CHAPTER 1

Introduction

The world's population is expected to increase dramatically between now and the year 2020 - and with this growth will come an increased need for water to meet various needs, as well as an increased production of wastewater. Many communities throughout the world are approaching, or have already reached, the limits of their available water supplies; water reclamation and reuse have almost become necessary for conserving and extending available water supplies. Water reuse may also present communities with an alternate wastewater disposal method as well as provide pollution abatement by diverting effluent discharge away from sensitive surface waters. Already accepted and endorsed by the public in many urban and agricultural areas, properly implemented nonpotable reuse projects can help communities meet water demand and supply challenges without any known significant health risks.

1.1 Objectives of the Guidelines

Water reclamation for nonpotable reuse has been adopted in the U.S. and elsewhere without the benefit of national or international guidelines or standards. Twenty-five states currently have regulations regarding water reuse. The World Health Organization (WHO) guidelines for agricultural irrigation reuse (dated 1989) are under revision (World Health Organization Website, 2003).

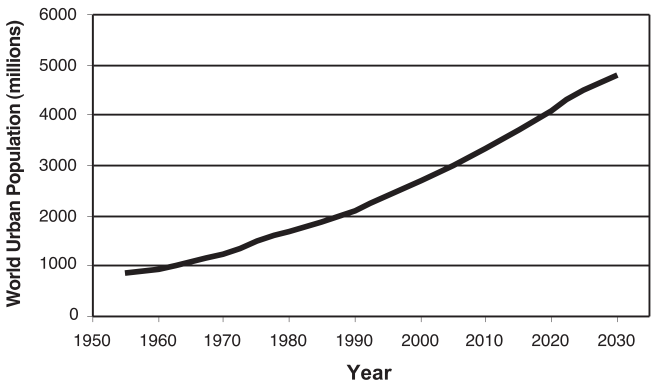
The primary purpose of the 2004 EPA *Guidelines for Water Reuse* is to present and summarize water reuse guidelines, with supporting information, for the benefit of utilities and regulatory agencies, particularly in the U.S. The *Guidelines* cover water reclamation for nonpotable urban, industrial, and agricultural reuse, as well as augmentation of potable water supplies through indirect reuse. Direct potable reuse is also covered, although only briefly since it is not practiced in the U.S. Please note that the statutes and regulations described in this document may contain legally binding requirements. The summaries of those laws provided here, as well as the approaches suggested in this document, do not substitute for those statutes or regulations, nor are these guidelines themselves any kind of regulation. <u>In addition, neither the U.S. Environmental Protection Agency (EPA) nor the U.S. Agency for International Development (USAID) proposes standards for water reuse in this publication or any other</u>. This document is intended to be solely informational and does not impose legally-binding requirements on EPA, states, local or tribal governments, or members of the public. Any EPA decisions regarding a particular water reuse project will be made based on the applicable statutes and regulations. EPA will continue to review and update these guidelines as necessary and appropriate.

In states where standards do not exist or are being revised or expanded, the *Guidelines* can assist in developing reuse programs and appropriate regulations. The *Guidelines* will also be useful to consulting engineers and others involved in the evaluation, planning, design, operation, or management of water reclamation and reuse facilities. In addition, an extensive chapter on international reuse is included to provide background information and discussion of relevant water reuse issues for authorities in other countries where reuse is being planned, developed, and implemented. In the U.S., water reclamation and reuse standards are the responsibility of state agencies.

1.2 Water Demands and Reuse

Growing urbanization in water-scarce areas of the world exacerbates the situation of increasing water demands for domestic, industrial, commercial, and agricultural purposes. **Figure 1-1** demonstrates the rapid growth rate of the urban population worldwide. In the year 2000, 2.85 billion people (out of a worldwide population of 6.06 billion) were living in urban regions (United Nations Secretariat, 2001). This increasing urban population results in a growing water demand to meet domestic, commercial, industrial, and agricultural needs. Coupled with depleting fresh water sources, utility directors and managers are faced with the challenge to supply water to a growing customer base.

Figure 1-1 Estimated and Projected Urban Population in the World



Adapted from: United Nations Secretariat, 2001.

The U.S. Bureau of Reclamation is developing a program, Water 2025, to focus attention on the emerging need for water. Explosive population growth in urban areas of the western U.S., along with a growing demand for available water supplies for environmental and recreational uses, is conflicting with the national dependence on water for the production of food and fiber from western farms and ranches (Department of the Interior/Bureau of Reclamation, 2003). The goals of Water 2025 are to:

- Facilitate a more forward-looking focus on water-starved areas of the country
- Help stretch or increase water supplies, satisfy the demands of growing populations, protect environmental needs, and strengthen regional, tribal, and local economies
- Provide added environmental benefits to many watersheds, rivers, and streams
- Minimize water crises in critical watersheds by improving the environment and addressing the effects of drought on important economies
- Provide a balanced, practical approach to water management for the next century

Meanwhile, water reuse in the U.S. is a large and growing practice. An estimated 1.7 billion gallons (6.4 million m^3) per day of wastewater is reused, and reclaimed water use on a volume basis is growing at an estimated 15 percent per year. In 2002, Florida reclaimed 584 mgd (2.2×10^6 m^3) of its wastewater while California ranked a close second, with an estimated total of 525 mgd (2.0×10^6 m^3) of reclaimed water used each day. Florida has an official goal of reclaiming 1 billion gallons per day by the year 2010. Likewise, California has a statutory goal of doubling its current use by 2010. Texas currently reuses approximately 230 mgd (8.7×10^5 m^3) and Arizona reuses an estimated 200 mgd (7.6×10^5 m^3). While these 4 states account for the majority of the water reuse in the U.S., several other states have growing water reuse programs including Nevada, Colorado, Georgia, North Carolina, Virginia, and Washington. At least 27 states now have water reclamation facilities, and the majority of states have regulations dealing with water reuse (Gritzuk, 2003).

1.3 Source Substitution

Under the broad definition of water reclamation and reuse, sources of reclaimed water may range from industrial process waters to the tail waters of agricultural irrigation systems. For the purposes of these *Guidelines*, however, the sources of reclaimed water are limited to the effluent generated by domestic wastewater treatment facilities (WWTFs).

The use of reclaimed water for nonpotable purposes offers the potential for exploiting a “new” resource that can be substituted for existing potable sources. This idea, known as “source substitution” is not new. In fact, the United Nations Economic and Social Council enunciated a policy in 1958 that, “No higher quality water, unless there is a surplus of it, should be used for a purpose that can tolerate a lower grade.” Many urban, commercial, and industrial uses can be met with water of less than potable water quality. With respect to potable water sources, EPA policy states, “Because of human frailties associated with protection, priority should be given to selection of the purest source” (EPA, 1976). Therefore, when the demand exceeds the capacity of the purest source, and additional sources are unavailable or available only at a high cost, lower quality water can be substituted to serve the nonpotable purposes. Since few areas enjoy a surplus of high quality water, and demand often exceeds capacity, many urban residential, commercial, and industrial uses can be satisfied with water of less than potable water quality. In many instances, treated wastewater may provide the most economical and/or available substitute source for such uses as irrigation of lawns, parks, roadway borders, and medians; air conditioning and industrial cooling towers; stack gas scrubbing; industrial processing; toilet flushing; dust control and construction; cleaning and maintenance, including vehicle washing; scenic waters and fountains; and environmental and recreational purposes.

The economics of source substitution with reclaimed water are site-specific and dependent on the marginal costs of new sources of high-quality water and the costs of wastewater treatment and disposal. Understandably, the construction of reclaimed water transmission and distribution lines to existing users in large cities is expensive and disruptive. As a result, wastewater reclamation and reuse will continue to be most attractive in serving new residential, commercial, and industrial areas of a city, where the installation of dual distribution systems would be far more economical than in already developed areas.

Use of reclaimed water for agricultural purposes near urban areas can also be economically attractive. Agricultural users are usually willing to make long-term commitments, often for as long as 20 years, to use large quantities of reclaimed water instead of fresh water sources. One potential scenario is to develop a new reclaimed water system to serve agricultural needs outside the city with the expectation that when urban development replaces agricultural lands in time, reclaimed water use can be shifted from agricultural to new urban development.

1.4 Pollution Abatement

While the need for additional water supply in arid and semi-arid areas has been the impetus for numerous water reclamation and reuse programs, many programs in the U.S. were initiated in response to rigorous and costly requirements to remove nitrogen and phosphorus for effluent discharge to surface waters. By eliminating effluent discharges for all or even a portion of the year through water reuse, a municipality may be able to avoid or reduce the need for the costly nutrient removal treatment processes. For example, the South Bay Water Recycling Project in San Jose, California, provides reclaimed water to 1.3 million area residents. By reusing this water instead of releasing it to the San Francisco Bay, San Jose has avoided a sewer moratorium that would have had a devastating impact on the Silicon Valley economy (Gritzuk, 2003).

The purposes and practices may differ between water reuse programs developed strictly for pollution abatement and those developed for water resources or conservation benefits. When systems are developed chiefly for the purpose of land treatment or disposal, the objective is to treat and/or dispose of as much effluent on as little land as possible; thus, application rates are often greater than irrigation demands. On the other hand, when the reclaimed water is considered a valuable resource (i.e., an alternative water supply), the objective is to apply the water according to irrigation needs.

Differences are also apparent in the distribution of reclaimed water for these different purposes. Where disposal is the objective, meters are difficult to justify, and reclaimed water is often distributed at a flat rate or at minimal cost to the users. However, where reclaimed water is intended to be used as a water resource, metering is appropriate to provide an equitable method for distributing the resource, limiting overuse, and recovering costs. In St. Petersburg, Florida, disposal was the original objective; however, over time the reclaimed water became an important resource. Meters, which were not provided initially, are being considered to prevent wasting of the reclaimed water.

1.5 Treatment and Water Quality Considerations

Water reclamation and nonpotable reuse typically require conventional water and wastewater treatment technologies that are already widely practiced and readily available in many countries throughout the world. When discussing treatment for a reuse system, the overriding concern continues to be whether the quality of the reclaimed water is appropriate for the intended use. Higher level uses, such as irrigation of public-access lands or vegetables to be consumed without processing, require a higher level of wastewater treatment and reliability prior to reuse than will lower level uses, such as irrigation of forage crops and pasture. For example, in urban settings, where there is a high potential for human exposure to reclaimed water used for landscape irrigation, industrial purposes, and toilet flushing, the reclaimed water must be clear, colorless, and odorless to ensure that it is aesthetically acceptable to the users and the public at large, as well as to assure minimum health risk. Experience has shown that facilities producing secondary effluent can become water reclamation plants with the addition of filtration and enhanced disinfection processes.

A majority of the states have published treatment standards or guidelines for one or more types of water reuse. Some of these states require specific treatment processes; others impose effluent quality criteria, and some require both. Many states also include requirements for treatment reliability to prevent the distribution of any reclaimed water that may not be adequately treated because of a process upset, power outage, or equipment failure. Dual distribution systems (i.e., reclaimed water distribution systems that parallel a potable water system) must also incorporate safeguards to prevent cross-connections of reclaimed water and potable water lines and the misuse of reclaimed water. For example, piping, valves, and hydrants are marked or color-coded (e.g. purple pipe) to differentiate reclaimed water from potable water. Backflow prevention devices are installed, and hose bibs on reclaimed water lines may be prohibited to preclude the likelihood of incidental human misuse. A strict industrial pretreatment program is also necessary to ensure the reliability of the biological treatment process by excluding the discharge of potentially toxic levels of pollutants to the sanitary sewer system. Wastewater treatment facilities receiving substantial amounts of high-strength industrial wastes may be limited in the number and type of suitable reuse applications.

1.6 Overview of the Guidelines

This document, the *Guidelines for Water Reuse,* is an update of the *Guidelines for Water Reuse* developed for EPA by Camp Dresser & McKee Inc. (CDM) and published by EPA in 1992 (and initially in 1980). In May 2002, EPA contracted with CDM through a Cooperative Research and Development Agreement (CRADA) to update the EPA/USAID *Guidelines for Water Reuse* (EPA/625/R-92/004: Sept 1992). As with the 1992 *Guidelines*, a committee, made up of national and international experts in the field of water reclamation and related subjects, was established to develop new text, update case studies, and review interim drafts of the document. However, unlike the 1992 version, the author and reviewer base was greatly expanded to include approximately 75 contributing authors and an additional 50 reviewers. Major efforts associated with the revisions to this edition of the *Guidelines* include:

- Updating the state reuse regulations matrix and adding a list of state contacts
- Updating U.S. Geological Survey (USGS) information on national water use and reuse practices
- Expanding coverage of indirect potable reuse issues, emphasizing the results of recent studies and practices associated with using reclaimed water to augment potable supplies
- Expanding coverage of industrial reuse issues
- Expanding coverage of reuse projects and practices outside of the U.S
- Adding more case studies to illustrate experience in all areas of water reclamation
- Expanding the discussion of health issues to include emerging chemicals and pathogens
- Updating the discussion of treatment technologies applicable to water reclamation
- Updating information on economics, user rates, and project funding mechanisms

The document has been arranged by topic, devoting separate chapters to each of the key technical, financial, legal and institutional, and public involvement issues that a reuse planner might face. A separate chapter has also been provided to discuss reuse applications outside of the U.S. These chapters are:

- **Chapter 2, Types of Reuse Applications** – A discussion of reuse for urban, industrial, agricultural, recreational and habitat restoration/enhancement, groundwater recharge, and augmentation of potable supplies. Direct potable reuse is also briefly discussed.
- **Chapter 3, Technical Issues in Planning Water Reuse Systems –** An overview of the potential uses of reclaimed water, the sources of reclaimed water, treatment requirements, seasonal storage requirements, supplemental system facilities (including conveyance and distribution), operational storage, and alternative disposal systems.
- **Chapter 4, Water Reuse Regulations and Guidelines in the U.S.** – A summary of existing state standards and regulations as well as recommended guidelines.
- **Chapter 5, Legal and Institutional Issues** – An overview of reuse ordinances, user agreements, water rights, franchise law, and case law.
- **Chapter 6, Funding Water Reuse Systems** – A discussion of funding and cost recovery options for reuse system construction and operation, as well as management issues for utilities.
- **Chapter 7, Public Involvement Programs** – An outline of strategies for educating and involving the public in water reuse system planning and reclaimed water use.
- **Chapter 8, Water Reuse Outside the U.S.** – A summary of the issues facing reuse planners outside of the U.S., as well as a comprehensive review of the variety of reuse projects and systems around the world.

1.7 References

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