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Sediment Dynamics upon Dam Removal



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EWRI ENVIRONMENTAL & WATER RESOURCES INSTITUTE

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Sediment Dynamics upon Dam Removal

Prepared by
the Task Committee on Sediment Dynamics Post-Dam Removal of
the Environmental and Water Resources Institute of
the American Society of Civil Engineers

Edited by
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PREFACE

With the growing concern over adverse environmental impacts of dams on ecosystems and fish populations, the number of dam removals is rapidly increasing. Questions regarding sediment behavior and overall stream geomorphology when a dam is removed have thus come to the fore. It has therefore become essential that guidance and documentation of experience in dam removal be made available to the river management and engineering community. This manual contains several chapters covering numerical and physical modeling and field experience regarding dam removal and its modeling, and is intended to be of use to watershed and river agencies and their consultants as well as researchers in their continued efforts to enable people to live in a healthy balance within their environments.

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PART I: SUMMARY AND REVIEW

CHAPTER 1

SEDIMENT DYNAMICS POST-DAM REMOVAL: STATE OF THE SCIENCE AND PRACTICE

Athanasios (Thanos) N. Papanicolaou, Brian D. Barkdoll, Laura Wildman, Cassie C. Klumpp, Blair Greimann, James G. MacBroom, and Mohamed Elhakeem

1.1 PROBLEM STATEMENT

There are more than 80,000 dams listed in the U.S. Army Corps of Engineers (USACE) National Inventory of Dams (NID) database. However, the NID limits its listings to dams with the following characteristics: (1) dams that are greater than 1.8 m (6 ft) in height with a storage volume greater than 61,700 m^3 (50 acre-ft); (2) dams that are greater than 7.5 m (25 ft) in height with a storage volume greater than 18,500 m^3 (15 acre-ft); and (3) dams of any size that can "pose significant threat to human lives or property." There are roughly 2 million dams estimated by the National Research Council (NRC 1992) that are not listed in the NID.

Dams were once considered long-term, permanent landscape structures (or, interchangeably, infrastructure) that provide for water supply, irrigation, flood control, hydropower generation, pollution control, navigation, or recreation (ASDSO 2005). Dams were once seen as sources of clean energy that did not require the burning of coal and, therefore, negated "raping" of the land through strip mining and the production of acid rain. In addition, dams helped make possible the migration of new settlers in the western part of the United States. In North America, 3,123 dams were completed in 1960, the greatest number of dams completed in one year (WWF 2009) and more than 200 major dams were completed each year between 1962 and 1968 (Beaumont 1978).

However, dams have also changed the ecology of thousands of rivers, disrupted native populations of fish and wildlife, and adversely affected



A B

Figure 1-1. Dam removal. (A) Smelt Hill Dam removal in 2002, Presumpscot River, Maine (photo courtesy of Friends of the Presumpscot River); (B) Embrey Dam removal in 2006, the Rappahannock River, Virginia (photo courtesy of the U.S. Dept. of Defense, Integration and Application Network, Image Library, http://ian.umces.edu/imagelibrary).

many local economies and communities (Babbitt 2002). Trade-offs between the dams' benefits and detrimental impacts have led to a reconsideration of the value of many dams in the nation. According to Hart et al. (2002), in the United States dam removal is "no longer considered a fringe radical approach for river restoration," especially when the operational costs and environmental impacts outweigh the benefits, or when the dam no longer serves any useful purpose. Over the past two decades there has been a clear shift toward the removal (or breaching) of structurally outdated, ecologically damaging dams from river systems (ASCE 1997). Such removals include not only small, obsolete dams (Fig. 1-1A), but also midsize and large dams such as Embrey Dam (Fig. 1-1B), which has caused great ecological damage to the Rappahannock River in Virginia (American Rivers 2002).

This struggle to balance the perceived needs of humans and those of wildlife and ecology have come to a head. The number of dams being built is declining (Fig. 1-2) (partly due to awareness of environmental effects and partly due to the lack of new appropriate dam sites), while the concurrent number of dams being removed is increasing exponentially. On average, ten dams were removed per year between 1940 and 1970, whereas the average number of dams removed per year in the 1980s and 1990s was 90 and 180, respectively (AR/FE/TU 1999). The number of dam removals, however, is still small compared to the number of dams built. If these trends continue, the number of dams removed each year will surpass the number of dams being built.