Law of the Non-Navigational Uses of International Watercourses* (United Nations 1997) may end this confusion about customary law. The UN General Assembly approved this convention in May 1998 by a vote of 104 to 3. Although it will not enter into force until it is ratified by 35 nations, the convention provides clearer standards for agreements concerning the shared use of international watercourses. The convention states:

#### Article 5

##### Equitable and reasonable utilization and participation

1. Watercourse States shall in their respective territories utilize an international watercourse in an equitable and reasonable manner. In particular, an international watercourse shall be used and developed by watercourse States with a view to attaining optimal and sustainable utilization thereof and benefits therefrom, taking into account the interests of the watercourse States concerned, consistent with adequate protection of the watercourse.
2. Watercourse States shall participate in the use, development and protection of an international watercourse in an equitable and reasonable manner. Such participation includes both the right to utilize the watercourse and the duty to cooperate in the protection and development thereof, as provided in the present Convention.

The Convention’s doctrine of “equitable and reasonable utilization” is similar to but more expansive than the U.S. Supreme Court’s doctrine of “equitable apportionment.” This is Article 6 of the Convention (1998):

#### Article 6

##### Factors relevant to equitable and reasonable utilization

1. Utilization of an international watercourse in an equitable and reasonable manner within the meaning of article 5 requires taking into account all relevant factors and circumstances, including:
  - (a) Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character;
  - (b) The social and economic needs of the watercourse States concerned;
  - (c) The population dependent on the watercourse in each watercourse State;
  - (d) The effects of the use or uses of the watercourses in one watercourse State on other watercourse States;
  - (e) Existing and potential uses of the watercourse;
  - (f) Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
  - (g) The availability of alternatives, of comparable value, to a particular planned or existing use.
2. In the application of article 5 or paragraph 1 of this article, watercourse States concerned shall, when the need arises, enter into consultations in a spirit of cooperation.
3. The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable and equitable use, all relevant factors are to be considered together and a conclusion reached on the basis of the whole.

Article 7 establishes the requirement for all parties to “prevent the causing of significant harm to other watercourse States.”

#### Article 7

##### Obligation not to cause significant harm

1. Watercourse States shall, in utilizing an international watercourse in their territories, take all appropriate measures to prevent the causing of significant harm to other watercourse States.
2. Where significant harm nevertheless is caused to another watercourse State, the States whose use causes such harm shall, in the absence of agreement to such use, take all appropriate measures, having due regard for the provisions of articles 5 and 6, in consultation with the affected State, to eliminate or mitigate such harm and, where appropriate, to discuss the question of compensation.

The convention further declares that all watercourse parties should “cooperate on the basis of sovereign equality, territorial integrity, mutual benefit and good faith in order to attain optimal utilization and adequate protection of an international watercourse” (Article 8).

One word of caution is appropriate. It has been noted that the “equitable and reasonable utilization” standards are vague and there is an absence of a neutral enforcement mechanism in the convention (Dellapenna 1997a). Both points demonstrate that the convention itself cannot stand alone in resolving conflicts over shared water resources. Rather, the convention should provide the standards and structure of a water sharing agreement developed for a specific watershed or river basin (Draper 2006).

In 2004, the International Law Association proposed changes to existing international laws concerning water resources (ILA 2004). In addition to recognizing the need for conjunctive management and integrated management, the rules added to the list compiled for Article 6 of the UN Convention (1998). In the ILA’s view, relevant factors and circumstances to be evaluated to define “utilization of an international watercourse in an equitable and reasonable manner” would include (ILA 2004)

- (h) The sustainability of proposed or existing uses; and
- (i) The minimization of environmental harm.

Notably, the *Convention on the Law of the Non-Navigational Uses of International Watercourses* (United Nations 1997) applies only to coriparians on international watercourses. Attention is directed to the terminology used in this Convention, especially regarding the term “equitable and reasonable utilization.” Nowhere in the convention does the term “beneficial use”

appear. This term of art is used extensively in those U.S. states adhering, in whole or in part, to the prior appropriation water allocation doctrine. Because the term “beneficial use” raises significant policy issues, especially with regard to the classification of instream uses as valid and legally protected water uses, and because current international law uses the term “equitable and reasonable utilization” to denote those water uses that are permissive, the latter phrase is used in this model agreement (Draper 2006).

The significant difference between international law and the laws of the United States is that, for the United States, the U.S. Supreme Court provides the institutional legal framework with a “court of last resort” to resolve interstate water disputes. No such forum exists for international water disputes; reliance should be placed on internationally accepted legal norms, such as a ratified the *Convention on the Law of the Non-Navigational Uses of International Watercourses* (United Nations 1997).

## 2.4 SUMMARY

A number of obstacles exist in developing an effective agreement to share water resources between governments. These obstacles include conflicts in the internal water laws and policies of the parties, an incomplete knowledge of the water resource availability and demand within the shared basin, and conflicts between the internal economic policies of the parties.

To negotiate these obstacles, efficient and effective water sharing across political boundaries requires that development of the agreement follow a certain pattern. The parties should acknowledge certain standards of conduct for negotiation. The parties should assume the obligation to cooperate and negotiate in good faith and the obligation to prevent unreasonable harm to other parties. They should commit to the equitable utilization of the shared water and to the values of water resource sustainability. The parties should assume the obligation to exchange adequate data with the other parties and make a commitment to do so. The obligation to cooperate and negotiate in good faith and the obligation to prevent unreasonable harm are standards of conduct clearly mandated by international law. Because the validity of the other standards of conduct should rely on international custom and the writings of highly qualified publicists,

the parties to the agreement should explicitly address those obligations in the agreement process. Negotiating the obstacles presented by conflicting economic objectives and priorities is especially difficult to overcome, in no small part because of the conflicting philosophical concepts of economic efficiency (ASCE 2004a, 2009a; Dellapenna 2007a).

Once these obligations are delineated, along with a mechanism to ensure that the parties embrace these obligations, the specifics of the agreement can be formulated. Significant sections of the agreement should include a mechanism to allocate the shared waters between the parties according to some objective function that includes the economic, social, environmental, and ecological objectives of the parties. An institution should then be developed that can effectively implement the agreement at a reasonable cost without unduly infringing on individual states and their separate authority over internal waters. Equally important, the source water needed to fulfill those objectives and the water available in the shared resource should be compared and the objectives modified as necessary to reflect the reality of the yield of the shared resource. This step requires significant scientific and engineering studies to estimate the water available under normal conditions, as well as under conditions of drought and flood. Finally, some dispute resolution mechanism should be constituted to minimize the potential for destabilization of the agreement (ASCE 2004a, 2009a; Dellapenna 2007a).

Necessarily, an effective agreement may only be achieved with an understanding of, and adherence to, the established laws of water sharing. Within the sense of federal law, an understanding of the application of federal law to water sharing between states is essential. Likewise, within the international context, an understanding of the norms of international law is essential. As supported by the American Society of Civil Engineers (ASCE 2009a), the techniques of alternative dispute resolution can often be used to avoid costly time delays that may disproportionately affect the economic, social, environmental, and ecological programs of affected states and/or nations.

The American Society of Civil Engineers (ASCE) supports dispute avoidance and alternative dispute resolution techniques such as those contained in the Engineers Joint Contract Documents Committee's (EJCDC) documents to bring disputes related to engineering and construction to a fair, timely, and cost-effective conclusion without litigation.

## Chapter 3

### RESOURCE ASSESSMENTS

The foundation of a water sharing agreement requires accurate and precise information about the availability of water, the quality of that water, and the demands that should be accommodated. A number of assessments should be conducted at the beginning of the formulation of the agreement. These assessments include definition of the geographical and political boundaries of the water sources to be shared and analysis of the water policies, laws, and regulations of the individual parties that may conflict. An assessment of the yield of the water sources for normal conditions should be made, as well as for extreme conditions of droughts and floods. An accurate accounting for existing demands and one for predicting future water demands should be made, as well as an assessment of the water quality and quantity necessary for ecological integrity. An economic impact assessment should then be made that correlates the other assessments. From a procedural standpoint, strategies for the development of a water sharing agreement should initially proceed with the exchange of data and information between technical experts, with the objective of reaching a technical consensus on both the actual and potential problems known or envisioned. Only then can alternative strategies to respond to the problems be developed (Eaux partagées 2002).

#### 3.1 GEOGRAPHICAL AND POLITICAL BOUNDARIES

One criterion of the *Convention on the Law of the Non-Navigational Uses of International Watercourses* (United Nations 1997) makes the definition of the waters to which an agreement applies a mandatory provision in the agreement. The parties should identify and document the type and geographical extent of the water resources to be subject to the agreement. This description allows all appropriate and necessary parties within the geographic-political region to be included in the agreement and negotiation process. Only then can an investigation of any conflicts in water law and policy proceed (Dellapenna 1994, 1997a, 1997b; ASCE 2004a).

To formulate an effective agreement, the parties should analyze the factors that influence the water resource in question, including the climatology, physiology, geology, and the interaction between underground and surface water resources. The analysis should identify pollution sources and the resulting effect on water quality. The geographic scope of the water resources to be covered by the agreement should be sufficiently expansive to fully address all the water sharing issues involved. It is important to acknowledge that the agreement reflects the particular circumstances and compromises reached in its formulation and that it applies only to the waters shared between the parties (Draper 2002b, 2006). The agreement should include the total surface area of drainage throughout the basin, including the aquifers underlying the surface drainage. Some tributaries could be connected to the underlying aquifers, and some of the aquifers could be connected to more than one of the surface water basins (Draper 2002b).

The purposes and scope of an agreement weigh heavily on this assessment, delineating the parties to be included. All principal stakeholders, such as persons, institutions, or governments directly affected by the shared use should be identified and included in the negotiations and the agreement, including any government that has direct access to the sources of water. Both governmental and private stakeholders should have a voice in formulation of the agreement. The *Treaty for Amazonian Cooperation* (1978), involving a balance of development and environmental protection, is a good example. Without the combined signatures of Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Surinam, and Venezuela, the agreement could not be effective.

In terms of atmospheric water, the analysis of meteorological and climatological factors should identify those states or nations that will be affected. The applications of new techniques for weather modification or of atmospheric water management might have effects beyond any one state's borders (Gochis 2001; ASCE 2004b; Keyes 2006). For instance, significant extraction of atmospheric water in western Canada may affect other provinces in Canada, as well as the United States. However, because the effect of extraction of atmospheric water may extend far distances in ever-decreasing or increasing significance, the parties should adopt some measure of "reasonable impact" (Draper 2006).

Although private water rights holders within the various jurisdictions are not parties to the agreement, the various persons and organizations associated with the various water demands should have a voice in formulating the agreement. Although the extent of consultation with private groups depends largely on the political nature of the governments themselves, some recognition of existing rights is required. In most situations, a conflict exists between demands for water for economic purposes and the needs of environmental and ecological protection. Water users frequently need external incentives to accept the reservation of some water for environmental and ecological protection. Unless the governmental entities involved with formulating the agreement actively seek to include the various interest groups, the effectiveness of the agreement may be compromised (Draper 2001, 2006; Keyes 2006).

#### 3.2 ASSESSMENT OF WATER LAWS AND POLICIES

Different water issues may exist for the individual parties, both within the state and across the state's boundaries. Each party may have developed, therefore, certain laws and policies to deal with these issues, which may be at variance with the laws and policies of other parties. Comparing and contrasting the different laws to expose conflicts that may affect water sharing is essential (Dellapenna and Draper 2002b). Within the United States, the extent of conflicts varies not only between the states involved but also with an array of federal and tribal water rights and issues. It has

been observed that current United States water-use policy is in such disarray that many critical interstate water basins are left “dangling under Solomon’s sword” (Tarlock 2001). This situation does not make water sharing between political entities any easier (Draper 2006).

**3.2.1 Water Rights.** Differences in law should be identified and accounted for in the agreement. By comparing and contrasting the laws of the individual parties, drafters of the agreement can identify potential conflicts and determine the areas requiring meticulous coordination. Each jurisdiction should have mechanisms to implement and enforce the laws. Knowledge of the administration and management institutions of each is necessary to administer the water sharing agreement and to ensure that its provisions are enforced. Participants should review and analyze each jurisdiction’s institutional mechanisms that affect any form of water management. For instance, definition of legal terms within the individual jurisdictions is a prerequisite for understanding the conflicts and similarities in their laws. Of specific concern are the definitions of “reasonable use” and/or “beneficial use” and the term “equitable” (Draper 2006).

Whereas most jurisdictions maintain governmental control over the allocation of water and its use, the use of private water markets has been contemplated as a means to make the allocation process more efficient. The existence of such a private water market policy may result in significant differences in the way individual water rights are transferred. How water rights are lost is a concern in each jurisdiction. Each of these matters affects the final form of the agreement (Draper 1997).

The analysis to compare and contrast the water laws of the different participants can be efficiently accomplished within the context of the legal theories of water law and property rights. Legal theory establishes three basic approaches to water law and property rights: common property, private property, and public property (Freyfogle 1999; Dellapenna 2000; Gleick 2000a; Dellapenna and Draper 2002b).

Although the disciplines of science and hydrology have long recognized that surface water rivers and underground water aquifers are interrelated waters, the law has not (Eckstein 1998; Dellapenna and Draper 2002b; Glennon 2002). Traditionally, the framework of water law for surface water and underground water has been separate and distinct. Rights to use surface water (rivers and streams) are generally provided in one of three water right doctrines: riparian rights, appropriative rights, and regulated riparianism (Dellapenna 2001b).

The riparian rights doctrine is a surface water rights doctrine, typified by common law, that treats water as a common resource. This surface water rights doctrine, also referred to as the doctrine of “reasonable use” or “eastern water law,” permits a landowner adjacent to a watercourse to withdraw and use the water as long as the use is “reasonable.” The doctrine leaves the courts to resolve conflicting claims of right to use the common resource. Shortfalls in water availability are shared by all riparians, with courts deciding each user’s share according to its reasonableness at the time of the decision (Draper 2006).

The appropriative rights doctrine is a second surface water rights doctrine that treats water essentially as private property. Water is appropriated according to “first in time, first in right.” The senior appropriator is the one who first puts a specific amount of water to beneficial use. All others who put water to beneficial use later are junior appropriators. In cases of water scarcity, there is no sharing of the shortfall in water; the junior appropriator forfeits his or her water use until the senior appropriator has fully satisfied his or her appropriation. This doctrine is also referred to as “western water law.”

The regulated riparianism doctrine is a third surface water rights doctrine that has begun to supplant common law riparian rights. This supplanting has occurred because states have recognized the need for active public management of water as the needs of large water users (e.g., commercial, municipal, industrial, and agricultural) increase and begin to compete for the available water supplies. Rather than treating water as a common resource (as under common law riparian rights) or as a private resource (as under appropriative rights), the regulated riparian rights doctrine treats water as a public resource. The central requirement of regulated riparianism is that water users should obtain state permission (time-limited permits) to withdraw and use large amounts of water for a specific purpose. Water withdrawals above a certain threshold are required to have a permit; withdrawals below the threshold are exempted. The threshold varies from state to state (Draper 2006).

The western doctrine of prior appropriation is premised on shortages allocated by priority schedules that provide a clear and complete risk allocation scheme before the shortages occur (Tarlock 2000). The water user need not be adjacent to the water source. In contrast, riparian rights are premised on shortages being shared in “reasonable use” by all riparians. The water user normally should be adjacent to the watercourse. International water law is similar to riparian rights and normally requires the equitable sharing of transboundary water resources (Draper 2006).

Five legal doctrines apply to underground water (Dellapenna and Draper 2002b; Draper 2002a). The absolute dominion doctrine allows an overlying landowner to withdraw an unlimited amount of water, unconstrained (in its purest form) by any concern about injury to another landowner. This doctrine is actually a form of the “water as private property” model, in which each common owner has the unlimited right to capture the underground water. The reasonable use doctrine for underground water requires the landowner to make “reasonable use” of water; any unreasonable use of underground water (uses that unreasonably injure adjacent landowners as determined in court) is actionable. However, the landowner may withdraw and consume the underground water for reasonable uses without regard to the effect on others. There is no sharing of the aquifer among landowners, as incorporated in surface water riparianism (Tarlock 1989), except as a court may determine that continuing a use is unreasonable. Implicit in the doctrine is that the “reasonable use” should take place on the land itself. Under the correlative rights doctrine, landowners may withdraw only their share of the underground water for “reasonable use.” If there is not sufficient water available, each landowner shares in the shortfall in proportion to the amounts allocated to that landowner’s use. This doctrine treats water as a common resource and resembles the common law riparian rights model described earlier (Trelease 1979; Tarlock 1989). Defining and enforcing the shares is a complex and often unsatisfactory process. Two other legal doctrines of underground water have evolved. Under the appropriative rights doctrine, underground water is allocated according to the “first in time, first in right,” as with appropriative rights doctrine for surface water. It treats water as private property. Finally, a growing number of states apply their regulated riparian system, created for surface water, or a similar system specifically to underground water. Under a regulated riparian approach, underground water is allocated by a statutory system of a comprehensive water withdrawal permit system (Draper 2006).

There can be significant differences in water laws even between parties that have similar water law systems. The difference may be especially important in how certain water rights are vested by the individual internal water laws. Initial identification

of vested water rights and knowledge of laws that may vest such rights in the future are necessary to prevent extremely complex water problems, such as those experienced by Los Angeles as Arizona and Nevada exercise their legal rights to the waters of the Colorado River (Dellapenna 2001b). These differences in the definition of the type, quantity, and extent of water subject to water laws can include the extent and duration of water rights; the permissible quantity of use; and the timing, pattern, and location of use.

Without careful consideration when the parties to the agreement have differences in their systems of water law and property, the understanding of specific provisions in the agreement by one party may be very different than the understanding of other parties. This difference could quickly lead to an unenforceable agreement.

**3.2.2 Water Policies.** An assessment is also necessary of water policies that are an extension of water law. However, an assessment is broader in scope and less tied to the formalities of legal provisions. These policies range from specific water policies, such as requirements for instream flow and safe yield, to economic policies that may indirectly affect water demand. It has been suggested that eastern and western water policies have begun to converge (Kundell and Tetens 1997), but for the foreseeable future, dramatic differences in water policy within the United States exist.

*Minimum Flow and Safe Yield.* A significant policy conflict may arise with regard to the individual party's requirements for minimum flows for surface water and safe yield for underground water (and reservoirs). Instream flow requirements can mean many things. It can be the amount of water remaining in a stream, without diversions, that is required to satisfy a particular aquatic environment (Nevada Division of Water Planning 1999) or the flows and levels reserved from allocation to protect the appropriate biological, chemical, and physical integrity of water sources (Georgia Water Coalition 2002). Required minimum flow may be defined as the minimum flow necessary to assimilate projected wastewater discharges. It can also mean the stream flows required for swimming, floating a canoe, supporting fisheries, sustaining waterfowl habitat, providing downstream water supplies, assimilating wastes, or generating hydroelectric power. These uses require different quantities of water at different times and at different levels of water quality (Sherk 2002). Other definitions set variable minimum flows that mimic natural flows (Poff et al. 1997). If the individual parties to the agreement do not agree to a common definition or requirement, or at least ensure that the agreement accommodates the difference, significant differences may arise (Draper 2006).

Safe yield or sustainable yield (Helweg 2000), as applied to underground water, is usually more limited in scope. Policies of maintaining safe yield usually refer to a management concept that allows water users to pump only the amount of groundwater that is replenished naturally through precipitation and surface-water seepage (Sophocleous 1998). As with differing policies regarding instream flow, differing policies of whether to restrict withdrawals can seriously damage the effectiveness of an agreement unless the difference is addressed in the agreement (Draper 2006).

*Interbasin Transfer of Water.* Interbasin transfer of water is the transfer of water rights and/or a diversion of water (either underground water or surface water) from one drainage or hydrographic basin (the basin of origin) to another (Nevada Division of Water Planning 1999; Draper 2004). As competition for limited water resources has increased, conflicts concerning interbasin water transfers have increased (Kundell and Tetens 1997;

Draper 2004). One party to the agreement may have a policy of meeting water supply needs in one region by transporting abundant supply from another (Hirji and Ibrenk 2001; Draper 2004). This policy may result in negative effects on both the environment and the economy of the basin of origin that may include alteration of stream flow affecting instream uses of the water and preclusion of potential future instream and offstream uses of water that support economic activity (Georgia Joint Comprehensive Water Plan Study Committee 2002; Draper 2004). For purposes of water sharing, unless the receiving basin is in a common river basin whose waters are shared by the parties, interbasin transfer can reduce the available water to be shared. Clearly, policies of interbasin transfer by one party could have a significant effect on the water to be shared. To reach an effective agreement, the interbasin policies of the respective parties should be closely analyzed. It may be necessary for the agreement to detail how and when interbasin transfers of shared waters can occur (Draper 2006).

Various governments have imposed different criteria for interbasin transfer. Commonly, such transfers are allowed only after a showing that, among other criteria, there is no other reasonable alternative and that programs of conservation and efficiency have been implemented (Georgia Joint Comprehensive Water Plan Study Committee 2002; Glennon 2002; Draper 2004).

*Flood Control.* Flood control policies and works may also have a dramatic effect on the timing and elevation of water levels and thus may become a contentious issue between the parties. The issue should be addressed as an individual area of coordination. This provision recognizes the right of each party to make efforts to safeguard its people and economic forces from flood damages, but it also establishes an avenue for the sharing of data on flood control efforts as well as an independent analysis of the effects of those efforts on other parties (Draper 2000a).

*Priority of Use.* The *Convention on the Law of the Non-Navigational Uses of International Watercourses* (United Nations 1997) advises that "(i)n the absence of agreement or custom to the contrary, no use of an international watercourse enjoys inherent priority over other uses." If sufficient water is available to meet all equitable and reasonable uses, all demands should be met and no need for prioritization exists. Even if sufficient water is available during normal conditions, restrictions on water rights during times of water shortages or dry periods should be analyzed (Kundell and Tetens 1997). If sufficient water is not available, it has been recommended that a priority of allocation be established. A number of prioritization schemes have been proposed. One suggestion includes a priority list of human needs, vested water rights, and minimum instream flow for environmental and ecological protection and water quality purposes, followed by allocations that balance demands that provide maximum economic benefit with demands that have a direct influence on quality of life issues but cannot meet the economic threshold (Sterner 1994). The Delaware River Basin Commission (DRBC 2003) and the Susquehanna River Basin Commission (SRBC 1970) provide priority for (1) domestic uses (drinking and bathing), (2) public safety, and (3) the minimum amounts necessary for preservation of livestock and property; thereafter they attempt to balance reductions in water use to maximize productivity and preservation of employment and preserve essential instream flows for water quality and biological conditions. The state of Pennsylvania prioritizes water use under drought conditions with domestic use (including drinking, bathing, cooking, laundry, livestock watering, and other uses necessary for life and health), which is given priority with no regard for the amount of water left in the stream or lake after these uses are satisfied. The next priority is the public's right to

navigate, followed by all nondomestic water uses. Upstream nondomestic uses, including irrigation, manufacturing, and power production, can be slowed if there is insufficient water to meet downstream domestic or navigational needs (Abdalla et al. 2007).

It can be argued, however, that placing domestic uses (drinking and bathing) or human needs as top priority does not match the reality of a rapidly urbanizing society. Most water for domestic uses is provided through a municipal system, and it is difficult to segregate what portion is for domestic use and what portion is for other uses, such as commercial. Once the law fixes domestic use as the top priority, authorities must then publish detailed requirements of what is and what is not allowed. Municipalities managing water use during drought emergencies may limit or ban lawn watering, car washing, and golf course irrigation, but enforcement is difficult at best. Moreover, it is difficult for political and factual reasons to curtail commercial or retail use. Separating water that is used within a shopping mall among the grocery store (food as a human need), the drug store (medicines as a human need), and the clothing store, for instance, is a challenge (Draper 2006).

### 3.3 ASSESSMENT OF WATER RESOURCES

Establishing equitable principles and standards for managing the shared use of water between governments requires detailed knowledge of the quantity and quality of the shared water resources and a comprehensive understanding of how the use of the water resources by individual parties will affect others (Draper 1997; Kaya 1998). Even more importantly, a mechanism to predict accurately future sources and demands is essential (GJCWPSC 2002). Such detailed knowledge is rarely available without extensive research and funding, even in the United States or other developed countries. If an effective water sharing agreement is really intended, the parties need to devote the human and financial resources necessary to develop a broad understanding of the extent and limits of the water sources available to be shared (U.S. Army Corps of Engineers 1995; Kundell and Tetens 1997).

The ultimate goal of the assessment of water sources is to determine whether existing or “reasonably anticipated” water sources are sufficient to meet the expected future demands (Ryan et al. 1998). Both natural factors and human effects may change the amount of water available. Factors that affect water availability include “climatic variability and change, population growth that reduces per capita water availability, contamination that reduces usable water supplies, physical overuse of a stock, such as underground water overdraft, and technical factors” (Dellapenna 1997a; Gleick 1998). The negative effect of human activities on water sources has been noted (Shiklomanov 1993):

Despite the ability of stream flow to renew and self-purify, in recent decades the intensive development of industry and agriculture throughout the world, population growth, the opening of new territories, the sharp increase in water withdrawals on all continents (except most recently in the United States and parts of Europe), and the transformation of the earth’s natural cover have begun to exert a significant impact on the natural fluctuations of the stream flow and the state of fresh water resources.

**3.3.1 Data Collection and Uncertainty.** Accurate and reliable data and information are key requirements in effective water planning and management (Dellapenna 1997b; Draper 1997; GJCWPSC 2002; Vörösmarty 2002; ASCE 2004a). Given the complexities of water resource decisions, collection efforts should focus on collecting the data and information needed to support those decisions by providing input for computer models

and geographic information systems used in making those decisions. Unfortunately, in many countries collection of hydrographic information has deteriorated (Vörösmarty 2002).

Accessibility to the data and information is equally important. Numerous national, state, and local agencies collect water-related data for various purposes and manage those data using incompatible formats and systems. Many records are maintained in paper files; on microform, microfiche, or microfilm; or on individual desktop computers. Demand for public access to data has skyrocketed as use of the Internet has become more commonplace. Although access to water-related data and information has improved significantly, limitations still remain. Successful development and implementation of a comprehensive, integrated data and information management system for the shared water resource depend on the strong commitment of participating agencies and strong executive and legislative leadership (Georgia JSC 2002).

Predicting the yield of shared water sources based on the historical record can result, however, in significant future problems. Future overallocation caused by an inaccurate historical record is illustrated by the 1922 Colorado River water allocation that was based on the 30 years of hydrological record available at that time. Later research, based on an analysis of tree rings, determined that the amounts of water used in the allocation were abnormally high, resulting in overallocation of the water source (Stockton and Jacoby 1976; Murakami 1995).

The issue of climate change has surfaced as a potential impediment to effective long-range policies and management of water resources (Nicholls 2000; Draper and Kundell 2007).

The challenge for the water manager is how a change in climate might dramatically alter how water as a scarce resource is allocated. Nowhere is this challenge greater than the allocation of shared waters between or among politically independent governments (Draper and Kundell 2007).

Sustainable water yields may or may not be reduced in the long-term average, but they are almost certainly less reliable in the short term (Sophocleous 1998; Draper and Kundell 2007). A rapidly growing body of evidence suggests that we are entering a somewhat warmer and definitely more variable world. The *ASCE Policy Statement* (ASCE 2010a), in Section 2.1.4, recognizes the problems associated with water resource planning and climate change.

Accurate and reliable data and information are key requirements in effective water planning and management (Dellapenna 1997b; Draper 1997, 2006; Vörösmarty 2002; ASCE 2004a; Draper and Kundell 2007). The effects of climate change extend across political boundaries. Therefore, the parties to a water sharing agreement should recognize that the water sharing agreement may need to be adapted, even significantly adapted or replaced, as more accurate and precise predictability becomes available on those changes (Frederick and Schwarz 1999). Climate change affects water sharing in many of the same ways it affects the management of water within a specific legal jurisdiction (Draper and Kundell 2007).

**3.3.2 Water Supply.** Surface and underground water resources are often managed as separate and distinct sources (Eckstein 1998; Draper 2002d). However, such individualized management does not provide a comprehensive understanding of either the water sources or their use. In reality, however, the three components of water—surface, underground, and atmospheric—are part of one hydraulic system (Glennon 2002). Before implementing transboundary water use allocation or transfer, participants should conduct a comprehensive inventory of the shared water resource. Such an assessment requires a sound historical

record of the natural water cycle, to the extent it is available, as altered by human intervention (Vörösmarty 2002).

In most situations, each component of water, whether it be surface, underground, or atmospheric water, has historically been assessed and managed as separate and distinct sources from the others. However, such individualized assessments do not provide an integrated understanding of either the water sources or their use (German Foundation for International Development 1998; Illinois State Water Survey 2001). The flows of surface waters and underground water are often closely linked and need to be studied and managed conjunctively (Winter et al. 1998; Illinois State Water Survey 2001; Glennon 2002). This interrelationship is significant because the interface between surface water and underground water is often direct, with streams sometimes recharging the aquifer and sometimes gaining water from the aquifer. It is estimated that the contribution of underground water to small- and medium-sized streams is between 40% and 50% (Fort 1998). Clearly, then, the available waters should be managed conjunctively (Hayton and Utton 1989).

Effective water sharing agreements need to have their provisions based on accurate and reliable data and information. The goal of the parties should be to collect and make available data and information that enable them to make timely, accurate, and complete decisions in the development of the water sharing agreement. Successful data development depends on a strong commitment of participating parties (Water Plan Advisory Committee 2002).

A comprehensive assessment requires that three conditions be met. First, the parties should define the critical hydrologic conditions that frame the water sharing agreement. Second, adequate and reliable data concerning the water sources and demands should be available. Third, a shared water resource database should be developed and maintained (GJCWPSC 2002). Certain parameters define the framework of the agreement. The parties need to specify the extreme hydrologic events that the agreement will cover. This requirement suggests that the parties should clearly establish the quantitative measures of “normal” or “average” hydrologic conditions and establish the levels when special management for drought (dry) or flood (wet) conditions arise. The parties should also define the levels of water quality degradation they are willing to accept as a result of meeting the demands for the water.

A number of factors influence the availability of water within the shared resource. Water in its different forms moves between the atmosphere, through precipitation and condensation, to rivers, streams, lakes, and reservoirs, to vegetation and soils, to aquifers or oceans, returning to the atmosphere through evaporation. Any efficient management of one form cannot be attained without linkages to the other, preferably dealing with both underground water and surface waters as a unitary whole (Haddadin 2000). The timing and amount of available water to be shared should be based on a careful analysis of this linkage (Illinois State Water Survey 2001). The timing and amount of water available for shared use is also linked to human intervention, both by the addition of supply augmentation facilities and programs, such as reservoirs and aquifer storage and recovery systems, and by the loss of reusable water consumed by individual uses and unavailable to others (Draper 2002e).

The goal of collecting data and information on precipitation amounts, recharge rates, and other data should be to determine the reliable available quantities of water to meet projected needs (Illinois State Water Survey 2001). The word *reliable* is emphasized because, in the absence of storage devices, the demand for water by the individual water user sectors should be reliable and consistent for extended periods of time. It is not sufficient that

the statistical average yield of the water source equal the projected demand. The yield of the shared water source should be able to meet the demand under most climatological, meteorological, and hydrological conditions.

Water utilization by one party can have serious effects on the quantity and/or quality of the water available for use by other parties. A significant source of controversy develops when one party undertakes the construction and operation of water supply reservoirs and hydropower facilities that may dramatically lower the flow or decrease the quality in the shared water resource. Although this reduction may be limited to the initial start-up period and may be limited to a period of several years, severe economic and social effects may occur to other parties. Return flows should be coordinated to ensure that downstream users are not significantly affected in an adverse manner. In the case of water supply reservoirs, this coordination may become critical during periods of drought. In the case of hydropower dams, especially those that provide power principally during peak electrical demand, usually in the morning and early evening, the timing of release may be critical. Other parties may also be affected by significant changes resulting from interbasin transfers or increased water consumption (Draper 2002b, 2004). Water supply reservoirs and hydropower facilities also often have significant biological effects that may or may not be related to total water supply or water quality.

**3.3.3 Underground and Atmospheric Water Supply.** Conjunctive analysis, considering surface and underground water supplies together, coordinates use and storage to increase the total water yield over time, thereby increasing the reliability of the water supply. Integrated analysis, considering water supplies and water quality together, coordinates the adequacy of the water supplies for those water uses that demand a certain level of quality (U.S. Advisory Commission on Intergovernmental Relations 1991).

Failure to deal specifically with the issue of underground water withdrawal has led to litigation in the context of existing interstate compacts in the United States. It is therefore recommended that underground and atmospheric water be included within the scope of the agreement. As technology advances, use of and control of atmospheric water may also become more commonplace (ASCE 2004b; Bomar 2006), and consideration should be given to dealing with the potential for such use and control before it becomes established and results in unexpected interference with the provisions made for underground and surface water (Draper 2002b). Shared aquifers require careful evaluation because there is a general lack of detailed data (ASCE 2001). The effects of the use of transboundary aquifers are subtle and widely spread geographically and often delayed in time (Puri and Arnold 2002).

Withdrawing water from shallow aquifers for public and domestic water supply, irrigation, and industrial uses is widespread. Withdrawing water from shallow aquifers can diminish the available surface water supply by capturing some of the underground water flow that otherwise would have discharged to surface water or by inducing flow from the surface water into the surrounding aquifer (Winter et al. 1998). Conversely, underground water resources can be used as an effective tool to mitigate the effects of drought. Because underground water aquifers are less affected by short-term variability in climate conditions than are surface water rivers and streams, they can be artificially recharged during high water periods and utilized during low water periods (ASCE 2001; Keyes 2006). However, increased use of underground water during droughts may have unanticipated effects. If an increase in underground water withdrawal is contin-

ued after the drought, a permanent and unanticipated change in the level of underground water may develop (Alley et al. 1999).

Provisions in water sharing agreements of transboundary underground water aquifers should distinguish between two types of aquifers. The first type includes aquifers that are hydrologically connected to surface waters, in which a conjunctive approach may be used directly. For this type, typified by the Floridian aquifer shared by many southeastern U.S. states where rates of aquifer recharge may be as high as 20 in. per year (Miller 1990), the transboundary concern is twofold. The first concern is the transboundary effect of excessive water withdrawal by the upgradient party and its effect on the water available to the downgradient party. Second is the possible reduction in the recharge of the aquifer by developmental activities within the recharge areas by one of the parties, usually the upgradient party. Clearly, knowledge of the aquifer recharge areas is extremely important (Dellapenna 1997b; ASCE 2009c).

The second type of aquifer includes those with no direct surface water connection (so-called “ancient” or “fossil” aquifers). In this case, typified by the Ogallala aquifer shared by many high plains U.S. states, recharge is negligible because recharge of these aquifers is normally quite slow, ranging in the tens of thousands of years (Cummings et al. 2001a). An estimate of the magnitude and extent of the water available for use in this case cannot be made without considering the risk to future users of exhaustion of the water source, an issue of sustainability (Donkers 1997). A problem that is even more significant in the sharing of such an aquifer involves the controlled depletion of storage. Increased use by one party may result in, or exacerbate, existing “mining,” where annual pumping exceeds natural recharge, effectively depleting the source (Cummings et al. 1996). In some areas of the Ogallala, more than 50% of the predevelopment saturated zone has been dewatered (Alley et al. 1999). The parties, however, can mitigate this issue of increased underground water “mining” by including in the water sharing agreement a requirement for more water-efficient irrigation systems, incentives for the introduction of crops that use less water, and the irrigation of fewer acres by underground water in some areas because of the declining water levels (Solley 1997).

**3.3.4 Quality of Water Supply.** The issue of water quality is also pertinent to an analysis of water resources. In many cases, providing adequate supplies of water for a particular demand is not sufficient. The need may well be adequate supplies of water at an acceptable level of quality (Draper 2001). The parties should recognize a level of water quality within the shared waters that meets a number of needs. At a minimum, the shared water should maintain ecosystem integrity and preserve aquatic ecosystems while sustaining economic growth and prosperity (ASCE 2009c). Integration of water quality and quantity programs is one aspect of, and is inseparable from, comprehensive, coordinated, multipurpose, basinwide water and related resource planning and management (Goldfarb 1993).

Surface and underground water may be degraded by a variety of factors. Major problems affecting the quality of these water resources arise, for instance, from inadequate domestic sewage treatment, inadequate controls on the discharge of industrial waste and effluent, the diversion of waters resulting in insufficient water to assimilate waste, the loss and destruction of catchment areas, the improper locating of industrial plants, deforestation, and poor agricultural practices that cause leaching of nutrients and pesticides (Draper 2002b). In coastal regions, saltwater intrusion can nullify the underground water supply as a viable water source to meet the needs of agricultural irrigation and municipal water supply (State of Georgia 1997).

Poor-quality water imposes risks that the parties should recognize as a common threat. There is, for instance, the potential health risk to the population that uses the water for domestic purposes. If the available water does not meet the minimum standards for certain industrial purposes, there is the risk that economic growth may be impaired. Also, there is the risk that quality degradation may have a severe effect on long-term sustainability. Therefore, integration of water quality and quantity is essential (Ahlander 1994). The *Convention on the Law of the Non-Navigational Uses of International Watercourses* (United Nations 1997) establishes the criterion that “watercourse States shall, individually and, where appropriate, jointly, protect and preserve the ecosystems of international watercourses.”

Within the United States, the Clean Water Act (1987) provides a baseline for surface water quality programs, but the same cannot be said of underground water. Treaties between Canada and the United States and between Mexico and the United States have established water quality norms in North America (Killgore and Eaton 1995). Similar norms exist for the European Union and the Amazon Basin (Draper 2002b). However, in many other regions of the world, water quality criteria are not prescribed (Draper 2006).

**3.3.5 Water Supply Augmentation.** Water augmentation projects and programs are techniques to change the timing and/or quantity of water available for use. Examples of effective water augmentation techniques include surface water reservoirs, aquifer storage and recovery, precipitation enhancement, inter-basin transfer, evaporation suppression, desalination, and wastewater reclamation and reuse (Keyes 1977).

Reservoirs can significantly augment water supply in areas or periods of water scarcity. Therefore, the parties may need to assess both existing dams and potential construction of new dams. With regard to existing reservoirs, almost half the world’s large reservoirs have been built exclusively or primarily for irrigation. An estimated 30% to 40% of the 268 million hectares (662 million acres) of irrigated lands worldwide rely on dams. Dams are estimated to contribute from 12% to 16% of world food production (World Commission on Dams 2000). However, in addition to growing demand for municipal water supply, a combination of social pressures is emerging, with the potential to shift the operational priorities of reservoirs significantly in the near future between, among others, hydropower and water supply (McMahon and Farmer 2002). However, reallocation of reservoir storage by one party may cause unintended consequences on the quantity, timing, and quality of water available to the other party. One of the specific risks associated with reservoirs is degraded water quality, resulting from increased levels of mercury pollution early in the postconstruction life of the reservoir. Another potential problem that may have a detrimental effect on long-term water supply availability is the tendency of reservoirs to emit greenhouse gases, carbon dioxide, and methane, adding to the projected increase in climate change (Pielou 1998).

Recreation has also developed into a significant competing purpose with other traditional uses, at least for reservoirs in the United States. Both lake and river recreation has been noted as a significant national resource and public benefit, making an important contribution to local, state, and national economies. However, recreation at federal lakes has not heretofore been treated as a high priority, or as an equal with other reservoir uses, even if it is designated as an authorized purpose (National Recreational Lakes Study Commission 1999).

As water scarcity continues to grow and needs change, reallocation of the purposes of reservoirs mounts. Although

reallocation often considers changes in purpose from hydro-power to municipal use in the United States (McMahon and Farmer 2002), in other areas reallocation from irrigation to industrial use might be appropriate.

Construction of new reservoirs by one party can also significantly affect the quantity, timing, and quality of water available to other parties, especially downstream parties. A large number of aquatic and ecosystem effects exist that should be considered, including the effects of reservoirs and flow modifications on terrestrial ecosystems and biodiversity, the emission of greenhouse gases associated with reservoirs, and the accumulation of pollutants. The effects of altering the natural flood cycle on downstream floodplains and the effects of reservoirs on fisheries in the upstream, reservoir, and downstream areas can be significant. The cumulative effects of a series of reservoirs on a river system should be carefully considered (World Commission on Dams 2000).

Aquifer storage and recovery (ASR) is the storage of water in aquifers during times when water is plentiful and recovery of the water during times when it is needed. Proponents claim that this technique provides a cost-effective solution to many of the world's water management needs, storing water during times of flood or when water is plentiful and quality is good, and recovering it later during emergencies or times of water shortage, or when water quality from the surface water source may be poor. Large water volumes can be stored deep underground, reducing or eliminating the need to construct large and expensive surface reservoirs. In many cases, the storage zones are aquifers that have experienced long-term declines in water levels because of heavy pumping to meet increasing urban and agricultural water needs. Underground water levels can then be restored if adequate water is recharged (Pyne 2008). The primary benefits include significant cost savings from not having to construct expensive surface reservoirs. Potential disadvantages include lowering water quality because of mixing higher and lower quality water sources. From the shared water perspective, a good understanding of the regional hydrogeologic framework is essential to assess the regional costs and benefits of any proposed regional ASR systems (Water Science and Technology Board 2001). The identification and protection of the sources of aquifer recharge is essential (ASCE 2001).

Artificially induced precipitation is another water supply augmentation technique that, if harmfully practiced by one party, may affect the water available to the other party. The moisture suspended in the atmosphere is a natural resource. It has been estimated that only about 2% to 3% of the moisture in the atmosphere falls as natural precipitation (*Colorado Weather Modification Permit Program* 2002). Techniques to increase precipitation artificially have become increasingly more viable (ASCE 2006; Keyes 2006).

For effective water sharing, an understanding of the potential effects of such an inducement both within and outside of the shared resource in question is necessary (ASCE 2004b). A number of economic, environmental and ecological, social, and legal factors determine the acceptability of a cloud seeding program (Keyes 2006). A considerable amount of research has been conducted in the western United States on the potential environmental and ecological effects of cloud seeding projects (Reinking et al. 1995; Keyes 2006). Some of the more common concerns that could be addressed include toxicity of seeding materials (i.e., silver iodide), extension of the snowmelt in higher elevations, and increases in soil erosion. Published results from these projects indicate no significant effect from winter or summer projects. The parties to any agreement should recognize that the effects of artificially induced precipitation might extend

beyond the borders of the party boundaries, depending on the scale of the program to augment precipitation. Any party that augments precipitation within the basin might be entitled to full and exclusive use of additional water supplies resulting from such augmentation, if those supplies can be effectively measured, notwithstanding any other standard of allocation set forth in the agreement, as long as the downwind party is satisfied that the augmentation does not affect precipitation elsewhere in the shared water resource (Draper 2002b, 2006).

Interbasin transfer of water, long a fixture in the western United States, is an increasingly significant water augmentation technique in eastern states. In the international arena, Canada has passed legislation widely prohibiting interbasin transfers. Interbasin transfer with the Great Lakes as the basin of origin has been increasingly controversial as the Great Lakes states and provinces seek to define what might or might not be considered acceptable interbasin transfers (Draper 2004).

Interbasin transfer of water involves the withdrawal, diversion, or pumping of surface water from one river basin or the withdrawal of underground water from a point located within or beneath one river basin and release of all or any part of the water into a river basin different from the basin of origin (Draper 2004). The transfer of water to outside the boundaries of a river basin has effects on the water and other resources in the basin of origin and on the receiving basin. Such effects differ from those caused by uses of water within the same basin because the nonconsumed water may not be returned to the stream from which it is taken for further use in that river basin (Georgia JSC 2002). In a favorably configured basin that is well managed, most water supplies can be utilized a number of times as the water is withdrawn, used, and the nonconsumed water returned after treatment to the original water source. Water transferred by interbasin transfer is essentially fully consumed and unavailable for further use by those downstream in the basin of origin.

The parties should consider three aspects of interbasin transfer. The first is interbasin transfer to another basin outside the boundaries of the shared water resource. Such a transfer by one party diminishes the water available to some downstream parties by the elimination of returned flows into the shared basin of origin. The second aspect is transfer of water from a watershed within the shared water basin to another watershed within the shared water basin. Such a transfer definitely affects the water available to the downstream users in the watershed of origin. The third aspect is a transfer of water into the shared water basin. In this case, an importation of water from outside the basin may be excluded from the provisions set forth elsewhere in the agreement, and the party importing such water should have the right to full and complete use and consumption of such imported water, as determined by the party's internal laws (Draper 2002b, 2004). However, water quality issues may be significant. It has been claimed that interbasin transfers are not a "supply augmentation" but rather a reallocation that can be characterized as changes in use (Hall and Meral 2002).

Other water augmentation techniques include water reuse and desalination of seawater and brackish underground water (El-Naser 2001; Pankratz 2004). Water reuse involves water reclamation and the treatment of wastewater to make it reusable for other applications, such as irrigation, industrial cooling, washing, and specific environmental and ecological purposes (Basin Advisory Council 2002). In some cases, direct water reuse, for cultural or perceived public health reasons, cannot be used for municipal supply. However, by using reclaimed water for irrigated agriculture or industry, it can reduce the demands on present and future water supplies (El-Naser 2001). The primary

concern for the parties to a water sharing agreement is the scale and scope of water reuse by one of the parties, especially the upstream party. Because any reuse results in some percentage of the water being consumed and unavailable for further use downstream, the potential exists that this water augmentation technique, while augmenting the upstream party's available water, may reduce the water available to downstream users if such reuse is at a large enough scale. Desalination is an expensive augmentation technique, at least under current technology. In Toronto, the cost of traditional surface water withdrawal is approximately \$0.87/m<sup>3</sup>, whereas desalination costs are approximately \$8.00/m<sup>3</sup> (Zimmerman 2002). A primary reason for this cost differential has been reported as the concentrate disposal techniques used (Hightower 2004; Keyes 2007). This difference suggests that significant engineering advances must be made before the technique reaches its full potential. As desalination technology advances (Wiseburgh 2002), the technique will become a viable option, especially in those areas that experience increasing costs for water (Pankratz 2004).

### 3.4 ASSESSMENT OF WATER DEMANDS

The need for water reaches into all aspects of human life. The existence of life requires adequate supplies of clean water. Estimates of the human need for water to sustain a minimum acceptable quality of life range from 50 L/day to 100 L/day (Falkenmark and Lindh 1974; Gleick 1996). Food production for the world's expanding population depends largely on irrigation. Agriculture demand is estimated to account for 60–80% of water consumption worldwide (Postel 1993; Rothfeder 2001; Barlow and Clarke 2002). It requires approximately 3.0 liters (0.79 gallons) of water a day to grow the food for one person's nutritious but low-meat diet (de Villiers 2001). Beyond survival, adequate supplies of clean water are required for economic prosperity (Draper 2001). Water needs in the economic sector can be enormous. It requires almost 543,000 L (143,000 gal.) to produce

one ton of paper (Gleick 1993) and more than 150,000 L (40,000 gal.) to produce an automobile (Barlow and Clarke 2002; Gleick 1993). Global water withdrawal and use by industry has been estimated at 22% of withdrawals (World Bank 2001). Water is important for other aspects of the quality of life for the human species, as well. The demands for good public health, recreation, and a sustainable environment depend largely on adequate amounts of instream water being available (Draper 2001). Forty percent of the world's population and more than 90% of the people in the United States depend on waters shared with other states or countries to fulfill their water needs and demands (International Network of Basin Organizations 2002; Sea River 2002; Draper 2003).

### 3.5 SUMMARY

Effective water sharing is based on the ability to allocate reliable, or consistent, supplies of source water to fulfill the existing and future demands of the parties. Therefore, the parties should identify and document the type and geographical extent of the water resources to be subject to the agreement. This description should allow all appropriate and necessary parties within the geographic and/or political region to be included in the agreement and negotiation process. It also allows an analysis of the different water laws and policies of the parties to expose conflicts that may affect water sharing.

Having defined the hydrogeographic boundaries of the shared water resources, the parties may proceed to develop an accurate estimation of water supplies of sufficient quality that may be reliably available to meet the geographic and temporal demands within the shared water resources. Identification of existing demands for the shared waters is essential to enable estimates of future water demands. As with the assessment of water sources, it is important that the parties devote the human and financial resources to determine existing as well as future demands within the context of the agreement (Draper 2006).

## Chapter 4

# ADMINISTRATION OF AGREEMENTS

The importance of the administration and institutional provisions of the agreement cannot be overemphasized. The effectiveness of any agreement or law depends on how effectively it is administered and how rigorously its provisions are enforced. These institutional provisions involve far more than just hydrologic or engineering management of the water resources in question. They also involve establishing procedures to manage complicated coordination among a number of private and public institutions, addressing critical social issues, and responding to complex environmental and sustainability needs. The institutional provisions should provide for effective mechanisms for cooperation, coordination, and communication. These provisions should also establish a structure that resolves conflicts in a timely and cost-effective manner. Although no single legal model or approach to cooperation is appropriate for all or even most situations (*Berlin Recommendations for the International Roundtable on Transboundary Water Management* 1998), certain standards are appropriate for any water sharing institution.

### 4.1 THE CHALLENGE

Proper administration and management of shared water resources requires reconciling a variety of issues. Political issues are an important consideration. State and local government water management agencies may disagree among themselves on specific provisions because the agencies respond to different constituencies and interest groups that often diverge with respect to water needs. Not only may political issues divide agencies, constituencies, and interest groups horizontally (e.g., state agencies for agriculture, environmental and ecological protection, and industry and trade may disagree), but vertically as well (i.e., national, state, and local agencies may disagree). The administrative and institutional provisions should also address geographical issues that refer to the scale of the agreement: river basin, national subdivisions, national, regional, or global. There is little disagreement among experts that the appropriate administrative entity for international water sharing is the river basin (Gooch et al. 2003). Environmental and ecological issues should address integrated analysis of water, as well as biological and wildlife issues. Functional issues focus on consideration of diverse water use applications, such as urban water supply, wastewater management, navigation, and irrigation (Kliot and Shmueli 2001).

Because basins throughout the world exhibit a wide range of existing water resource issues and management institutions, no single type of coordinating institution is appropriate for all (Eaux partagées 2002). Without question, the specific water resource problem at hand should drive the institutional design. Water resource problems are customarily defined through the political process, but once the water resource problem has been defined, certain principles and practices guide institutional design to ensure that the solution to the problem is effective and permanent. A critical need is the active support and long-term commit-

ment on the part of top-level political leaders and representatives involved in the establishment of such an institution (Kliot and Shmueli 2001).

### 4.2 THE HISTORICAL RECORD OF INTERNATIONAL WATER SHARING INSTITUTIONS

Typically in the international context, water sharing agreements empower a joint agency that consists of national sections, each of which obtains funding from within its own government to cover the internal office, staff, printing, travel, and other administrative expenses (Hayton and Utton 1989; Dellapenna 1994; Killgore and Eaton 1995). Two different legal model institutions are highlighted.

**4.2.1 Coordination and Cooperation Agreements.** The *Treaty between the United States and Great Britain Relating to Boundary Waters* (1909), between Canada and the United States, has been offered as a good model for an international water sharing agreement (Nile Management Roundtable 2001). This model provides excellent “cooperation and coordination” capabilities that provide an umbrella under which agreements for specific projects may be created. The treaty manages transboundary water sharing issues across and along the longest undefended boundary between two countries in the world (Draper 2002b). The treaty established the International Joint Commission (IJC), whose mission is to prevent or resolve disputes by resolving issues between the two countries over boundary and transboundary waters and making recommendations about their management. Its authority is limited to boundary waters themselves, not to tributaries or waters lying wholly within one of the nations. However, the treaty provides a forum for subsidiary agreements that relate to a specific geographical area or specific problem. It sets forth a process and an administering body for future decision making with regard to issues of the defined transboundary water resources. It has been used over the past nine decades to successfully resolve more than 95% of the issues addressed under its jurisdiction. Key organizational features include six commissioners (three from each country) who make decisions by consensus, supported by small staffs in both countries and by boards and task forces composed of equal members from each country serving in their personal and professional capacity rather than as representatives of their countries or organizations and operating based on joint fact finding and consensus (Killgore and Eaton 1995).

**4.2.2 Comprehensive Agreements.** At the other extreme is the *Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin* (1995), which evolved from the 1957 adoption of the *Statute of the Committee for the Coordination of Investigations of the Lower Mekong Basin* by the four lower riparian states of Cambodia, Laos, South Vietnam, and Thailand (Radosovich and Olson 1999). The agreement’s original purpose

was cooperation and coordination with the intent of enlarging its mandate to encompass the development of tributaries and possibly mainstream projects. Because of the political instabilities over the ensuing decades, it was not until 1995 that the *Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin* was signed. The agreement created the Mekong River Commission (MRC), composed of three permanent bodies: the council, the joint committee, and the secretariat (Radosевич and Olson 1999). The council membership includes one member from each riparian state at the ministerial and cabinet level who is authorized to make policy decisions on behalf of his or her government. The joint committee membership includes one member from each riparian state who performs technical decision making for the commission. It oversees implementation of the policies and decisions of the council and supervises the secretariat. Subcommittees of the joint committee focus on three critical areas: the basin development plan, water allocation, and water quality. The secretariat provides technical and administrative services to the council and joint committee. A nonriparian CEO recommended by the joint committee and approved by the council directs the secretariat. Multilateral and bilateral donor agencies, primarily the United Nations Development Programme and the World Bank, provide grant funding for almost all of the MRC program and project costs; administrative costs are apportioned among member states (Radosевич and Olson 1999; Draper 2002b, 2007a).

**4.2.3 Analysis.** International water sharing agreements display large differences in administration because of different purposes, political influences, hydrology, and economic conditions, among other factors. However, the successful agreement between Israel and Jordan to share the Jordan River is due, in large part, to the establishment of a joint agency, the Joint Water Committee, which provides a forum for ongoing communication between the two parties (Dellapenna 1994, 1997a; McCaffrey 1997). That being said, though, simply providing a forum for ongoing communication by itself does not result in optimum water sharing (Albert 2000). A survey of the water sharing agreements in force in Africa suggests that three other principles, in addition to providing for a joint agency, are important for effective agreement to share international waters. First, agreements should be multipurpose rather than single purpose. Second, there should be shared financial responsibility and adequate funding for administration and enforcement. Finally, those agreements with joint research initiatives within the agreement, with the implied financial responsibility, seem to be more successful. This same study concluded that the principal problems to be faced when developing a joint agency for water sharing included

- (1) an overpoliticization of the institutions;
- (2) the tendency for proliferation of institutions that lead to duplications and increased financial requirements;
- (3) the distortion of economic needs with perceived political needs;
- (4) overcentralization of institutions and the stifling of public initiatives; and
- (5) financial mismanagement (Okidi 1997).

A different analysis of nine international water sharing agreements has noted, however, that a formal multipurpose joint development agency by itself does not ensure the effectiveness of a water sharing agreement. Other organizational principles should be applied to the formation of the administrative mechanism developed in the agreement. The Ganges has been noted as exemplifying the shortcomings of any unwillingness to cooperate in the whole basin (Kliot et al. 1998).

A recent study in Europe has reported similar criteria for effective water sharing agreements. This study listed five minimum requirements for the administration of a water sharing agreement:

- (1) The agreement should provide for an assembly (similar to a commission or council), composed of members appointed by the states and associated authorities, which elects its president, who may alternate among the members of each state.
- (2) A board of trustees to oversee the administration and enforcement of the agreement on a regular basis should be appointed.
- (3) A dispute resolution mechanism should be included.
- (4) The institution should include the formation of various working groups directed at the principal purposes of the agreement, and the groups should meet periodically in places set out in the agreement.
- (5) A permanent secretariat (commission or council) is essential. The agreement should set forth the role of each component of the structure as well as the rules for decision making, such as unanimity, majority, or qualified majority (Eaux partagées 2002).

These criteria find support in a previous study of the Mekong River Agreement (Radosевич and Olson 1999).

## 4.3 THE HISTORICAL RECORD OF U.S. WATER SHARING INSTITUTIONS

Within the United States, four institutional models have been used for interstate water sharing. The predominant administrative mechanism for action or coordination of interstate rivers and streams has been the interstate compact, a water sharing agreement between states without active federal participation, or federal participation at the technical level only (Grant 2001). A second mechanism is the federal–interstate compact, an agreement between states that includes active federal participation. A third form, federal administration of shared waters without specific state involvement, has been used in two instances (U.S. Army Corps of Engineers 1999). Finally, a fourth mechanism, the Title II river basin planning commission, was introduced beginning in 1965, but federal funding ended in 1981 (Wade et al. 1994). The model is presently in disfavor because it failed to achieve their objectives in the past, primarily because of reluctance by the states and federal agencies to provide sufficient authority to the river basin commissions to accomplish their missions (Eisel and Aiken 1997).

**4.3.1 Interstate Compacts.** Interstate compacts administer the shared waters according to agreement among the riparian states. These water sharing mechanisms are contracts among the states themselves. Unless the agreement is so inconsequential that it does not encroach upon federal authority, the compact should have the consent of the U.S. Congress (*Virginia v. Tennessee* 1893; Sundeen and Runyon 1998). The federal government, though not a signatory, may assist the states in the development and operation of the compact. The decision making is normally made with a commission whose members are usually the state governors or their representatives; each state has one vote. The rules of decision typically require unanimity. Although the federal government does not have voting powers in the operational decisions of the compact, it has veto power where federal interests exist. An interstate compact is a contract enforceable in the U.S. Supreme Court by specific performance and by damage awards (DuMars 1990; McCormick 1994a, b).

Although an interstate compact may serve a “wide range of functions (U.S. Army Corps of Engineers 1999), usually the purpose of the compact is specific because the formation of the compact occurs only when the need exists for an urgent solution to a specific problem. Normally, interstate compacts do not create mechanisms for the actual management of water sources or for allocation of water among particular users. Rather, the agreement allocates the shared water between and among the states that then allocate water to specific uses and users. The effectiveness of interstate compacts, at least with regard to drought, is “predicated on having well-publicized plans and rules for planning purposes” (Walker et al. 1991). Although there are exceptions, the determination of whether an interstate compact formed under water scarcity conditions is successful seems to turn on whether the compact provides an active mechanism for compact administration and whether a dispute resolution mechanism exists (Draper 2006, 2007a).

Among interstate compacts that have no active administration, the 1943 *Republican River Compact* is a good example. The compact originally provided only that “it shall be the duty of the three states to administer the compact.” Such an absence of active administration proved unworkable. The states subsequently found it necessary to create a Republican River Compact Administration to manage compact issues (McCormick 1994b). Because no dispute resolution mechanism exists within the compact, it would appear that absent an informal agreement among the parties, the only recourse is the U.S. Supreme Court. The most significant issue relates to underground water pumping and its effect on river flows, but the issue was not explicitly addressed in the compact (McCormick 1994b). A similar situation of no active compact administration exists with the ongoing dispute among Alabama, Florida, and Georgia. A compact has been signed and ratified by each state pending an agreement on an allocation formula for the Apalachicola–Chattahoochee–Flint rivers. Although the compact creates a commission of the three governors, neither an active administrative mechanism nor a dispute resolution mechanism exists. The 1923 *South Platte River Compact* likewise established no administrative or dispute resolution mechanism and has the potential for protracted litigation since irrigation demand exceeds supply (Draper 2007a).

The 1955 *Bear River Compact* is similar, having no active administration or dispute resolution mechanism, although the fact that unanimity is not the rule in decision making minimizes disputes. Also, this compact explicitly contained a provision requiring review and possible revision at no less than 20-year intervals. The success of this compact can be traced to these compact characteristics and the fact that the compact is limited to division of rights to flowing water and storage among users (Draper 2006, 2007a).

**4.3.2 Federal–Interstate Compacts.** Federal–interstate compacts are similar to interstate compacts with the exception that the water sharing agreement is between the riparian states themselves and the federal government, in equal partnership. The exercise of federal powers is subject to the terms and conditions of the compact and the authority of any compact-created commission or agency (Wade et al. 1994; Dellapenna 2001b). Two instances of the federal–interstate compact exist: the *Delaware River Basin Compact* (1961) and the *Susquehanna River Basin Compact* (1970). These compacts provide for multijurisdictional commissions to manage water sources with authority to allocate water among particular users during times of shortage (Dellapenna 2001b). In granting its consent to these compacts, Congress included reservations to prevent impairment of future exercise of federal power and avoid future limitations on

congressional power to pass laws inconsistent with the provisions of either compact (U.S. Army Corps of Engineers 1999).

The *Delaware River Basin Compact* (1961) involves the states of Delaware, New Jersey, New York, and Pennsylvania, and the *Susquehanna River Basin Compact* (1970) involves New York, Maryland, and Pennsylvania. Each compact creates a regional entity composed of the governor of each of the involved states and one member appointed by the president of the United States. Each member is entitled to one vote, and no action may be taken unless a majority is present and votes in favor of the proposal. The jurisdiction of the commissions is limited to the geographical boundaries of the basins. The compacts provide the commissions with regulatory authority and responsibilities relating to water supply, pollution control, flood protection, watershed management, recreation, hydroelectric power, regulation of withdrawals and diversions, intergovernmental relations, capital financing, and planning and budgeting. The commission can regulate individual water users within the basins if necessary to accomplish their responsibilities. The compacts provide the commissions with power to allocate the waters of the basins among the signatory states and to impose conditions, obligations, and release requirements (Wade et al. 1994; Dellapenna 2001a). A unique feature is the compacts’ power to allocate the waters of their respective basins among the signatory states in accordance with the U.S. Supreme Court’s doctrine of equitable apportionment (Muys 2001).

Analysis of the federal–interstate legal model suggests that it can be effective in maximizing the benefits of the waters of the basin when all parties are in agreement. According to some commentators, however, several issues have limited the full potential of the Delaware River Basin Commission (DRBC). These issues relate primarily to the lack of a sufficiently strong commitment by the federal representative and the federal agencies to the compact objectives, as well as noncompliance by the federal government regarding its financial commitment (Muys 2001). Because no DRBC provision provides the commission with alternate means to generate sufficient operating funds, this lack of federal funding has a significant impact on the effectiveness of the compact (Bush 2004).

This model does require the individual parties to cede a significant amount of their authority and control over internal waters to decision makers who are not directly accountable to the state governments, possibly making the development of individual economic and environmental and ecological plans and programs difficult.

**4.3.3 Federal Administration of Shared Waters.** Federal administration of river basins provides management of shared waters without state participation. Two instances of this model have been applied in the United States. These instances are the extensive federal management of the Tennessee River and of the Colorado River. The Tennessee Valley Authority (TVA) was created as a federal regional agency to operate a basinwide system of dams and reservoirs to (1) control flooding along the Tennessee River and its major tributaries, (2) maintain navigation depths on rivers, and (3) generate power (TVA 1933). Its mandate has since been broadened to include pollution control and provision of recreational opportunities (Freeman and Lesesne 1980). The TVA is governed by a board of directors, composed of three members appointed to overlapping nine-year terms by the president of the United States, with confirmation by the Senate. The board of directors appoints a general manager, who operates as the administrative head of the corporate agency, with general policy direction supplied by the board (TVA 1933). The TVA is structured hierarchically, with the board of directors over

the office of the general manager, which in turn oversees seven offices: general counsel, agricultural and chemical development, power, engineering design and construction, natural resources, community development, and management services. The powers given to the TVA are considerable, in keeping with their mandate for planning and operations of navigation, flood control, and hydropower facilities, as well as responsibilities for water quality and multipurpose reservoir operations (Freeman and Lesesne 1980). Essentially, the TVA provides comprehensive water management of the entire river basin without state involvement (other than political) (TVA 1933).

The second form of exclusively federal management of interstate water resources is the single federal administrator, used for allocation of the waters of the Colorado River Basin. The U.S. Secretary of the Interior on a yearly basis allocates the waters of the Colorado River to the riparian states, as stipulated in the *Colorado River Basin Project Act* of 1956 and the *Colorado Project Act* of 1968 as well as the *Colorado River Compact* (1928; Anderson 2002). The U.S. Bureau of Reclamation (USBR) manages the allocation program (Carter and Morehouse 2001). The USBR operates eight dams on the Lower Colorado River and bases the allocation on a reservoir routing analysis of the discharge from two federal projects, the Glen Canyon Dam and the Hoover Dam. The allocation to the states is based on (1) the amount of water already in storage; (2) the anticipated releases for various uses, such as hydroelectric power generation; and (3) the need to equalize storage behind the two dams (Carter and Morehouse 2001). The seven Colorado River Basin states and other stakeholders are consulted (Anderson 2002). The Lower Colorado Basin (Arizona, California, and Nevada) is managed according to strict adherence to inflexible rules, primarily because of continuing tensions among the three Lower Basin States and because portions of the river below Lake Mead are relatively heavily populated (Pagano et al. 1999). Within the Upper Colorado Basin (Colorado, New Mexico, Utah, and Wyoming), however, the USBR operates the reservoirs under an adaptive management approach that emphasizes monitoring the effects of allocations on the environment, followed by adjustments to reflect the findings of such monitoring.

Analysis of this single federal administrator model suggests that it does not lead to efficient and equitable resource allocation because it does not provide for appropriate representation and participation of all major affected interests. It does not facilitate communication and bargaining among states to adopt and implement operating rules that resolve conflict (Lord et al. 1995).

**4.3.4 Title II River Basin Planning Commissions.** Title II river basin planning commissions provide passive management of shared waters under authority of Congress. River basin planning commissions were established under the authority of Title II of the *Water Resources Planning Act of 1965* (subsequently repealed in 1981). Although no longer authorized, lessons may be learned from a consideration of the strengths and weaknesses of the Title II model.

The 1965 act established the Water Resources Council, composed of the U.S. Secretary of the Interior; the U.S. Secretary of Agriculture; the U.S. Secretary of the Army; the U.S. Secretary of Health, Education, and Welfare; and the chair of the Federal Power Commission. It also established planning commissions composed of federal and state representatives with equal voting power for the Missouri, New England, Great Lakes, Ohio, Columbia, and Upper Mississippi regions or river basins. The council, among other things, reviewed plans from comprehensive regional or river basin commissions and established the principles, standards, and procedures for federal participants in

those plans. The river basin planning commissions were responsible for coordinating federal, state, interstate, local, and nongovernmental plans for development of a comprehensive plan for all federal, state, interstate, local, and nongovernmental development of water and related land resources. The planning commissions developed recommendations for long-range schedules of priorities for data collection and analysis, planned for specific projects, and undertook studies of water necessary in the preparation of the comprehensive plan (Draper 2006).

The chair for each river basin commission was appointed by the president of the United States to serve as the representative of the federal government and coordinator for federal members of the commission. Commissioners included one member appointed by each state, one member appointed by any interstate agency created by an interstate compact with jurisdiction in the area, a representative for Native American tribes within the region or basin, and an international representative, when appropriate. Commission actions required the consensus of all members. Significantly, however, its decisions were not binding to the participants. This aspect necessarily hindered the effectiveness of the river basin commissions.

The planning commission's authority was limited primarily to passive powers: planning, internal administrative, and operational functions. The planning functions of the Title II commissions varied, although most included preparing and updating a comprehensive plan for water and related land resources development within the basin (U.S. Army Corps of Engineers 1999). For example, the New England Commission focused on power plant siting, coastal zone coordination, and nonstructural flood control, whereas the Upper Mississippi Commission was specifically oriented toward navigation improvements, among other elements (Mitchell 1990). Commission expenses were shared among federal and state members. Each commission recommended what portion of expenses should be borne by the federal government, subject to approval by the Water Resources Council. The commissions were responsible for apportioning the remainder of the commission's expenses among the various members (Mitchell 1990). The *Water Resources Planning Act* (1995) also authorized appropriations for the council and for financial assistance to the states in the form of grants to assist states to participate in the development of comprehensive water and related land resource plans. The basis for allotments to the states included evaluation of several factors, including population, land area, the need for comprehensive water and related land resource planning programs, and the financial needs of the respective states (Mitchell 1990). As noted, this legal model was abandoned in 1981 by U.S. presidential executive order.

## 4.4 ORGANIZATIONAL DESIGN PRINCIPLES

The design of the institution should consider each of the following characteristics: interdisciplinary analysis, legal basis, political validity and equitable participation, financial viability, implementation and enforcement competence, stakeholder involvement, and adaptability.

**4.4.1 Interdisciplinary Analysis.** Regardless of the institutional framework, it is clear that no single discipline—neither law, nor economics, nor engineering—provides all of the answers for resolving water disputes (Wolf 1998; Draper 2001).

**4.4.2 Legal Basis.** The institution should possess adequate legal authority to cope with the problem (Dellapenna 1994; Eheart 2002). In the United States, the legal basis of interstate compacts, including ratification by state legislators and consent by the U.S. Congress, provides legitimacy for the institution as

it fulfills its responsibilities and authorities. In the international arena, legitimacy may be established by the acknowledgment of and consent to the agreement by the national governments and by any regional government involved (Draper 2006, 2007a).

**4.4.3 Political Validity and Equitable Participation.** The institution should be validated by a political consensus among the parties involved, as well as by the nongovernment organizations representing the various private stakeholders (Kakebeeke et al. 2000). “The issue with many water institutions is their failure to adequately address issues of equity” (Gleick 1998). The institutional provisions should be constructed through a bottom-up planning process that includes the balancing of the interests of all possible stakeholders. The process should be able to ensure equitable treatment of all interests involved with or affected by the agreement. Mechanisms should exist for equitable participation, including participation by politically weak stakeholders and consideration of ecosystems and future generations (Draper 2006, 2007a).

**4.4.4 Financial Viability.** The agreement, or the cooperating parties themselves, should provide financial capability to perform the authorities and responsibilities outlined in the agreement (ARCADUS 2001; *Berlin Recommendations for the International Roundtable on Transboundary Water Management* 1998). The role of the private sector, or public-private partnerships, should be considered when appropriate (Draper 2001). This consideration is especially critical when a disparity in the financial capabilities of the individual parties exists. Unequal financial resources available for data collection, hydrologic modeling, human resources, and other items may destroy the effectiveness of the agreement. It may be necessary for one party to subsidize another, or the institution itself could be charged with data collection, financed as appropriately befits the needs and benefits accruing to the individual parties (Draper 2006, 2007a).

**4.4.5 Implementation and Enforcement Competence.** The institution should be structured to ensure that implementation of the agreement is feasible, efficient, and effective. The parties should provide the means for resolving intra- and interagency, intra- and interstate, and international conflicts. At the political level, policy decision-making mechanisms should be included in the agreement that satisfy, or at least acknowledge, all political viewpoints associated with the potential problems. At the environmental and functional levels, the institution should possess management capacity and institutional culture consistent with problem solving (Dellapenna 1994).

**4.4.6 Stakeholder Involvement.** A top-down administrative mechanism is not conducive to effective water allocation, and all relevant stakeholders should be involved in the decision-making process (Olem and Duda 1995; Fort 1998; Bandaragoda 2000; Kakebeeke et al. 2000; Lubell 2000; Planning and Management Consultants 2000; World Commission on Dams 2000; Gooch et al. 2003). These stakeholders should include governmental and nongovernmental organizations, as well as private stakeholders (Fort 1998; German Foundation for International Development 1998; Barlow and Clarke 2002). Public education programs should be developed to create awareness, shape public attitudes, and drive behavior change (Bandaragoda 2000; Draper 2001).

**4.4.7 Adaptability.** Just as the agreement should be adaptable to conform to changing economic, hydrologic, environmental, and ecological conditions, so should the institutional framework to administer the agreement be adaptable to changing institu-

tional needs (Draper 1997, 2002a, 2004, 2007a; Bandaragoda 2000).

## 4.5 CHOICES IN INSTITUTIONAL DESIGN

The choice of institutional framework requires detailed consideration. The long-term success of commissions should be based on the careful design of management structures that provide for effective planning and management, allow administrators and technical staff to operate efficiently, and are cost-effective (Dellapenna 1994; German Foundation for International Development 1998).

**4.5.1 Purpose and Objectives.** The purpose and objectives of the institution itself should be clearly and effectively defined and described since they will determine the powers assigned to and authorized for the institution. They may involve either passive or “soft” administration of the agreement, or they may involve active or “hard” management (Derthick 1974; Teclaff 1987).

Passive administrative objectives are those that require little or no substantive decision making by the institution. Such activities include but are not limited to collecting, correlating, and reporting data and information; maintaining records; advising decision makers; providing independent research and/or analysis; coordinating and cooperating in studies; and investigating alleged violations (Draper 2007a).

In addition to these passive management objectives, active administrative objectives include those activities involving substantive decision making. Such activities include but are not limited to planning, developing projects, operating and maintaining facilities, formulating and implementing regulations, and taking remedial action for violations (Draper 2006, 2007a).

**4.5.2 Rules of Decision.** The rules of decision include the membership of the decision-making body, the levels of decision making, and, when appropriate, the voting rules. The agreement should carefully define membership in the substantive decision-making bodies (Dellapenna 1994). Normally the agreement designates specific representatives of the signatory parties who may modify and interpret the agreement itself. The nature of the membership and/or representatives changes depending on the purpose and scope of the agreement. The model water sharing agreements provide typical examples (Draper 2007a).

The agreement should also describe when unanimity, consensus, or majority voting is applicable (Dellapenna 1994; McCormick 1994a). The agreement may delegate other substantive decisions to the institution designed to manage the agreement. The rules of decision should provide for adequate consideration of the interests of all stakeholders (Roll and Lopman 2001). Several options exist for the voting process for decision makers. Many existing water sharing agreements provide for making decisions informally through consensus. Discussions during the consensus-building process often prevent disputes that might arise from lack of information or misunderstandings. Rules that require unanimity effectively give one party a veto in any decisions, but unanimous voting may be the only politically feasible option for certain decisions. Decisions requiring nonunanimous votes can be extremely effective for decisions that are not politically sensitive or those involving technical matters. The rules of decision can call for a simple majority or some higher percentage (Dellapenna 1994).

**4.5.3 Powers and Duties.** The agreement should describe in detail the powers authorized for and the duties assigned to the institution. In addition to the concern for whether the institution should have a passive or active management style, the agreement