Appendix A Clarification of Project Objectives and Scope

In clarification of this goal, the ALA representative emphasized the fact that potable water utilities have systems whose components have extremely varying degrees of operational importance. (Kickoff meeting, 8/31/01) Natural disasters test this operational importance. Some components, such as a solo water treatment plant or a single water conveyance facility may have extreme operational importance. Other components, such as a water distribution reservoir, may if damaged in a natural disaster be supplemented by other distribution reservoirs or other means of providing adequate water flows and pressures. System redundancy—important for normal operations and maintenance—can become extremely critical in the response to natural disasters.

Given the paramount significance in this document of treating water components as part of systems, Mr. Honegger stated further that this document is to serve as a vehicle for a Standards Developing Organization (SDO) in order to develop a variance to existing codes and standards. (8/31/01) To elaborate on this idea, one may consider most codes and standards developed for water system components as (a) treating each component on a site-specific basis rather than as part of a geographically spread system and (b) at best employing a subjective notion of importance in order to take into account extreme variations in the importance of water utility components. This subjective notion of importance typically evaluates the importance of specific facilities in terms of the "kind" or "type" of facility (e.g., all water distribution reservoirs are subjectively treated as one kind, and so as being equally important). In contrast, this document will (a) stress the operational or systematic nature of components within water systems and hence (b) will provide guidelines for the objective evaluation of the operational importance of individual water system components.

Those who are intimately acquainted with a water utility system, such as its management and technical staff, have a better grasp of the operational importance of its individual components than do code-developers. Better yet, through a formal evaluation of the water system, the operational importance of its components can be clarified. Such a formal evaluation will by and large confirm the intuitions of those intimately acquainted with the system.

Appendix B Defining the Water Utility System at Risk

B.1 Introduction

This appendix provides a commentary on Chapter 2 of Volume I: Defining the Water System at Risk. In this appendix, discussed are:

- information and display technologies (B2)
- an illustrative water utility system (B3), and
- further considerations on hydraulic modeling (B4)

B.2 Information and Display Technologies

Information technologies exist (and continue to evolve) for compiling and displaying water systems. This document does not recommend that such information and display technologies are essential as opposed to being desirable. However, some of the pros and cons of available technologies can be succinctly stated.

Geographic Information Systems (GIS) and Computer-Aided Drafting (CAD) systems (e.g., ArcInfo, MapInfo, AutoCad) have become a key tool for water transmission and distribution system inventory, especially for larger agencies. These systems replace manual drawings, and there are significant costs involved in converting from manually-drafted drawings to an integrated electronic representation of piping systems, major plant structures and equipment. Design documents for new buildings and equipment are often maintained on CAD systems.

The evaluation of risks to water systems from natural hazards risk is greatly facilitated when water agency inventory data is well maintained using information technologies. GIS systems permit the overlay of piping systems with various geologic and topographic conditions, and so are very useful in natural hazard risk assessment. GIS representations of the water system facilitate hydraulic analysis in common software (e.g., WaterCad, H2ONet).

B.3 An Illustrative System

The Basics of the Hypothetical System

For purposes of illustrating the general inventory process, Figure 1 provides a hypothetical water system that contains virtually all of the major types of components of interest.

The water system in Figure 1 contains two basic raw water sources, from a river and from runoff from snow-pack and mountain streams. Penstocks, canals, and aqueducts convey the raw water from the mountain streams to a water treatment plant. A tunnel could be included for some systems. Intake piping conveys the raw water from the river to a second water treatment plant.

A third source of water is a groundwater well. The system contains booster pump stations and a distribution storage reservoir. Such a sub-system in a water system might be called a "pump-tank" sub-system. Treated water moves though transmission piping to distribution piping and finally into service connections and fire hydrants.

The water system in Figure 1 should not be regarded as being separate from other infrastructure systems: wastewater, electric power, communications, and roadways and highways. The interdependence of these systems is a key element to consider in the analysis of water system function following many of the natural hazards considered in these guidelines. Moreover, there may be many sources of contaminants found in such a system that may pose special water quality problems after natural disasters.

Basic Components Listed

Basic components of interest (with photographic examples referenced in parenthesis) include:

- Aqueducts made up of canals, tunnels, pipelines and sometimes flumes (photos 11 and 12)
- Intake piping (at lakes or rivers)
- Water treatment plants (Photo 1)
- Groundwater pumping wells (Photo 2)
- Booster pumping stations (Photo 3)
- Steel and concrete reservoirs (Photos 4, 5, 6, 7 and 8)
- Open surface water reservoirs (Photos 9, 10, and 13)
- Pressure vessels (e.g., surge tanks) (Photos 21, 30 and 31)
- Valves and valve operators (Photo 27)
- Sumps
- Transmission piping (Photo 25)
- Distribution piping
- Service connections
- Fire hydrants
- Above-ground piping structures: pipe bridges, pipe supported on saddles (Photo 29)
- Electric substation equipment: control equipment, electrical raceways (Photos 23 and 32)
- Penstocks
- Mechanical equipment, pumps (Photos 2, 3, 17 and 18))

- (SCADA) Instrumentation, chlorination control, surveillance (Photos 7, 16, 19 and 20)
- Equipment for chemical storage and usage; chemical piping (Photo 21)
- Utility buildings, including administrative headquarters; an emergency and normal operating center, maintenance facilities, spare parts, equipment, and material storage (Photos 3, 14, 15 and 19)

B.4 Further Considerations on Hydraulic Modeling

A hydraulic model consisting of the minimum data required would yield a steady state model that could model the system as one point in time. Additional data incorporated with the minimum required data would allow the purveyor to analyze the system over a period of time and at a particular point in time. Such models are commonly referred to as an Extended Period Simulation (EPS). On larger systems, an EPS model would allow the purveyors to predict the performance of system components at any point in time. Most importantly would be the ability to trace water quality throughout the system should the system integrity be compromised.

With the incorporation of available GIS databases from local and federal agencies, information can be quickly integrated to predict population exposure; residential, commercial or industrial area exposure; sensitive habitat exposure; etc.

Figure 2 provides a composite map from two data sources: Water Utility Map from a water purveyor overlaid onto USGS Mapping. USGS Mapping shows typical information available from USGS mapping. The utility map identifies major transmission lines and distribution piping larger than 12 inches (305mm).

From Figure 2, the water purveyors system maps would allow pipe diameters to be identified, as well as location of pressure zones and major features of the system. In addition if the drawing is to scale, lengths can be obtained. Knowledge of the system would be invaluable as operation and maintenance personnel would readily be able to identify location of control valves and other system components. From USGS mapping, contour information is readily available to assign elevations to junction nodes. Digital elevation models (DEM) can also be used in GIS or CAD systems. Utility maps and most likely scaled distances can assist in adjusting coordinates for street layouts. Global Positioning System (GPS) equipment can be used in conjunction with water system field surveys to check key coordinates.

Other data necessary would include flow demands and known pressures at each node. This information can be obtained from SCADA information, utility personnel, field recorders, fire flow data, static pressures from water storage tank elevations, or rule of thumb numbers based on accepted standards of practice. The primary purpose of this model is to assess portions of and /or all of a water distribution systems risk. This model is also useful in planned outages for scheduled maintenance.

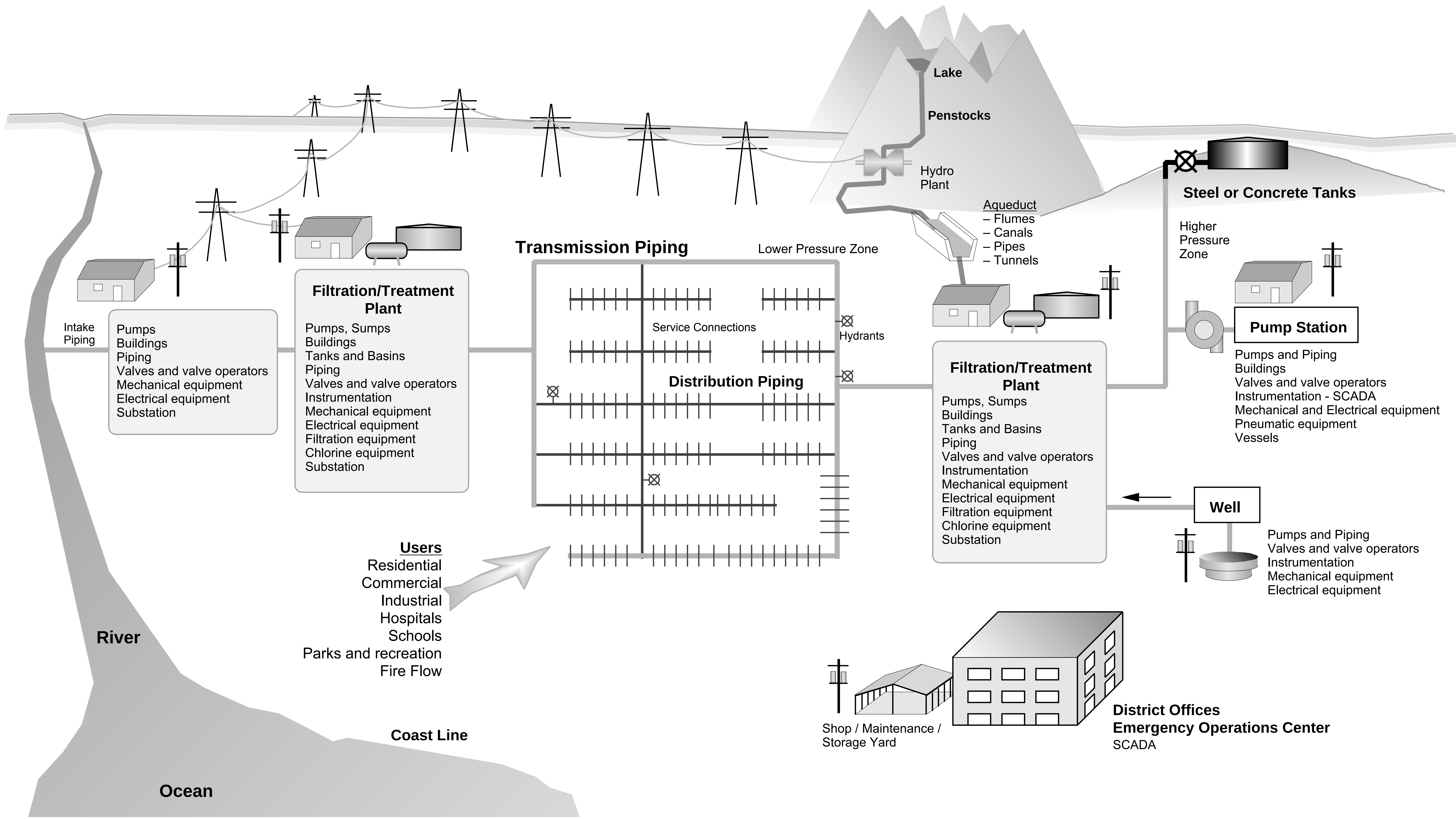

Figure 1: Hypothetical Demonstration System

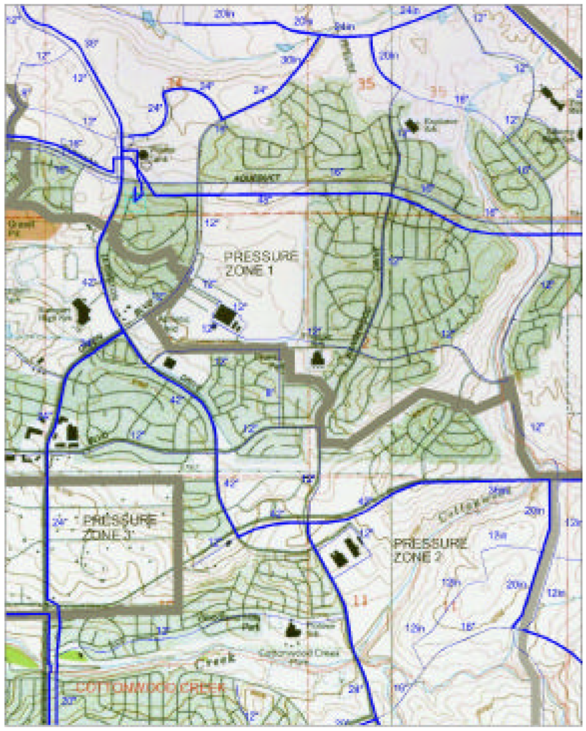

Figure 2: Composite Water System Map