Chapter 1
INTRODUCTION

1.1 INTENT OF THE MANUAL

The intent of this manual is to provide guidelines and methods for conducting underwater engineering assessments of underwater components of existing waterfront facilities constructed of materials such as concrete, masonry, metals, composites, and wood and located in near-shore, waterfront, and inland locations exposed to freshwater or saltwater. It includes, but is not limited to, bridges, dams, discharge and intake structures, locks, port and harbor structures, waterfront and waterway structures, pipelines and tunnels, and other structures that are located in, store, or transport water. For convenience, in this manual, the term *waterfront structures* is used to refer to any of the types of structures listed here, where it is appropriate and not specifically limited. Offshore structures and nuclear facilities are beyond the scope of this manual.

A structural inspection and condition assessment of a waterfront facility can be undertaken for one or more purposes. They can include determining the existing or baseline condition, recommending and prioritizing maintenance and repair actions, determining the suitability and serviceability for specific uses and loads, ensuring life safety, improving durability, enabling historic preservation, establishing a baseline condition for change of ownership or legal purposes, or many other special purposes on the basis of the specific structure and its current or proposed function.

This manual presents guidelines for assessment procedures, including inspection, investigation, evaluation and testing methods, and a general format for an assessment report. Specific inspection techniques are beyond the scope of this manual because it is presumed that inspection personnel will possess the requisite knowledge based on their qualifications. Because any condition assessment will require "engineering judgment" and contain factors that cannot be readily defined and standard-

ized, this manual is intended as a guide to be used by the professional engineer as part of an underwater structural condition assessment of an existing facility. The adoption or use of some or all of the recommendations contained in this manual by personnel not experienced or qualified in the appropriate areas of waterfront structures is not an acceptable substitute for the use of qualified professional engineering services.

The scope of this manual is limited to the engineering and technical requirements for conducting underwater facility assessments. Diving and related safety issues may be significant factors in conducting the assessments, but they are not covered within the scope of this manual. However, the very nature of the work, in addition to requiring technical competence, also requires proper training and preparation. This training is necessary to offset the inherent special hazards and to allow the safe operation of special underwater equipment and techniques, breathing apparatus, and special suits. Such special hazards may include differential pressures; high-velocity water flow; zero-visibility conditions; underwater entanglement hazards; confined space entries; equipment tag-out and lock-out procedures; penetration diving; contaminated water diving; and diving-related sicknesses and injuries such as embolisms, the bends, nitrogen narcosis, and physical exhaustion. It is therefore imperative that applicable safety and training requirements be adhered to in conducting such work.

1.2 IMPORTANCE OF INSPECTIONS

Underwater inspections are a necessary part of effective structure maintenance and management programs. They play an important part in protecting the public, providing reliable service, and reducing maintenance and construction costs. Structural conditions above water that could lead to failure, loss of life, or property damage are often observed by engineers, maintenance workers, and sometimes passing motorists. Similar structural conditions underwater are almost never observed by these same groups until the distress has progressed to the point that damage is evident above water. Failures of bridges due to underwater causes have led to requirements for periodic underwater inspections of bridges in the United States. Other public and private organizations have also adopted similar policies.

Underwater inspections can play an important part in structure maintenance programs. All structures deteriorate and are subject to environmental and external physical forces. Although individual materials have differing mechanisms of deterioration, the environment at the waterline, with moderate temperatures, moisture, oxygen, and chlorides or other chemicals, is conducive to most forms of deterioration. This distress may not be recognizable from above water, nor can the extent and severity be

determined in most cases. An engineer cannot fully define the extent of distress or design an appropriate repair without the benefit of an underwater inspection. Designers sometimes attempt to overcome shortcomings in knowledge of the distress by requiring contractors to "repair the structure to its original configuration and dimensions." Because contractors try to avoid risk to themselves, they pass on the cost of this risk to the owner through higher bids and ultimately higher costs. Well-defined construction and repair requirements, based on competent underwater inspections, reduce these costs.

Construction of new facilities and repairs to existing facilities are routinely inspected above water and often include comprehensive quality control and quality assurance programs. The same type of monitoring is warranted for underwater work. In fact, greater inspection is necessary because it is impossible to casually observe the quality of underwater work. Engineers, with responsibilities to their clients and to the public, must take whatever means are available to ensure that their clients receive the highest quality and to ensure the safety of the structure for the public. This obligation often requires competent underwater inspection.

1.3 LIMITS OF INSPECTIONS

Underwater inspections should include all portions of structures that cannot be inspected from above water. In very shallow waters, often an underwater inspection can be accomplished by wading or by probing from above water. The depth of water for which such methods are appropriate is very shallow. In fast-moving waters, waters with slippery or unstable bottoms, and very turbid water, even a few feet of water may be too deep to permit a safe or satisfactory inspection from above water. The responsible authority must determine whether a realistic assessment of the condition of the structure can be achieved solely from an above-water inspection; if not, an underwater inspection should be conducted.

For waterfront structures, except for those in shallow water as described above, the underwater inspection should extend from the channel bottom or mudline to at least the high-water level.

In some special circumstances, some limited excavation may be necessary at the interface between the structure and the mudline. Such excavation should be clarified in the scope of work and may require special environmental permits. For structures on which it is difficult to inspect some above-water portions, such as the underside of a deck system, it may be appropriate to include above-water portions with the underwater inspection. In many cases, inspections of the above-water and below-water portions of the structure should be performed by inspectors working with the same engineering team to make a meaningful assessment of components

that are located both above and below water. Conduct of the inspection of the above-water and below-water portions of the structure by the same inspection team generally will also be more cost-effective.

1.4 ORGANIZATION

This manual has been organized in sections to provide both general and specific guidance. Chapter 2 provides an overview of the general requirements for conducting underwater inspections. It also includes descriptions of the common types of inspections and guidelines for inspection frequency. In addition, recommended qualifications of inspectors are presented along with assessment rating guidelines that are applicable to, or can be readily adapted to, most structures.

Chapter 3 provides guidance for developing scopes of work for various types of assessments and inspections.

Chapter 4 provides guidelines for preparing a report of the underwater structural condition assessment. It outlines the contents of a typical report, which include background information; descriptions of the inspection, the testing methods, and the facilities inspected; reporting and documentation of inspection results; topics to be discussed in the assessment; and conclusions and recommendations.

Chapter 5 provides general guidelines for developing agreements between consultants and facility owners. It also presents an overview of the special requirements for insurance related to underwater engineering assessments.

Appendices A through D include descriptions of approaches to specific types of structures and problem areas associated with those structures, descriptions of various mechanisms of deterioration that are applicable to the types of materials found in waterfront structures, and references to other standards. A glossary of generally accepted standard terms related to waterfront structures is also included.