CHAPTER 1
INTRODUCTION

1-1. Purpose and Scope. This manual presents structural and operational solutions to ice problems on rivers that are used for navigation throughout the winter. These solutions will contribute to efficient, cost-effective, reliable, and safe navigation during ice periods. This manual also presents guidance for developing River Ice Management Plans for specific rivers or river systems. The information used in preparation of this manual largely derives from experience and knowledge gained during the five-year River Ice Management (RIM) Program (1984-88) conducted by the U.S. Army Corps of Engineers.

1-2. Applicability. This manual is applicable to major subordinate commands, districts, laboratories, and field operating activities having civil works design, construction, or operations responsibilities with respect to navigation projects or flood control projects experiencing ice problems.

1-3. References.

a. EM 1110-2-1611. Layout and Design of Shallow-Draft Waterways

b. EM 1110-2-1612. Ice Engineering

c. EP 70-l-l. Remote Sensing Applications Guide

d. ER 1110-2-248. Requirements for Water Data Transmission Using GOES/DCS

e. ER 1110-2-249. Management of Water Control Data Systems

f. ER 1110-2-1458. Hydraulic Design of Shallow-Draft Navigation Projects

g. ER 1125-2-308. Radio Frequency and Call Sign Assignments

1-4. Bibliography and Definitions. A bibliography is provided in Appendix A that lists additional references cited in the text, plus other references that supplement several of the topics covered in this manual. These may be consulted for further study of topics related both to winter navigation on inland waterways and to river ice management. A list of specialized terms and definitions is included as Appendix B.

1-5. Background. Ice-prone rivers in the United States directly serve 19 states containing 45% of the Nation's population. These rivers also serve as conduits to eight other river states and connect the U.S. heartland to world markets through the Gulf of Mexico, the St. Lawrence Seaway, and the ports of the Northwest. The principal rivers among these that generally support year-round navigation are the Ohio River (including the Monongahela and Allegheny Rivers), the Illinois Waterway, and the Upper Mississippi River from Keokuk, Iowa, downstream to Cairo, Illinois (its

junction with the Ohio). When ice causes navigation to stop or to become significantly curtailed on these rivers, the river-dependent portions of the local, regional, and national economies may be adversely affected.

a. Ice Interference with Lock and Dam Onerations. Corps of Engineers navigation projects cannot operate properly when ice accumulates at locks, dams, and related facilities. Ice interferes with the movement of lock and dam gates, and places added loads on structural components. Lock widths are often not fully usable owing to the accumulation of broken ice in recesses behind miter gates (preventing full gate opening) and the buildup of ice collars on one or both walls of the chamber. Broken ice is pushed into lock chambers ahead of tows, sometimes limiting the length of tow that can fit. Floating mooring bitts freeze in place, becoming useless. Passing ice at dams, while at the same time maintaining navigation pool levels and avoiding downstream scour, is often difficult or impossible. These few examples illustrate how ice at navigation projects leads to accelerated damage and increased maintenance needs, greater demands on personnel and more dangerous working conditions, and, most importantly, reductions in waterway readiness and capability, leading to lower levels of service to waterway users.

b. Ice Problems for Towboat Operators. Aside from the obvious effects of ice on the navigation industry, such as increased demands on personnel, accelerated wear and tear on equipment, and increased maintenance requirements for towboats and barges, ice imposes several limitations on tow operations that directly affect the industry's efficiency. The first of these is reduced tow size. The added resistance caused by the heavy ice accumulations means that towboats are unable to push as many barges through the ice as through open water. Thus, for the same operating costs, less tonnage can be moved when ice is extensive. A related factor is that ice restrictions on usable lock widths dictate narrower tows (e.g., two-barge-wide tows at 70 ft, rather than three-barge-wide tows at 105 ft). The next limitation is lower travel speeds. Again, this is a function of the extra energy needed to move a tow through ice accumulations, and it varies with the amount of ice in the waterway. And finally, there are delays at locks. Ice can increase actual lockage times for several reasons. Broken ice may need to be locked separately through the chamber before a tow can enter. Double lockages (i.e., breaking up a tow into two parts) may be required because of length or width restrictions in the chamber from ice on the lock walls, gates, or barges. And, where two lock chambers exist, frequently only one of them will be available during ice periods because the other is needed to pass ice. Longer lockage times with heavy traffic mean that tows collect while awaiting their turns to lock through. All these limitations may increase operating costs and decrease operating efficiencies.

c. Ice Effects on Industry. Commerce. and the General Public. When freight is delayed or stopped on ice-prone rivers by adverse ice conditions, the effects are felt by industries served by river transportation. And, as industry is affected, so also are commerce and the general public, since they rely directly or indirectly on industrial payrolls. Ice problems can curtail shipments of fuels, industrial feedstocks, finished goods, road salt, etc. These delays may lead to a range of results, from added transportation costs for alternative shipping modes, to industrial plant cutbacks with associated layoffs. Delayed movement of goods leads to the depletion of reserve stockpiles,

added inventory carrying costs, and extra labor costs for additional handling of bulk products. Road salt shortages may result in hazardous road conditions. Fuel shortages affect both industry and homes; often when fuel is scarce, industrial cutbacks (and layoffs) are implemented to ensure at least minimum service to hospitals and residences. Major interruptions in industrial raw materials lead to terminating process heating, and this can result in costly shutdown and restarting expenses.

d. Ice-Related Shore and Structure Damage; Ice-Jam Flooding. Damage caused by normal ice conditions in ice-prone rivers is generally minor. But in more severe ice seasons, scour and ice-force damage to shorelines, pilings, piers, and levees may become significant. Unprotected earth surfaces at shorelines can be severely gouged and eroded. Public and private river-edge structures can be weakened, distorted, or even destroyed. Once heavy accumulations of ice start to move downstream in the spring, people are at the mercy of the elements. River ice jams may contribute to winter and early spring flood damage. Ice blockages in main stems and tributaries cause stages to rise and force water out of the channel over the floodplain, even when discharges are low compared to warm water floods. The factors and relationships that determine the probability of ice jams and ice-jam flooding are more complex than those related to open-water flooding. This means that the extensive statistical analysis methods applied to normal flooding phenomena are not readily applicable to ice-related occurrences.