PART 2:

FLOOD STUDIES AND MAPS

This part of the floodplain reference manual includes five sections on the flood data, studies and maps that communities need to carry out their floodplain management program. It reviews:

- Flood study and map terminology.
- How flood studies are prepared.
- How the NFIP maps display the study data.
- How to use study data and maps.
- How to keep regulatory data and maps up to date.

SECTION 4: FLOOD INSURANCE STUDIES

Contents

4.1. FEMA'S MAPPING EFFORTS

4.1.1. Flood studies and maps

Flooding is not static. Watershed, channel, and floodplain characteristics change over time so the conditions that create floods change over time. A flood map based on today's conditions can be slightly out of date tomorrow because of a development project or natural change to the earth's surface.

Floodplain mapping is also subject to change. New data become available over time. More is known now about rainfall patterns than 20 years ago. New techniques are making maps more accurate and more areas can be studied at less cost.

Above all, a floodplain map's accuracy depends on the purpose for which it was prepared and the resources put into it. Some maps are prepared just to show general areas subject to flooding. Others are done for a flood control project. The latter needs to be more accurate and are, therefore, more expensive.

Flood maps were prepared with a purpose in mind. A general regulatory map will not show every flood problem that has been reported or that could exist. In some cases, it may not provide flood elevations.

It's important to remember that someone can always spend more money to produce a new map which might be more accurate or up to date. Therefore, it's important to know how maps are prepared and the process for updating and revising them. That is the subject matter of Part 2 of this desk reference.

4.1.2. FEMA's mapping program

The National Flood Insurance Act of 1968 directed the FEMA to:

- Identify all floodprone areas within the United States.
- Establish flood-risk zones within floodprone areas.

To implement this directive, FEMA has conducted flood studies and produced various forms of maps. The flood studies analyze the terrain and the factors that affect flooding. This information is used to draw the maps that delineate the boundaries of the floodplain.

The initial flood study and mapping efforts of the NFIP were focused on identifying all floodprone areas within the United States. Using flood data and floodplain information from many sources — such as soils mapping, actual high water profiles, aerial photographs of previous floods, topographic maps, etc. — the *approximate* outline of the base floodplain for specific stream reaches was overlaid on available community maps, usually U.S. Geological Survey topographic quadrangle maps.

Today these documents are referred to as Flood Hazard Boundary Maps and they were based on approximate studies. Most communities used a Flood Hazard Boundary Map when they first joined the NFIP.

As money was appropriated by Congress, FEMA performed more detailed studies for many communities, resulting in the publication of Flood Insurance Study reports and Flood Insurance Rate Maps (FIRMs). These studies provide communities with data needed to adopt and implement more comprehensive floodplain management measures and to enter the Regular Phase of the NFIP.

Flood studies, also referred to as detailed studies, were carried out for developed communities and for those areas experiencing rapid growth. They are used to guide future development within flood hazard areas and to provide the information needed for new construction allowed in already developed areas.

Today, almost every community in the NFIP has a FIRM. The community's FIRM may have:

- all areas mapped in detail based on a flood insurance study,
- all areas based on an approximate study (where there is little or no development or expectation of development), or
- some floodplains mapped using each approach.

Additional studies have been conducted by other agencies, but FEMA's studies and maps are what a community must start with in managing floodplain development.

4.1.3. Map modernization

Nationwide, approximately 75% of FEMA's flood maps are more than 10 years old. Since flood hazards are dynamic and usually increase over time as development occurs, old maps tend to understate actual, existing flood hazards. Additionally, most FEMA maps were produced using manual cartographic techniques.

In 1997, FEMA designed a plan to modernize its flood studies and mapping program in an effort to provide more accurate and extensive flood hazard information to communities. The plan proposed a 7-year upgrade to the flood map inventory and an enhancement of products, services, and processes that entails. The goal of FEMA's Map Modernization Plan is to upgrade the 100,000-panel flood map inventory by:

- Developing up-to-date flood hazard data for all floodprone areas nationwide
- Providing the maps and data in digital format to improve the efficiency and precision with which mapping program customers can use this information
- Fully integrating FEMA's community and state partners into the mapping process to build on local knowledge and efforts
- Improving processes to make it faster to create and update the maps
- Improving customer services to speed processing of flood map orders and raise public awareness of flood hazards

FEMA has received increased appropriations to begin the "Map Mod" program. More information about the program can be found on FEMA's website (www.fema.gov).

4.1.4. Cooperating Technical Partners

An objective of Map Mod is to increase local involvement in the mapping process. Cooperating Technical Partners (CTPs) are communities, regional agencies, or states with the interest and capability to be active partners in FEMA's flood mapping program. Regional agencies that would qualify would be those active in floodplain mapping. They could also include county agencies active in preparing maps for unincorporated and municipal floodplains.

CTPs enter into an agreement that formalizes their contribution and commitment to flood mapping. The objective of the program is to maximize limited funding by combining resources and helping to maintain consistent national standards. Each CTP enters into an agreement with FEMA, specifying which mapping activities it will implement. These could be as varied as:

- Refinement of approximate Zone A boundaries
- Hydrologic and hydraulic modeling and floodplain mapping
- Digital Flood Insurance Rate Map (DFIRM) preparation and maintenance
- Redelineation of detailed flood hazard information using updated topographic data
- Digital base map data sharing
- Hydrologic and hydraulic review of requests for map revisions
- Adoption of specific technical standards or processes appropriate for local conditions

The CTP agreement is a cooperative agreement in which both parties benefit. FEMA gets more resources and the latest local data to prepare a better FIS. The community gets more input into the mapping process and the techniques and standards that will be used. It also gets a product that better fits local conditions. Furthermore, since resources are pooled, the study usually covers more streams or a larger area than if FEMA prepared it alone.

4.2. FLOOD STUDY TERMINOLOGY

Before describing how flood studies are developed, we first need to introduce some of the common terms used in floodplain analysis and in the NFIP. The following terms are integral for understanding the basis for flood studies and flood maps:

- The base flood
- Special Flood Hazard Area (SFHA)
- Base Flood Elevation
- Datum
- Elevation reference mark
- Floodway

> Note: For additional useful terms see the Glossary in Section 21.

4.2.1. The base flood

Floods come in many sizes — with varying degrees of magnitude and frequency. Rivers and lakes are expected to flood, as all bodies of water have floodplains. But rivers and lakes differ from one to another, as well; each river segment and lake has its own probability of flooding. Probability is a statistical term having to do with the size of a flood and the odds of that size of flood occurring in any year.

For each river, engineers assign statistical probabilities to different size floods. This is done to understand what might be a common or ordinary flood for a particular river verses a less likely or a severe flood for that same river.

In order to have common standards, the NFIP and the State of Illinois adopted a baseline probability called the base flood. The base flood is the one percent chance flood. The one percent chance flood is the flood that has a one percent (one out of 100) chance of occurring in any given year.

The one percent chance was chosen as a compromise between excessive exposure to flood risk from using a lower standard (such as a 10 percent chance flood) and applying such a high standard (say, a 0.1 percent chance flood) that it would be considered excessive and unreasonable for the intended purposes of requiring the purchase of flood insurance and regulating new development.

The one percent chance flood has also been called the 100-year flood. The term 100-year flood is often misconstrued. Commonly, people interpret the 100-year flood definition to mean “once every 100 years.” This is not correct. There could be a 100-year flood two times in the same year, two years in a row, or four times over the course of 100 years. It is also possible to not have a 100-year flood over the course of 200 years.

To avoid confusion (and because probabilities and statistics can be confusing), the NFIP uses the term base flood. A 100-year flood is defined as having a one-percent chance of being reached or exceeded in any single year. Thus, the 100-year flood also is called the “one-percent annual chance flood.” Figure 4-1 further describes the odds of a base flood.

To restate, the 100-year flood, the base flood, refers to a flood that the one percent chance of occurring in any given year. The terms base flood, 100-year flood, and one-percent annual chance flood are used interchangeably throughout the NFIP.

Another term used is the “500-year flood.” This has a 0.2% chance of occurring in any given year. While the odds are more remote, it is the standard used for protecting critical facilities, such as hospitals and power plants.

WHAT ARE THE ODDS OF A BASE FLOOD?

The term "100-year flood" has caused much confusion for people not familiar with statistics. Another way of looking at it is to think of the odds that a base flood will happen sometime during the life of a 30-year mortgage (26% chance).

Chance of Flooding over a Period of Years

Time Period	Flood Size 10-year	25-year	50-year	100-year
1 year	10%	4%	2%	1%
10 years	65%	34%	18%	10%
20 years	88%	56%	33%	18%
30 years	96%	71%	45%	26%
50 years	99%	87%	64%	39%

Even these numbers do not convey the true flood risk because they focus on the larger, less frequent, floods. If a house is low enough, it may be subject to the 10- or 25-year flood. During the proverbial 30-year mortgage, it may have a 26% chance of being hit by the 100-year flood, but the odds are 96% (nearly guaranteed) that it will be hit by a 10-year flood. Compare those odds to the only 5% chance that the house will catch fire during the same 30-year mortgage.

Figure 4-1: What are the odds of a base flood?

4.2.2. Special Flood Hazard Area

The land area covered by the floodwaters of the base flood is the base floodplain. On NFIP maps, the base floodplain is called the Special Flood Hazard Area (SFHA). The SFHA is the area within which the NFIP’s floodplain management regulations must be enforced by the community and the area where the mandatory flood insurance purchase requirement applies.

4.2.3. Base flood elevation

The computed elevation to which floodwater is anticipated to rise during the base flood is the 100-year flood elevation, or the base flood elevation (BFE).

Technical terms
Base flood = 100-year flood = 1% chance flood
Base flood elevation = 100-year flood level
Base floodplain = 100-year floodplain = Special Flood Hazard Area = SFHA

4.2.4. Datum

If a site or a base flood is at an elevation of "22 feet," above what starting point does the 22 feet refer? Generally, "above sea level" is what is meant. However, the sea is actually not the same level everywhere. Furthermore, some inland communities' elevation records may be in relation to some other starting point. The use of a common starting point or "datum" ensures uniformity and avoids confusion.

During the 1920s, the U.S. government created a network of 21 tidal gauges in the U.S. and five in Canada to provide a fixed continental datum that would bring a consistent relationship to all vertical determinations in the U.S. This new datum was known as the National Geodetic Vertical Datum (NGVD) of 1929 and is the base elevation to which all relief features and elevation data are referenced in the contiguous United States. NGVD is also the datum of reference for the vast majority of FISs.

An ultimate goal of the NFIP is to convert all FISs to a newer standard called the North American Vertical Datum (NAVD) of 1988. This latest standard will eliminate inconsistencies caused by assuming that 0 NGVD is the same as mean sea level at all 26 tidal stations. There are now 600,000 permanent benchmarks associated with the NAVD of 1988. See *Flood Insurance Study: Guidelines and Specifications for Study Contractors*, FEMA-37 (1995), for further information.

As FIS and FIRMs are revised the reference datum may or may not be converted from NGVD 1989 to NAVD 1988 depending upon availability of data. The datum of the FIS and FIRM is indicated on the panels and in the study and these should be checked to verify the study datum when comparing new information and information from other FIS and FIRMs.

4.2.5. Elevation reference mark

Elevation reference marks are marked locations on the ground that indicates the elevation of that location. The most dependable reference marks are government-installed benchmarks. These permanent brass markers are set in concrete. Most permanent elevation reference marks (or benchmarks) are referenced to the NGVD (see example in Figure 4-2).

Figure 4-2: Typical USGS benchmark

Each FIRM with base flood elevations provides one or more elevation reference marks. They are listed in the FIS text or on the FIRM. Figures 5-5 and 5-7 are examples of how they are shown on a FIRM.

While there are some benchmarks set by Federal agencies, most are established by private surveyors and local agencies. Local reference marks should relate to a national datum, but some may not. It is important to double check that the datum for elevation reference marks is the same as the one used for flood elevations.

Reference marks are not always permanent monuments. They can be squares chiseled into a sidewalk, bolts on a fire hydrant, or other designated markers left by surveyors. Over time, these may disappear or be moved (in which case they are undependable). The engineer's office should have a list of benchmarks in the community. If a surveyor suspects that an elevation reference mark is not dependable, e.g., it is in an area subject to subsidence and has not been checked for a while, it should not be used.

> Surveyors may use the reference marks shown on the FIRM, regular benchmarks, or other elevation reference marks as the basis for foundation elevations and Elevation Certificates, ***provided*** they use the same datum as the flood elevations on the FIRM.

If a surveyor finds a suspect reference mark, it should be reported to the community's engineer and to other surveyors. If it is one listed on the FIRM, the FEMA Regional Office should be advised, so the next FIRM revision will not include it. The report to FEMA should include the FIRM panel number, FIRM reference mark number, and, if available, data on one or more dependable reference marks in the area.

4.2.6. Floodway

The floodway is the central portion of a riverine floodplain needed to carry the deeper, faster moving water. NFIP's *Code of Federal Regulations* (see Section 8) defines regulatory floodway as the following:

> ***44 CFR 59.1*** *Definitions: "Regulatory floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.*

4.3. FLOOD STUDY

4.3.1. The FIS

When a flood study is completed for the NFIP, the information and maps are assembled into a Flood Insurance Study (FIS) report and maps. An FIS is a compilation and presentation of flood risk data for specific watercourses, lakes, and ponding flood hazard areas within a community. If a community has more than one identified hazard then the study results of each hazard analysis is combined and included in the FIS.

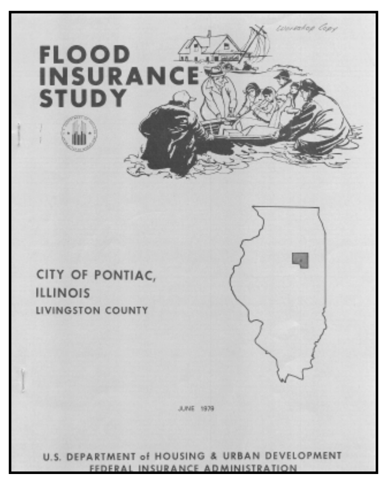
The FIS report and associated FIRM maps delineate the SFHA and the 500-year floodplain, designate flood risk zones and report base flood elevations. They serve as the basis for rating flood insurance and for regulating floodplain development and carrying out other floodplain management measures.

Most studies have three components:

1. The FIS — Flood insurance study report.
2. The FIRM — Flood Insurance Rate Map.
3. The Flood Boundary and Floodway Map, which is included in studies prepared before the late 1980's.

4.3.2. The FIS report

The FIS report includes:



- An appraisal of the community's flood problems in a narrative that describes:
  - -- the purpose of the study,
  - -- historic floods,
  - -- the area and streams studied, and
  - -- the engineering methods employed.
- A vicinity map of the community and, often, photographs of historic floods.
- Tables summarizing various study data.
- Computed flood profiles of rivers and streams that have detailed studies for various recurrence probabilities, usually the 10-, 50-, 100-, and 500-year floods.

4.3.3. State review

In Illinois, new FIS, revisions to FIS, and detailed studies that will be used for regulatory purposes are reviewed and approved by IDNR's Office of Water Resources. The purpose of this requirement is to ensure that:

- An adequate study was performed,
- IDNR's study standards are followed,
- Different studies on the same stream are consistent, and
- All map revisions to reflect on stream modifications and flood control structures are based on projects that have been approved by IDNR.

4.3.4. Example FIS - City of Pontiac

Included in Section 23 is the Flood Insurance Study report for the City of Pontiac, Illinois. A street map for Pontiac and excerpts from the City's FIRM and Floodway Map are also included in Section 23. Pontiac was chosen because it provides the best examples of the features in detailed FEMA flood studies and maps.

Note that the Pontiac street map has streets that do not appear on the FIRM or Floodway Map. There is a new subdivision around Site D. Most likely, it was platted after the FIS was done in the late 1970s.

Often, the FIRM and Floodway Map do not show or name streets away from the floodplain, because such details are not needed for floodplain management. For example, Washington, Madison, and Howard Streets are north of the floodplain and are not named on the FIRM.

4.4. RIVERINE FLOOD STUDIES

Detailed flood studies are conducted differently for different types of flooding, which are:

- Riverine flooding of rivers, streams, or other waterways.
- Shallow flooding, ponding, and sheet flow.

There are other types of flooding, such as ice jams and dam breaks that are not covered because each situation is unique.

Riverine flooding occurs in rivers, streams, ditches, or other waterways that are subject to overbank flooding, flash floods, and urban drainage system flooding. Riverine studies involve the collection and analysis of information about the river's watershed, the topography or the lay of the land along the river, precipitation, and the characteristics of the river itself.

For purposes of riverine flood studies, the study of the watershed's behavior is called hydrology and the study of the river or stream's behavior is called hydraulics. The results of a riverine study are flood depths and flood profiles, which are used to describe the SFHA.

4.4.1. Hydrology

In order to determine the depth of flood waters and to determine the size or width of floodplains, engineers must first examine the watershed to determine the amount of water that will reach a stream and be carried by the stream during a flood event.

The study of a watershed's behavior during and after a rainstorm is called hydrology. A hydrologic analysis determines the amount of rainfall that will stay within a watershed — absorbed by the soil, trapped in puddles, etc. — and the rate at which the remaining amount of rainfall will reach the stream.

The rainfall that reaches the stream is called runoff. The rate at which the runoff reaches the stream and flows downstream is the flood discharge. Discharges are measured in cubic feet per second (cfs). (A cubic foot of water is about 7.5 gallons.)

Runoff amounts and discharge rates vary depending on soil type, ground slope, land use, and the presence of storm sewers. In general, for the same amount of precipitation, more runoff occurs on unforested land, on paved and built-on urban land, and on steeper slopes. Flood storage in natural depressions, wide floodplain areas, and behind roadways and dams can have significant impacts on reducing downstream discharge.

Discharges are estimated by using rainfall and snowmelt data and historical stream records or by using regional equations that represent such data. Computer models allow engineers to incorporate numerous watershed characteristics into the hydrologic analyses. Discharge rates also generally increase as the size of a watershed increases.

Upon completion of the hydrologic analysis, engineers have flood discharges for various size rainstorms that are measured at different points along a stream, such as at the confluence with another stream and at the mouth of a tributary stream.

For flood studies to be used to regulate development, including Flood Insurance Studies, the discharges for the base flood must be submitted to IDNR's Office of Water Resources for review and approval. They are then filed with the official State flood data repository at IDNR's Water Survey.

4.4.2. Cross sections

All detailed flood studies examine the areas through which floodwater will flow. This requires a determination of ground elevations and obstructions (such as buildings, bridges, and other developments) for these areas. Accurate data on the shape of the stream and changes in the floodplain are obtained from ground surveys, aerial photo maps, or topographic maps.

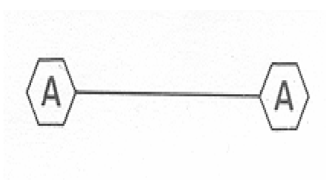
To locate the true elevations at a site, surveyors have established elevation reference marks or benchmarks that are referenced to a common vertical elevation reference called a datum. The use of a datum ensures uniformity of use and avoids confusion.

While there are some benchmarks set by Federal agencies, most of them are established by private surveyors and local agencies. Local reference marks should relate to a national datum but some may not. It is important to double check that the datum used in the community for elevation reference marks is the same used for flood elevations. Established reference marks and benchmarks with a recorded elevation allow surveyors to describe the changes in the ground levels or stream characteristics as elevations. They are also used by surveyors to determine the elevations of buildings that are at risk of flooding.

Note: Any new reference mark should be tied to two existing reference marks.

A cross section is a graphical depiction of the stream and the floodplain at a particular point along the stream and it is based on field-surveyed elevation and distance data from the overbank on one side of the stream through the channel and up into the overbank of the opposite side of the stream. This survey data is tied to the datum of the FIS. It is taken perpendicular to the flow of the stream. At each cross section, the engineer has accurate information on the size of the channel, the shape of the floodplain, and the changes in the elevation of the ground. A typical surveyed cross section is shown in Figure 4-3.

Cross sections are taken of the floodplain at locations along the stream that are representative of local conditions. They are taken at each bridge or other major obstruction and at other locations, depending on how much the stream or adjacent floodplain conditions change.



Cross sections are shown on Floodway Maps with a line and a letter in a hexagon at each end (shown to the left). Take a look at Pontiac's Floodway Map in Section 23. Note that the study contractor took cross sections B and C on each side of the Route 66 bridges and E and F on each side of the railroad bridge.

Generally, the more changes there are in topography (e.g., steep river banks changing to large flat overbank area), the more cross sections are needed to define the floodplain accurately. For example, in the Pontiac study, the contractor decided to take a cross section at the dam (cross section D) to be sure that it will be reflected in the flood study.

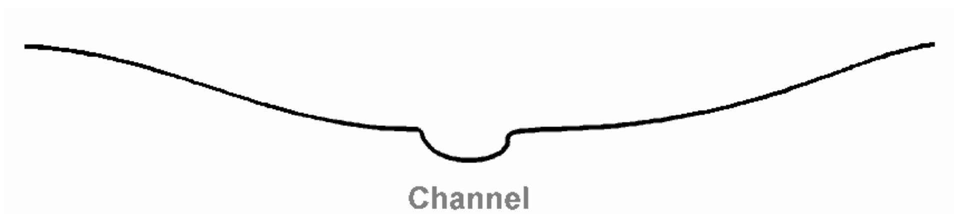


Figure 4-3: Surveyed cross section

4.4.3. Roughness

The surveyors and engineers also estimate the roughness factor along the floodplain to determine how fast floodwater will flow through the area. Roughness factors are related to ground surface conditions, and they reflect changes in floodwater velocity due to ground friction. For example, water will flow faster over mowed grass and pavement than it will over an area covered in bushes and trees, or planted in tall crops.

4.4.4. Hydraulics

For purposes of floodplain analysis, hydraulics is the study of floodwaters moving through the stream and the floodplain. Hydraulic analysis combines:

- Flood hydrology, i.e. the discharges.
- The cross section data on how much area there is to carry the flood.
- Stream and floodplain characteristics — "roughness," slope, locations and sizes of structures. Water will flow faster where the slope is steeper and the floodplain is "smooth," e.g., where there are no trees and buildings to cause turbulence. It can be seen that redeveloping an area can change the hydraulics of a flood.

The data are usually processed using a computer model, such as FEQ, HEC-2 or HEC-RAS. The hydraulic study produces determinations of flood elevations, velocities and floodplain widths at each cross section for a range of flood flow frequencies (Figure 4-4). These elevations are the primary source of data used by engineers to map the floodplain. See also pages 7 – 8 of Pontiac's FIS.

A Flood Insurance Study usually produces elevations for the 10-, 50-, 100-, and 500-year floods. Elevations for the 10-year, 50-year and 500-year floods are typically used for other floodplain management purposes. For example, the 10-year flood data may be used for locating septic systems, the 50-year flood for placing bridges and culverts, and the 500-year for setting critical facilities.

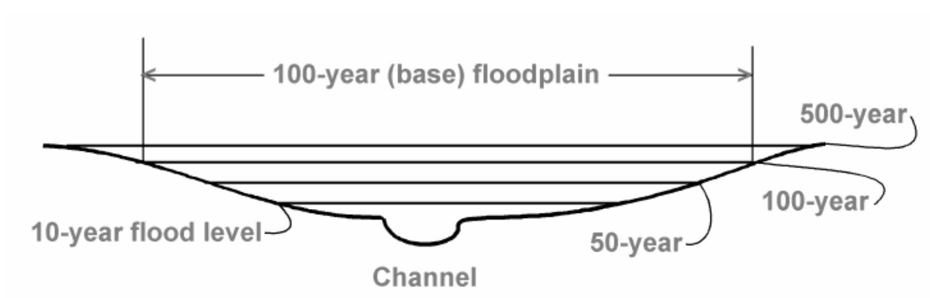


Figure 4-4: Cross section with flood elevations

4.5. Flood Profiles and Maps

4.5.1. Flood profiles

The hydraulic computer program gives elevations at each cross section, but flood elevations at locations between the cross sections need to be determined as well. This is done by plotting the elevations at the cross sections on a graph and connecting the plotted points. Such a graph is called a flood profile.

The flood profile for the Vermilion River in Pontiac is found in the back of the Pontiac FIS report. It comes in two pages, 01P is for the lower end of the river, up to Mill Street and the dam at cross section J. Profile 02P covers the reach that is upstream of Mill Street and the dam.

The bottom of the graph (the horizontal axis or x-axis) shows the distance along the stream, which is commonly called stationing. For stationing, start at the mouth of a stream (its point of discharge into a larger body of water) and look upstream. When profiles are plotted, the slope of the stream bed will rise when reading the graph from left to right.

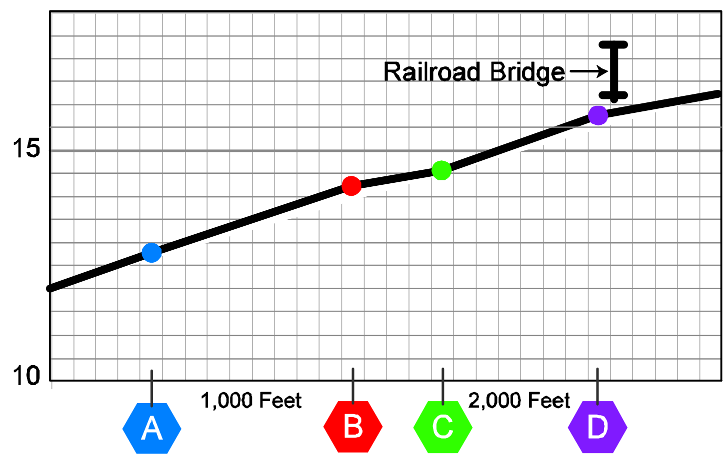


Figure 4-5: Profile.
The elevations for the base flood from cross sections A – D are plotted on a graph and the points are connected by lines to create the flood profile.

River distances are measured in either feet or stream miles. For most profiles the distance is measured above the mouth of the stream or above its confluence (where it meets with another stream).

The Vermilion River at Pontiac is 60 miles upstream of its confluence with the Illinois River. Therefore, the profile's stationing starts at the lower end of the study, at Airport Road. Stream distance is measured in feet above (upstream of) Airport Road.

The left side of the graph (the vertical axis or y-axis) shows elevation in feet (NGVD). The legend at the bottom right corner shows the symbol for each flood profile plotted. Bridges are indicated with an "I" shaped symbol, which represents the distance from the bridge's low chord (lowest beam) to the top of the roadway (Figure 4-5).

Additional information is provided on the profiles, such as corporate limits and confluences with smaller streams. Profiles also provide a picture of stream characteristics, such as steep sections of the stream bed and where restrictive bridge openings cause floodwaters to back up.

Figure 4-6 shows a profile for a steeper stream than the Vermilion River. Note the "I" for Ralph Plumb Street and how flood heights back up upstream (to the right) of the bridge. The bridge affects the 10-year flood profile more than the 100-year flood profile. This is because the higher floods flow over the bridge and it is less of an obstruction proportionally.

By reading a profile, the flood elevation at any point along the stream can be determined. Reading profiles is covered in Section 5.

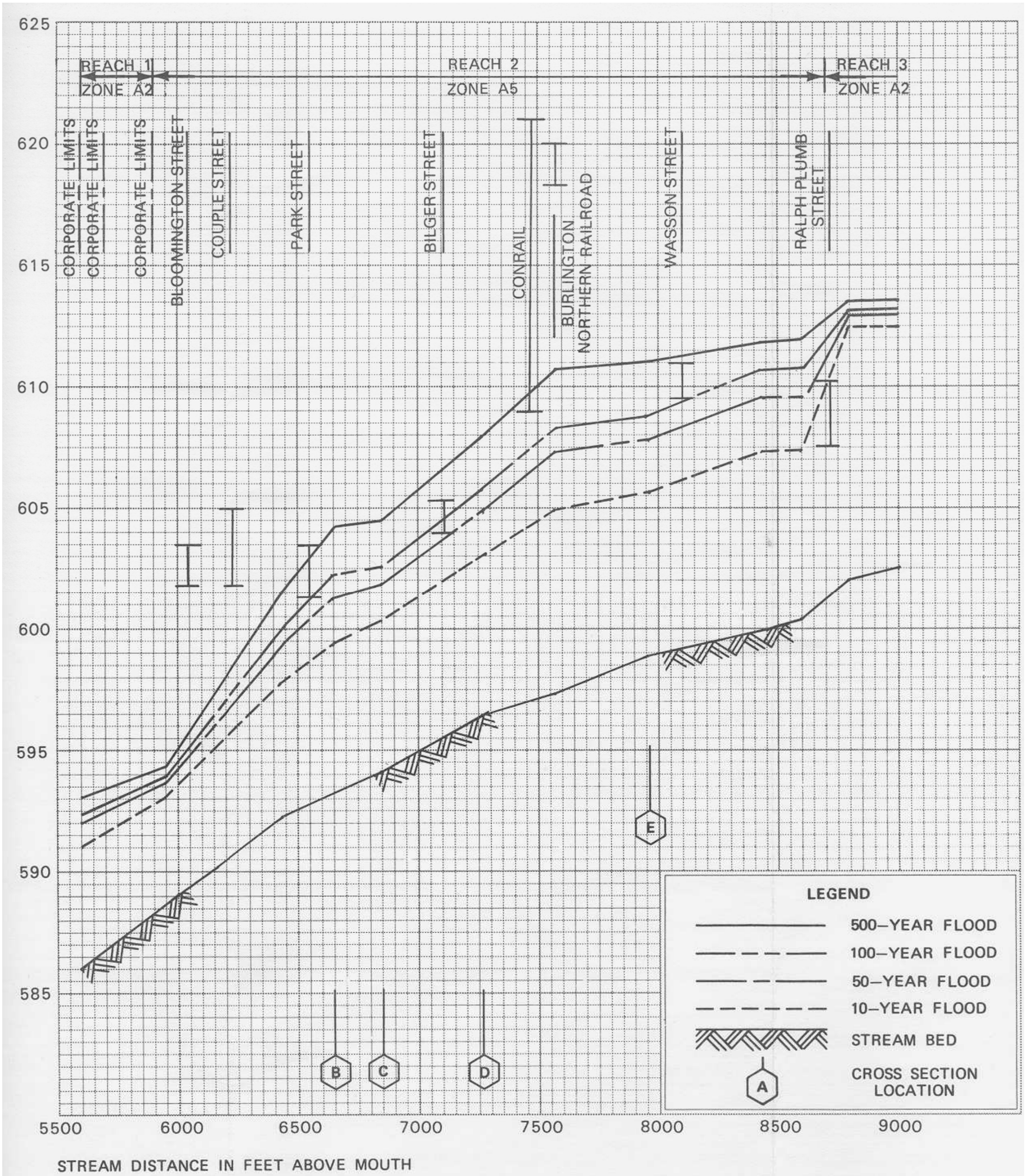


Figure 4-6: Flood profile for Prairie Creek in Streator, Illinois

4.5.2. Floodplain mapping

The next step in the mapping process is to transfer the flood elevation data onto a map showing ground elevation data. This is called a topographic map or contour map because points with the same elevation are connected by a contour line. The topographic or contour map is often referred to as the work map.

The most common topographic maps used are produced by the U.S. Geological Survey. Some communities have prepared their own topographic maps and provided them to FEMA to improve the accuracy of their floodplain maps.

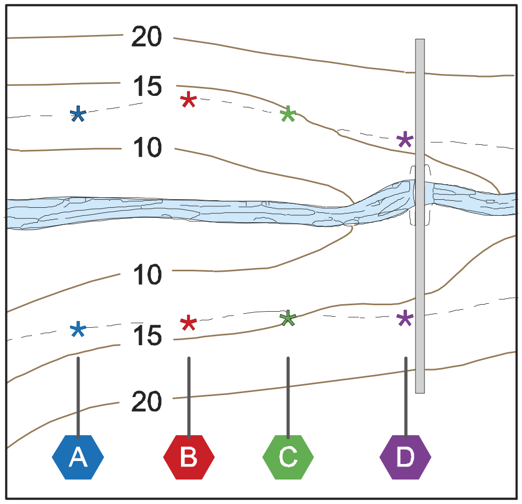


Figure 4-7: The flood elevations from the profile in Figure 4-5 are transferred to the contour map to delineate the floodplain boundary.

The base flood elevations from the cross sections and profiles are plotted on the topographic map. Floodplain boundary lines are drawn connecting these plotted points using the contour lines as a guide (see Figure 4-7). The completed map describes the base floodplain (the SFHA).

Floodplain map boundaries are only as accurate as the topographic map on which they are drawn. Since the USGS topographic quadrangle maps have so large a scale, the SFHA boundaries cannot be precisely mapped. This is important to remember when determining if a building is in or out of the floodplain.

Correlating map features with ground features requires care, because maps do not always represent exact conditions on the ground. Where there is an apparent discrepancy between flood boundaries shown on a map and actual ground conditions, the local floodplain administrator can use elevation data to resolve the matter by locating the flood elevation on the ground via an elevation survey. The elevation represents the actual extent of flooding for that particular flood.

It must be noted that banks (and others who must read the FIRM to determine if flood insurance is required) must go by the map. They cannot make on-site interpretations based on data other than the FIRM. However, they may recommend that the property owner submit a request for a map revision or map amendment so the map can be officially changed to reflect the more accurate data (see Section 7).

4.6. FLOODWAY MAPPING

The final step in preparing most riverine flood studies is to produce the floodway analysis, which identifies where encroachment by development can and cannot be allowed.

4.6.1. The floodway

The floodway is the stream channel and that portion of the adjacent floodplain which must remain open to permit passage of the base flood. Floodwaters generally are deepest and swiftest in the floodway, and anything in this area is in the greatest danger during a flood.

The remainder of the floodplain is called the fringe (Figure 4-8), where water may be shallower and slower. NFIP minimum standards provide that other areas outside the boundaries of the floodway can be developed. Consequently, most communities permit development in the fringe if the development is elevated or otherwise protected to the base flood level (or any higher state or local standards).

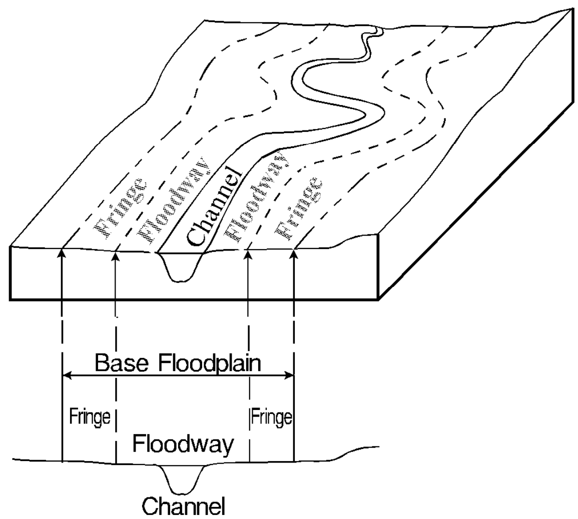


Figure 4-8: Floodway cross section and map

4.6.2. Floodway analysis

A floodway analysis determines the boundaries of the floodway using these floodplain management concepts:

- Continued development in the floodplain will likely further obstruct flood flows, which will back water up or divert it to other properties.
- Properties on both sides of a river or stream should be treated equitably. The degree of obstruction permitted now for one should be permitted in the future for the other.
- Property owners should be allowed to develop their land, provided they do not obstruct flood flows, cause damage or create a nuisance to others. (A community may allow development in the fringe that cumulatively increases the BFE, but State regulations specify that such total increases cannot exceed 1/10th foot (0.1') at any point along the stream.)

It should be noted that Illinois' 1/10th foot standard is more restrictive than FEMA's minimum requirement. Therefore, all Illinois communities with a floodway map are eligible for credit under the Community Rating System (see Section 18). In addition, Illinois requires the floodway to preserve 90% of the total floodplain volume and limits velocity increase to 10%.

A floodway analysis is done with a computer program that can make the necessary calculations of the effects of further development. Beginning at both edges of the floodplain, the computer model starts “filling” in the floodplain. This “squeezes” the floodwater toward the channel and causes the flood level to rise. At the point where this process reaches a 0.1 foot rise, the floodway boundaries are drawn (Figure 4-9).

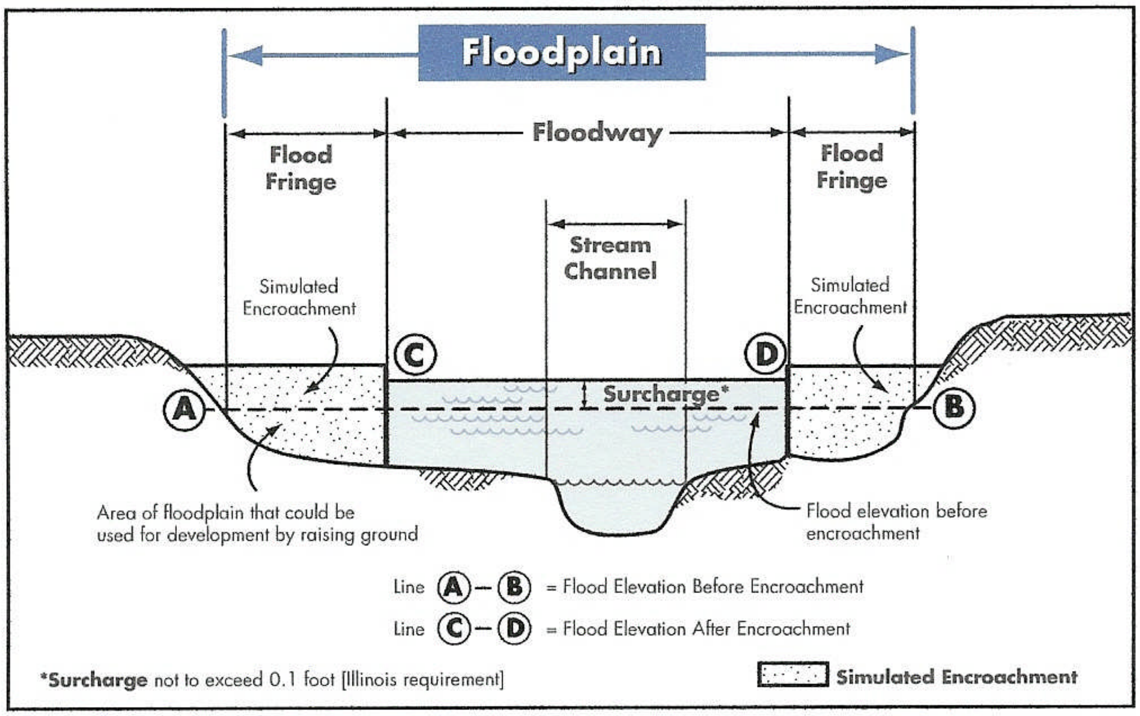


Figure 4-9: Computer floodway analysis
Source: IDNR’s Floodplain Management Quick Guide

The floodway boundaries at each cross section are transferred to the topographic or contour map that shows the SFHA map. The plotted points are connected to show the floodway and fringe on the floodplain map.

Not every cross section will show an exactly 0.1 foot rise. Topographic conditions and the need to “smooth out” the floodway line will result in some cross sections having surcharges of less than 0.1 foot.

Allowing flood heights to rise up to 0.1 foot is a compromise standard. Prohibiting any rise in flood heights would prohibit most types of development. On the other hand, allowing development to cause significant increases in flood heights can cause great problems for others.

A floodway analysis should be prepared with close coordination between the modeling engineer and those who are responsible for community planning and floodplain management.

The number of possible floodway configurations is almost limitless. Therefore, in choosing a regulatory configuration, the interests of individual property owners and the community as a whole must be weighed.

4.6.3. State review

When a flood study is completed, it is sent to IDNR's Office of Water Resources for the State review. IDNR issues a letter stating that the discharges, base flood elevations, and floodways have been approved for regulatory use.

FEMA will not publish a Flood Insurance Study, FIRM, Floodway Map, or a map revision without IDNR's approval.

4.7. OTHER FLOOD STUDIES

4.7.1. Shallow flood studies

For the NFIP, shallow flooding is defined as flooding with an average depth of one to three feet in areas where a clearly defined channel does not exist. Shallow flooding can exist in any of the following situations:

- *Ponding:* In flat areas, water collects or "ponds" in depressions.
- *Sheet flow:* In steeper areas where there are no defined channels or on flat plains, water will spread out over the land surface.
- *Urban drainage:* Local drainage problems can be caused where runoff collects in yards or swales or when storm sewers back up.

For the purposes of the NFIP, shallow flooding is distinguishable from riverine flooding because it occurs in areas where there is no channel or identifiable flow path.

Shallow flooding is mapped based on historic flood experiences and a study of the topography. In some areas, the techniques used for riverine studies are used. The result will either be a BFE (i.e., in NGVD) or a base flood depth (i.e., in feet above the ground). A shallow flooding study usually produces data for the base flood, but not for the 10-year or other floods.

These areas are usually designated as an "AO" or "AH" Zone on a FIRM (see Figure 5-14 in the next section).

4.7.2. Approximate studies

Detailed studies are expensive — a riverine study typically costs $5,000 to $10,000 per mile of stream that is to be mapped — so it is not cost effective to perform a detailed study in watersheds where there is little or no development and none is anticipated, such as in rural areas.

Some NFIP maps show floodplains that were mapped using approximate study methods. Using flood data and floodplain information from a variety of sources — such as soils mapping, actual high water profiles, aerial photographs of previous floods, topographic maps — the approximate outline of the base floodplain for specific stream reaches was overlaid on available community maps, usually U.S. Geological Survey topographic quadrangle maps.

An approximate study shows the estimated boundary of the SFHA. It does not establish a BFE, as there are no elevation data in the FIS report and therefore no designated floodways. The boundaries are drawn on the best available topographic map using knowledge of past floods and the judgment of experienced engineers.

Many flooding sources have been studied by other federal, state or local agencies. Such studies that do not meet the NFIP standards for an FIS often contain valuable flood hazard information which may be incorporated into NFIP maps as approximate studies.

For example, most approximate floodplains in northeastern Illinois were taken from the Hydrologic Atlas prepared by the Northeastern Illinois Planning Commission and the U.S. Geological Survey in the 1970s. This atlas was based on USGS contour maps and showed reported historical flooding.