

# INDIANA'S URBAN FLOOD PLAIN MAPPING PROGRAM

JOHN SIMPSON  
Division of Water  
Department of Natural Resources  
Indianapolis, Indiana

## INTRODUCTION

In an editorial in the March 11, 1937 issue of Engineering News-Record it was stated that, ". . . rivers were here long before man, and for untold ages every stream has periodically exercised its right to expand when carrying more than normal flow." Floods are acts of nature, but flood damages and problems result from man's actions in violating the natural use of flood plains and allowing urban development in areas which rightly belong to the rivers and streams.

## 1945 FLOOD CONTROL ACT

The 1945 Indiana General Assembly, recognizing the need for flood control in the state, enacted what is commonly known and referred to as the Flood Control Act. The act created the Indiana Flood Control and Water Resources Commission and declared that the loss of lives and property caused by floods, and the damage resulting therefrom, are a matter of deep concern to the state affecting the life, health, and convenience of the people and the protection of property; that to prevent and limit floods all flood control works and structures and the alteration of natural or present water courses of all rivers and streams in the state should be regulated, supervised and coordinated in design, construction, and operation according to sound and accepted engineering practices; and that the channels and that portion of the flood plains of rivers and streams, which are floodways, should not be inhabited and should be kept free and clear of interference or obstructions which will cause any undue restriction of the capacity of the floodways.

Further, the act directed the commission to make comprehensive studies and investigations of all pertinent conditions of the areas in the state affected by floods; determine the best method and manner of establishing flood control, giving consideration to the reservoir method, the channel improvement method, the levee method, the flood plain

regulation method and any other practical method; adopt and establish a comprehensive plan or master plan for flood control for all areas of the state subject to floods; determine the best and most practical method and manner of establishing and constructing the necessary flood control works; and adopt appropriate measures for the prevention of flood damages.

The act also stated that anyone desiring to erect, make, use or maintain any structure, obstruction, deposit or excavation within a floodway of a stream would need to obtain written authorization of the commission prior to construction. Additionally, the commission was directed to encourage and promote local initiative and effort in providing flood control and to cooperate with, advise, disseminate information to, and assist in matters relating to flood control and the development of water resources, including flood plain regulations or controls.

#### DEPARTMENT OF NATURAL RESOURCES FORMED—1965

In 1965 the Flood Control and Water Resources Commission, the Department of Conservation and two other smaller agencies were combined into a new Department of Natural Resources and all of the power, duties, work, responsibilities, and authority were then vested in the Natural Resources Commission.

#### PROCURING BASIC FLOOD PLAIN DATA

In accomplishing the work of planning flood control measures and regulating construction in floodways, as directed in the Flood Control Act, it is necessary to obtain basic data. In many areas of engineering, data and information are generally applicable and standardized for use on any project. However, in flood control a large part of the factors and conditions such as rainfall, runoff, topography, stream capacities, and width of the flood plain are variable and must be determined for each project. The procuring of the basic data needed is vital to dependable and economic flood control and adequate data can usually be secured only through years of patient work.

#### TOPO MAPS FOR URBAN AREA FLOOD PLAINS

An important part of the basic data is adequate topographic maps and one of the more significant programs developed by the staff of the department's Division of Water in recent years has been that of large scale urban flood plain mapping by aerial photogrammetric methods.

The recognition for the real need of such a program began in 1964 when it became obvious that extensive, accurately controlled, and highly

detailed large scale planimetry and topography maps were necessary if the advanced planning and development for the heavily urbanized region along the Little Calumet River in northwestern Indiana was to be further expanded in an orderly fashion with regards to the natural functions of the river channel. The smaller scale U.S. Geological Survey topographic maps, although of exceptional quality and detail, were just not suitable for anything other than preliminary planning.

The first efforts in the new program were in the selection of a proper and technically correct scale, contour interval, photographic technique, field survey and aerial photo control methods, drafting procedures, reproduction media, and numerous other details which would provide accurate flood plain maps at a reasonable cost to the state. Contracts were prepared and negotiated for the required services with private consulting companies who had the knowledge, equipment, and personnel to do this specialized work. We were very fortunate, during this early period, in receiving the gratuitous assistance of several private photogrammetric companies and federal agencies who had accrued valuable past experience in this profession; a fact which gave us a very good start in photogrammetry and allowed us to develop with the profession during the next years and subsequent projects. It has also assisted us in the preparations of specifications for our dam and reservoir site mapping, a slightly different type of graphic project. Our current contract, specifications, and final map materials and presentation are now considered by many to be of as good a quality for their intended purpose as any produced in the nation.

#### MODERN MAP SPECIFICATIONS USED

Our first specifications were generally based on the traditional "national map standards of accuracy". However, even though some of these standards are still very much in use today, they were developed for what was then called an intermediate scale map by the primary mapping agency of that era; namely, the Topographic Branch of the U.S. Geological Survey. With the advent of higher precision aerial cameras, film, and processing procedures; of much more sophisticated and accurate plotting equipment, whereby personal interpretation is less of a factor; of electronic distance measuring equipment for pinpoint field control surveys; and of the advanced drafting techniques by scribing on a dimensionally stable material for quicker, neater, and more consistent linework, the old standards of national map accuracy, never rewritten, have gradually become less severe. Specifications for our present aerial mapping work include provisions for all of these modern methods of production.

The scale of our urban flood plain maps is 1 in. equals 200 ft. with a 2-ft. contour interval. Aerial flights and subsequent photography are held within strict tolerances commensurate with the limits of various precise plotting machines used with the photography to achieve this scale and contour interval. Such items as the amount of tilt and crab of the aircraft, the height of the sun, the absence of foliage, water ponds, or snow cover, the amount of overlap and sidelap of successive photos and flight strips, the quality of photo film emulsion, and many other factors make up the intricate technical details which have to be tightly controlled for best results.

### GROUND CONTROL SPECIFICATIONS

Other controls include what we believe to be the tightest, yet the most important for nearly every purpose for which our maps have been put; namely, the ground survey specifications. Most large scale maps encompass a relatively small area, and therefore require little vertical or horizontal control for the bridging or extension of photo-models as projected in the plotting machine. Our maps, however, extend over a larger area and require more model set-ups; hence, we specify more and very accurate monumented primary geodetic surveys to assist in the expansion of the less accurate secondary or supplementary photo control surveys used to correctly orient the photography in the plotter. This eliminates many of the possibilities of errors which may be experienced in analytical computations from photo data in the bridging process. More important to us and others, though, is the fact that good high-order marks are available on the ground for possible future use in checking, updating, or expanding the subject maps; for implementation of any project emitting from hydraulic studies using the subject maps; and for many other types of future field measurements. Since every mark on our map is recorded to both a vertical and horizontal datum, we try to provide enough of the necessary accurate elevation and coordinate ground reference points to hold the maps, and any subsequent surveys in the area to a positive maximum accuracy.

### FORTY-SIX MAPPING PROJECTS SINCE 1964— 500 MILES

Although it is recognized that serious flooding can and does occur in rural areas, the main problems seem to be in the urban areas where increasing population and the industrial expansion is causing increased development and encroachment in the floodways. Therefore, we have concentrated our mapping efforts along the major streams in urban areas around the state.

Forty-six mapping projects have been completed since 1964 and encompass a total area of over 362,000 acres or nearly 565 square miles. The maps cover the flood plains of about 500 linear miles of major stream channels—see Figure 1. The accrued cost to the state for a total of 657 map sheets has been just a little over \$2,000,000, yielding a respectable general average cost of less than \$5.60 per acre. For this amount the state receives the aerial film negatives and three sets of positives, a photo index negative and positive, the diapositive glass plates used in the plotting machines, the field survey notes and computations,



Fig. 1. Flood Plain Mapping

the original and two copies of all map manuscripts, scribe coat negatives, and a film positive suitable for reproduction of each map sheet. In addition the photogrammetric company doing the work provides reproducible film positives of a specially prepared title sheet, index to map sheet and control, and a cover sheet.

## AGENCIES AND THEIR USE OF MAPS

The maps have been used quite extensively and have become a vital part of our Division of Water's flood control planning and regulatory activities. Additionally, the maps have been provided to local, state and federal agencies for their use and information.

More specifically the maps have been utilized, along with flood elevation data, to provide information to and assist local officials in their efforts in adopting flood plain zoning ordinances.

The maps have proved quite useful and beneficial in hydraulic studies being conducted for the Department of Housing and Urban Development by the Corps of Engineers, the Soil Conservation Service and the U.S. Geological Survey. These studies are conducted to outline urban areas subject to flooding for use in the Federal Flood Insurance Program whereby flood insurance is made available to communities adopting flood hazard ordinances. Not only are the maps useful in the initial studies and the outlining of flood areas but also in regulatory functions after the ordinance has been adopted.

The Division of Water staff has been able to utilize the maps in delineating floodways along the streams; in encroachment studies and determining the effects on flood flows where construction in the floodway is planned, or possibly already completed without approval; in project type studies where housing development or commercial and industrial development is contemplated; and in outlining and planning flood control measures and projects.

The Corps of Engineers has used the maps in Flood Plain Information Studies for various urban areas. In the areas where the mapping has been completed it was used in the reports thus saving the Corps of Engineers money while still providing high quality maps.

## CONCLUSION

In conclusion, it is certainly felt that Indiana's urban flood plain mapping program has proven successful and very beneficial in implementing the 1945 Indiana Flood Control Act.