Floodplain Mapping – Strategic Planning for MT

INTRODUCTION TO FLOODPLAIN MAPPING

INTRODUCTION

Intro to Floodplain Mapping

OVERVIEW

NFIP Background

Flood Map Development Process

Generating SFHA/Floodplain Map Data

- Standards
- Hydrology
- Hydaulics
- Work Map/DFIRM Production

Elevation/Topography Data

Aerial Photogrammetry & LiDAR

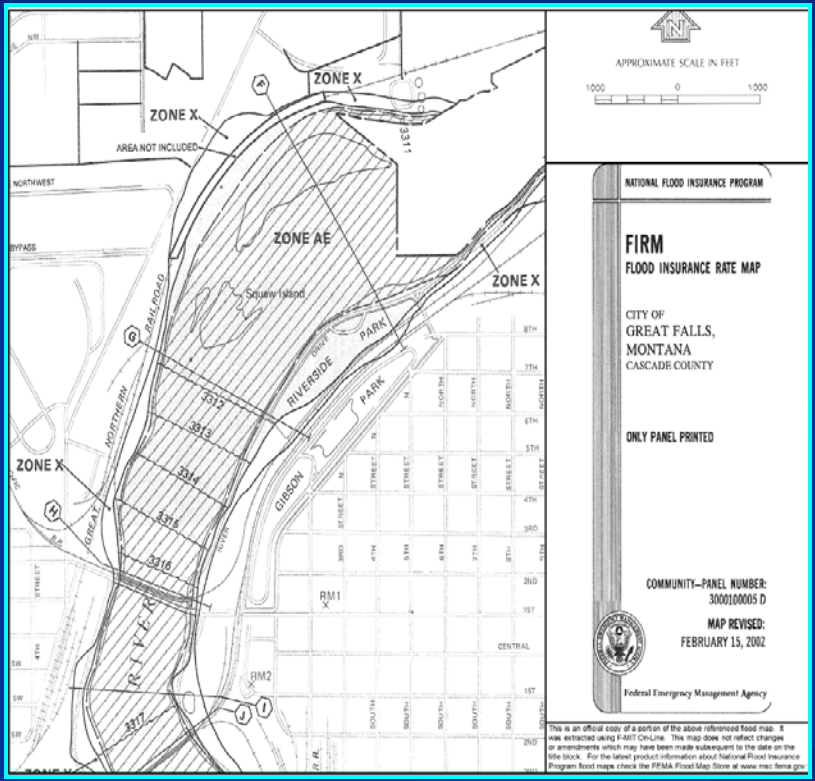
NFIP Background

There are 3 basic parts to the NFIP

1) Regulations
2) Insurance
3) <u>MAPPING</u>

NFIP Background

FEMA has prepared a floodplain map and developed flood hazard data for most communities in the country These maps are used for the following:



Regulating Development

Used for determination of the flood insurance purchase requirement.

Used to determine insurance rating

NFIP Background

The National Flood Insurance Act of 1968 directed FEMA to:

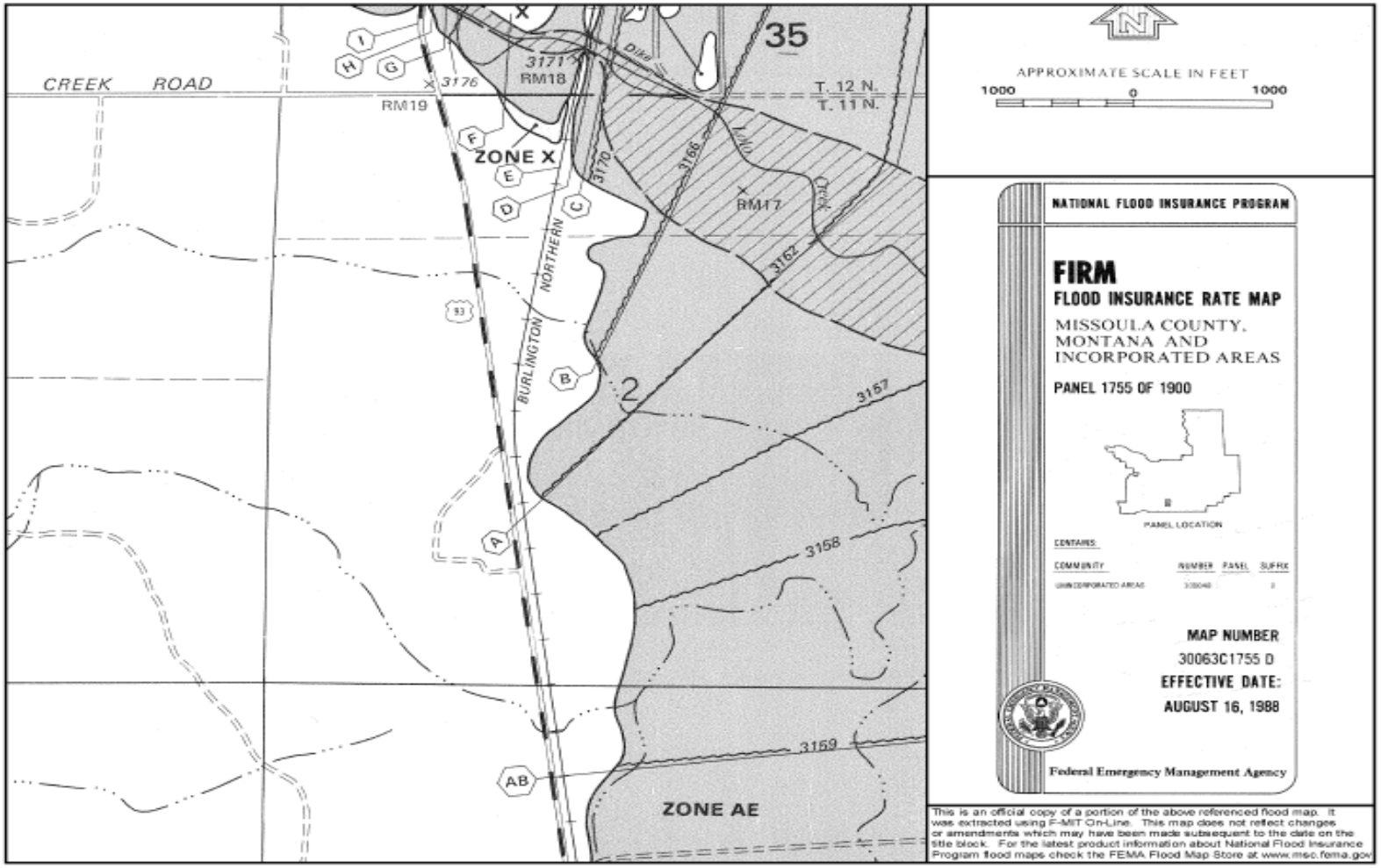
1) Identify all Floodprone areas within the US
2) Establish Flood Risk Zones in floodprone areas

NFIP Background

FEMA has issued 3 types of maps:

1) Flood Hazard Boundary Map (FHBM): First Generation Maps, Approximate
2) Flood Insurance Rate Map (FIRM): A more detailed depiction of the floodplain based of a flood insurance study. A FIRM ***usually*** provides base flood elevations for portions of the flood-plain.
3) NEW Digital Flood Insurance Rate Map (DFIRM)

Flood Insurance Rate Maps (FIRMS) also referred to as Flood Maps



Flood Map Development Process

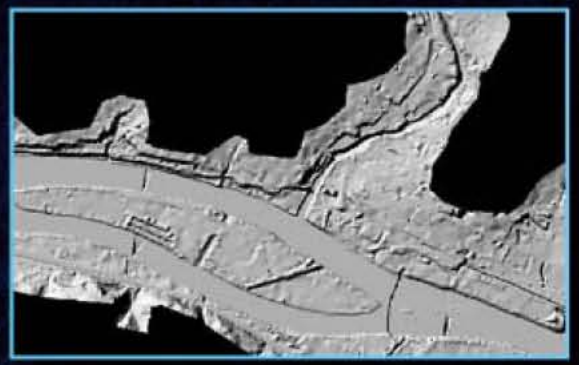
Floodplain Mapping Steps

1) Gather Topographic Data ($$$)
   - Floodplain Topography
   - Stream Cross Sections
2) Develop Hydrology: Determine 100-year discharge
3) Perform Hydraulic Analysis: HEC-RAS modeling
4) Delineate floodplain boundaries on map
5) Local/State/FEMA adoption

Primary Components of DFIRM

BASE

+



TOPOGRAPHY

+

FLOOD DATA

= DFIRM

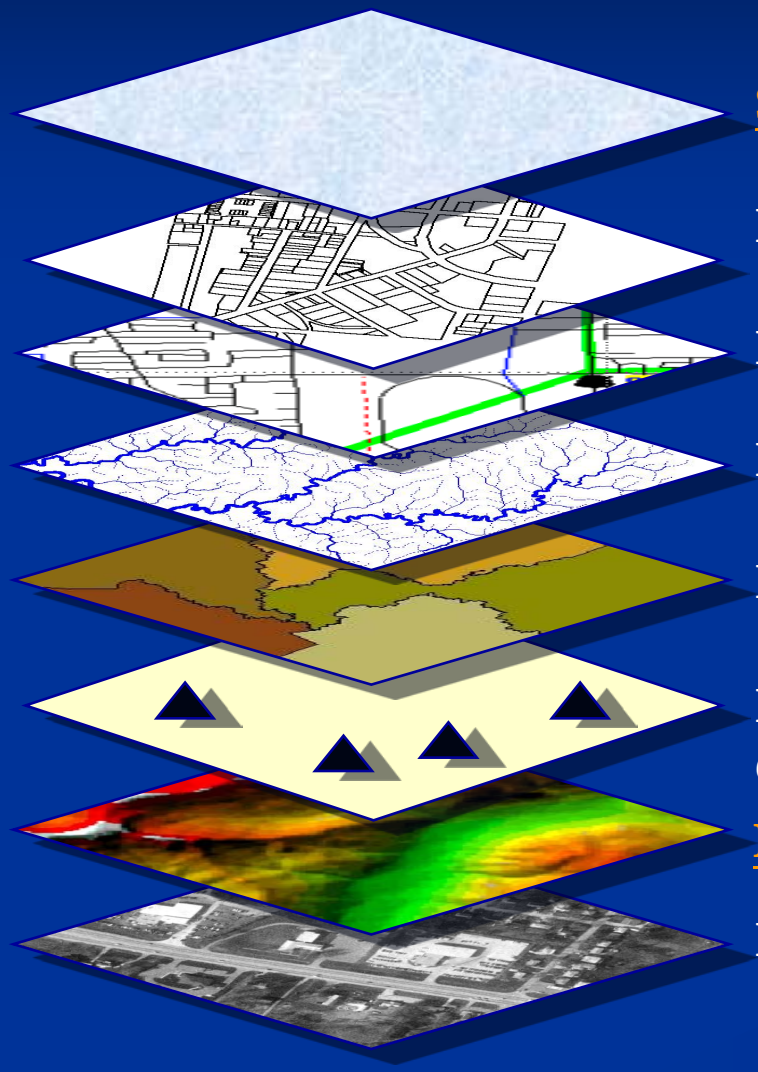
FEMA

DFIRM Development

What Kind of Data Does it Take to Create a DFIRM?

- Topography
  - New or Existing
  - Vertical coordinates (elevations) NAVD1988
- Hydrologic & Hydraulic Data
  - Engineering Analysis
- Base Map Data
  - Horizontal coordinates (NAD83)
  - Streets, streams, rivers, boundaries, etc.
- Other…land ownership, Letters of Map Revision (LOMR), etc.

DFIRM GIS/Map Layers



Special Flood Hazard Areas
= Flood Data

Base Map: Political Areas

Base Map: Transportation

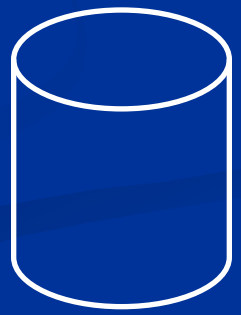
Base Map: Surface Waters

Base Map: Boundaries

Base Map: Geodetic Control/Benchmarks

Elevation (Topography)

Base Map: Aerial Imagery



DFIRM Geodatabase & Map

FEMA

DFIRM Flood Data

The Special Flood Hazard Area (SFHA)

The area of land inundated by the Base Flood, as depicted on a NFIP map.

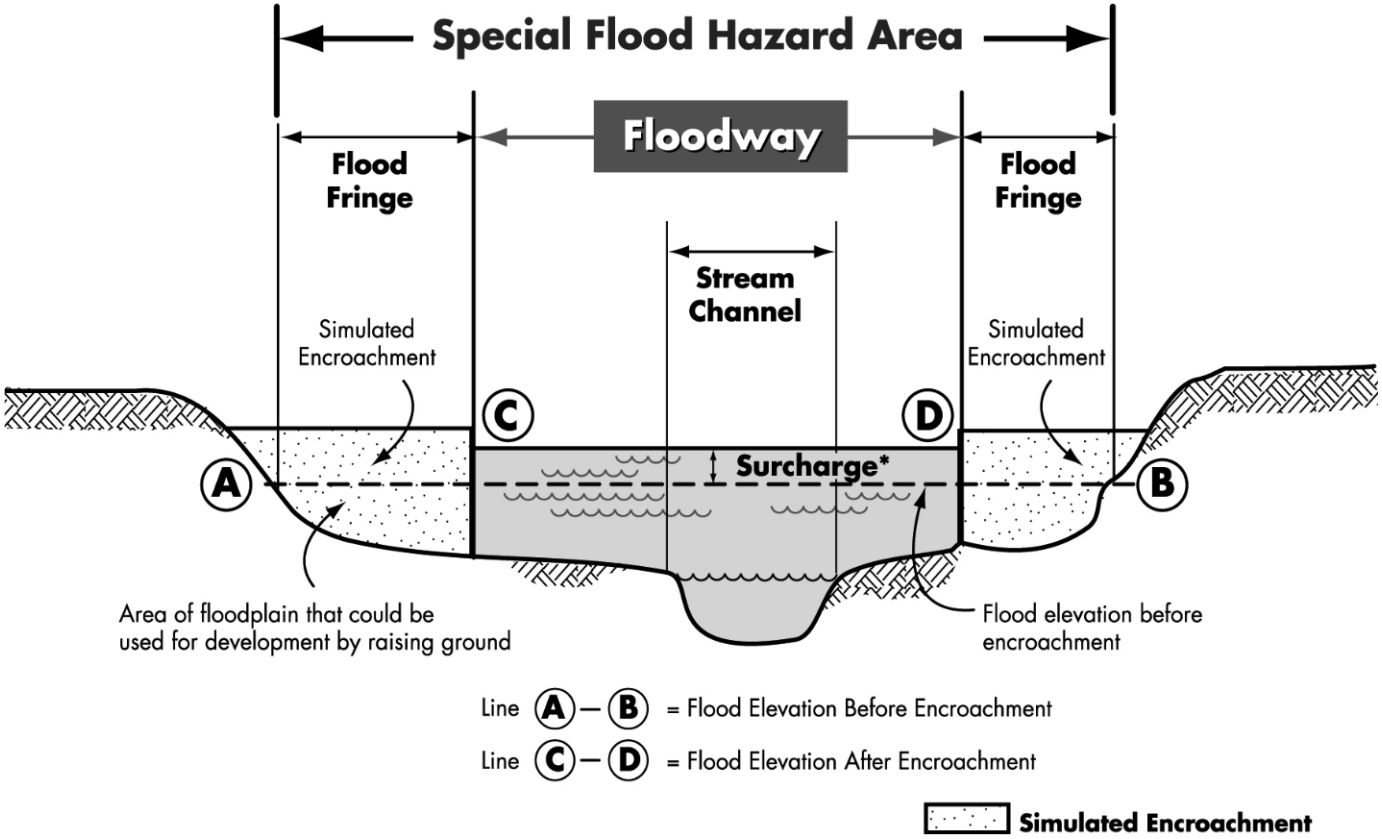
The minimum area subject to floodplain management regulation under the NFIP.

The SFHA includes both the floodway and flood fringe.

DFIRM Flood Data

The Special Flood Hazard Area (SFHA)

What makes up a Special Flood Hazard Area (SFHA)



Surcharge not to exceed .5 foot (State of Montana requirement)

Generating SFHA/Floodplain Map Data

Need to Establish Common Mapping Standards and Guidelines

Floods are variable in Magnitude & Frequency

Rainfall/Snowmelt - RUNOFF – Flooding

Magnitude/Size of flood measured by the streamflow or discharge (cfs)

Frequency is the recurrence interval, i.e., 50-year, 100-year, etc.

Probability: the 100-year discharge is 500 cfs.

Generating SFHA/Floodplain Map Data

NFIP adopted Baseline Probability called the BASE FLOOD

Base Flood = 100-year flood =

One-percent Annual Chance Flood

Is the National Standard for regulating new development and the mandatory purchase of flood insurance

Compromise between 5-year & 500-year

Hydrology

The scientific process combining engineering and statistical methods used to estimate flooding magnitude and frequency/recurrence.

Base Flood - The recurrence interval in terms of probability is 100-years: 1 divided by 0.01 (or 1%) =100

Flow rates for given recurrence intervals (Ex):

500-year: 1000 cfs

1000-year: 800 cfs

50-year: 500 cfs

10-year: 350 cfs

Questions

100-year Flood

(has a 1% chance of occurring in any given year)

Occurs only once every hundred years?

Can occur twice in the same year?

May not occur for 200 years?

Is likely to occur soon if it hasn't happened in the last 98 years?

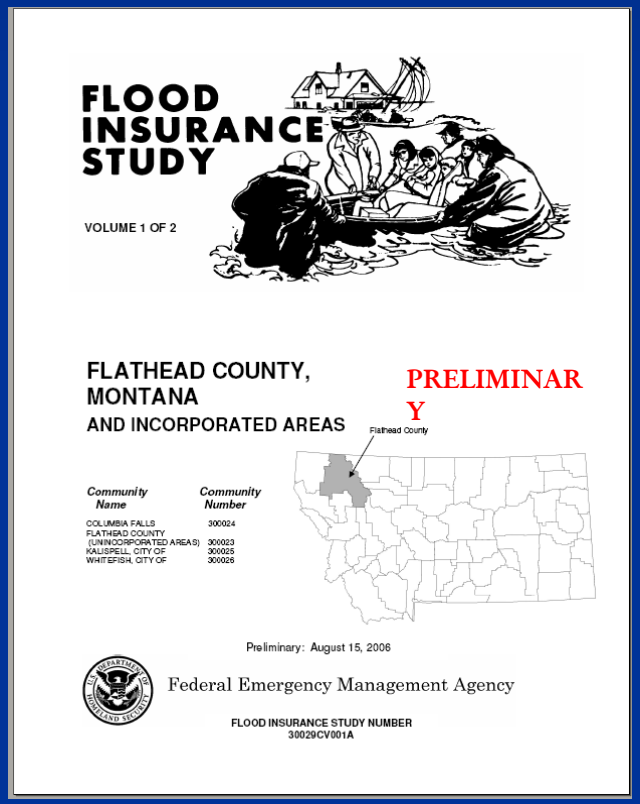
Generating SFHA/Floodplain Map Data

Flood Study Development

The data from the Hydrologic and Hydraulic analyses are used to develop the Flood Insurance Study (FIS) components:

- FIS Report includes: Purpose, Flood History, H&H details, summary of discharges table, floodway data tables, stream profiles.
- Maps - FIRM/DFIRMs

Flood Insurance Study (FIS)



FLOOD INSURANCE STUDY

VOLUME 1 OF 2

FLATHEAD COUNTY, MONTANA

AND INCORPORATED AREAS

PRELIMINARY

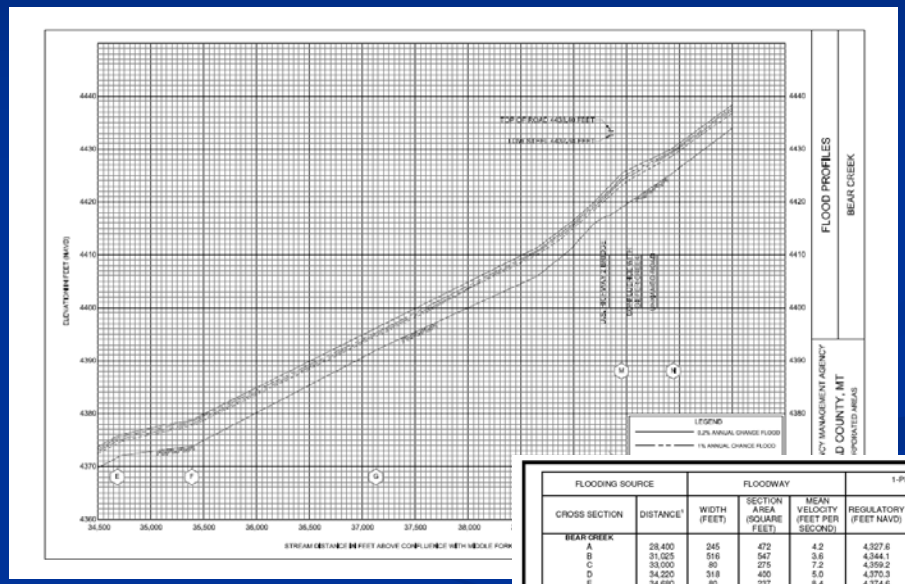
Flathead County

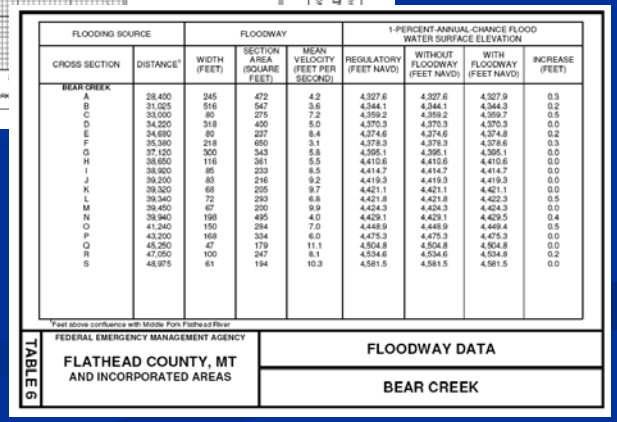
Community Name	Community Number
COLUMBIA FALLS	300024
FLATHEAD COUNTY (UNINCORPORATED AREAS)	300023
KALISPELL, CITY OF	300025
WHITEFISH, CITY OF	300026

Preliminary: August 15, 2006

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER 30029CV001A





FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BEAR CREEK								
A	28,400	245	472	4.2	4,327.6	4,327.6	4,327.9	0.3
B	31,025	516	547	3.6	4,344.1	4,344.1	4,344.3	0.2
C	33,000	86	275	7.2	4,359.2	4,359.2	4,359.7	0.5
D	34,220	318	400	5.0	4,370.3	4,370.3	4,370.3	0.0
E	34,690	80	237	8.4	4,374.6	4,374.6	4,374.8	0.2
F	35,380	218	650	3.1	4,378.3	4,378.3	4,378.6	0.3
G	37,120	300	343	5.8	4,395.1	4,395.1	4,395.1	0.0
H	38,650	116	361	5.5	4,410.6	4,410.6	4,410.6	0.0
I	38,920	85	233	8.5	4,414.7	4,414.7	4,414.7	0.0
J	39,200	83	216	9.2	4,419.3	4,419.3	4,419.3	0.0
K	39,320	68	205	9.7	4,421.1	4,421.1	4,421.1	0.0
L	39,340	72	293	6.8	4,421.8	4,421.8	4,422.3	0.5
M	39,450	67	200	9.9	4,424.3	4,424.3	4,424.3	0.0
N	39,940	198	495	4.0	4,429.1	4,429.1	4,429.5	0.4
O	41,240	150	284	7.0	4,448.9	4,448.9	4,449.4	0.5
P	43,200	168	334	6.0	4,475.3	4,475.3	4,475.3	0.0
Q	45,250	47	179	11.1	4,504.8	4,504.8	4,504.8	0.0
R	47,050	100	247	8.1	4,534.6	4,534.6	4,534.8	0.2
S	48,975	61	194	10.3	4,581.5	4,581.5	4,581.5	0.0

[1]Feet above confluence with Middle Fork Flathead River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

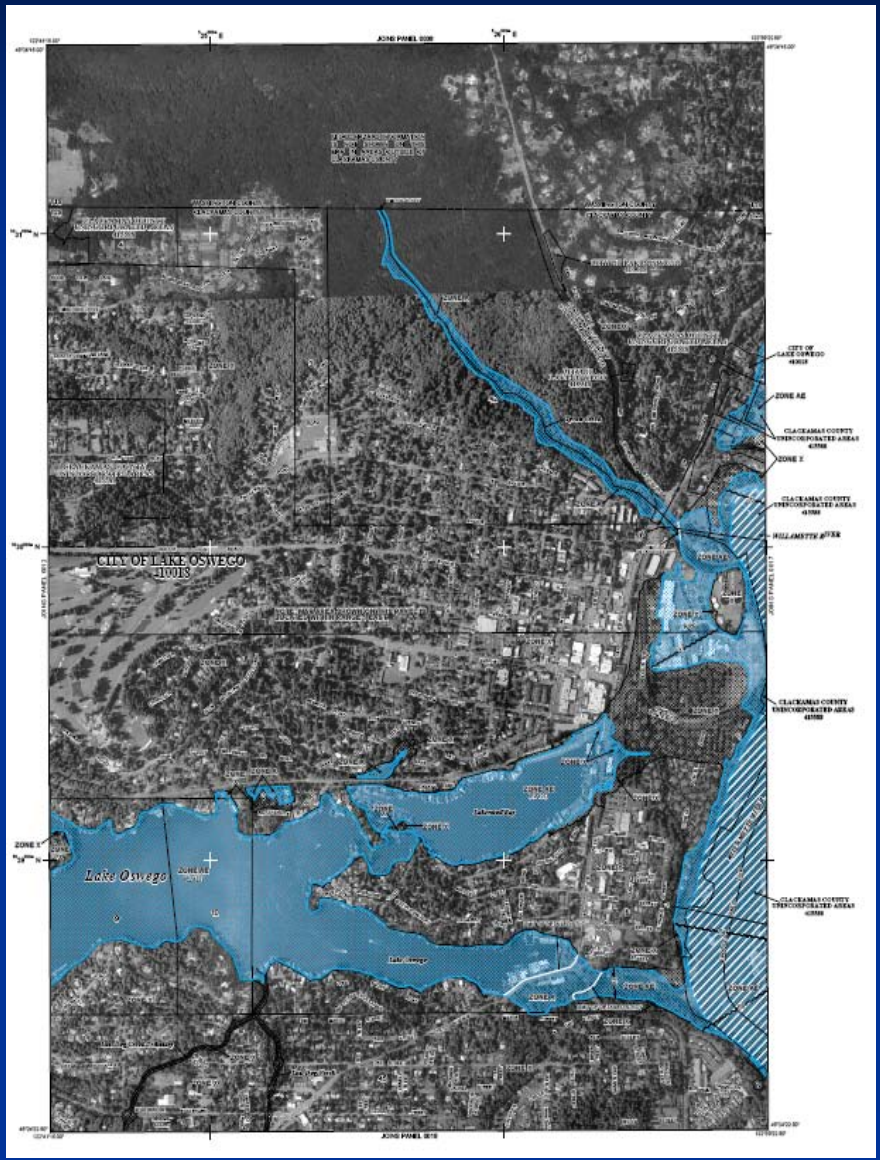
FLOODWAY DATA

BEAR CREEK

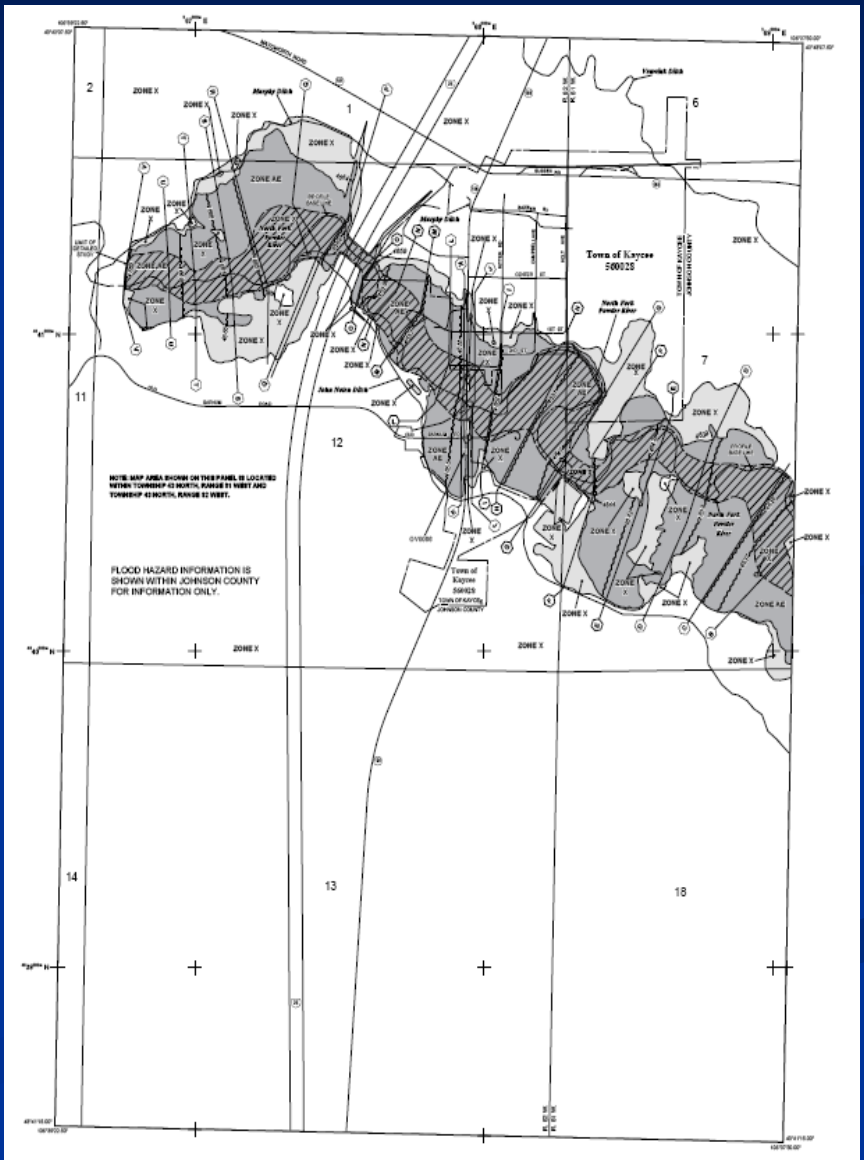
FEMA

DFIRM vs. FIRM

DFIRM



FIRM



Hydraulics

The science of fluids in motion. For floodplain analysis, it's the study of floodwaters moving through the stream and floodplain.

Hydrologic analysis is the process used to estimate flood depths and velocities for a given quantity of water along the stream channel.

Used to generate the Base Flood Elevation data (100-year water surface elevations).

Hydraulics

Hydraulic Analysis – Data Requirements:

Flood Discharges (from Hydrologic analysis): For detailed studies, need the 10,50,100, & 500-year discharges.

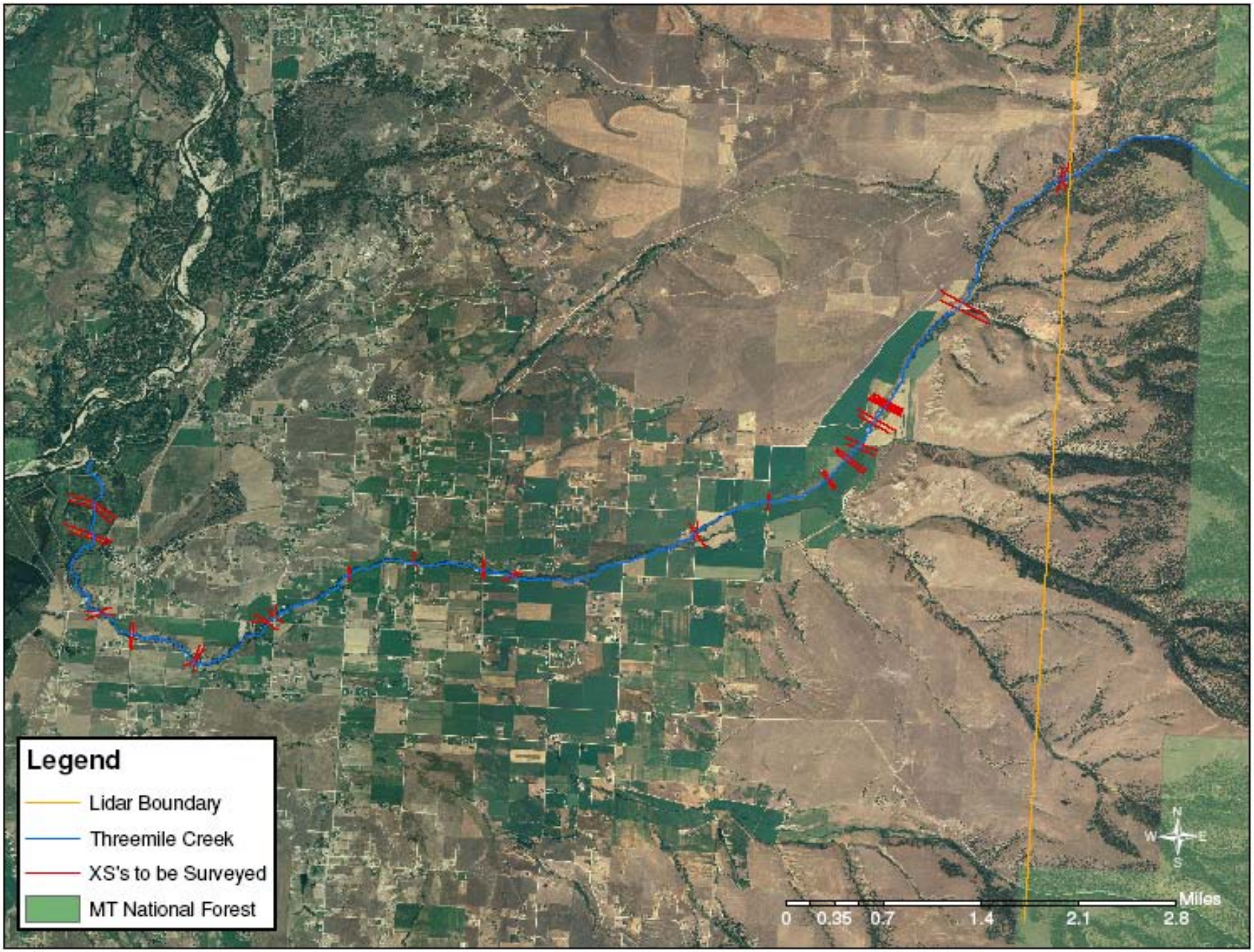
Geometric Data – Channel cross-sections (from ground survey, aerial mapping (photogrammetry or LiDAR) or topo maps)

Stream Characteristics: channel slope, roughness, obstructions (bridges, culverts).

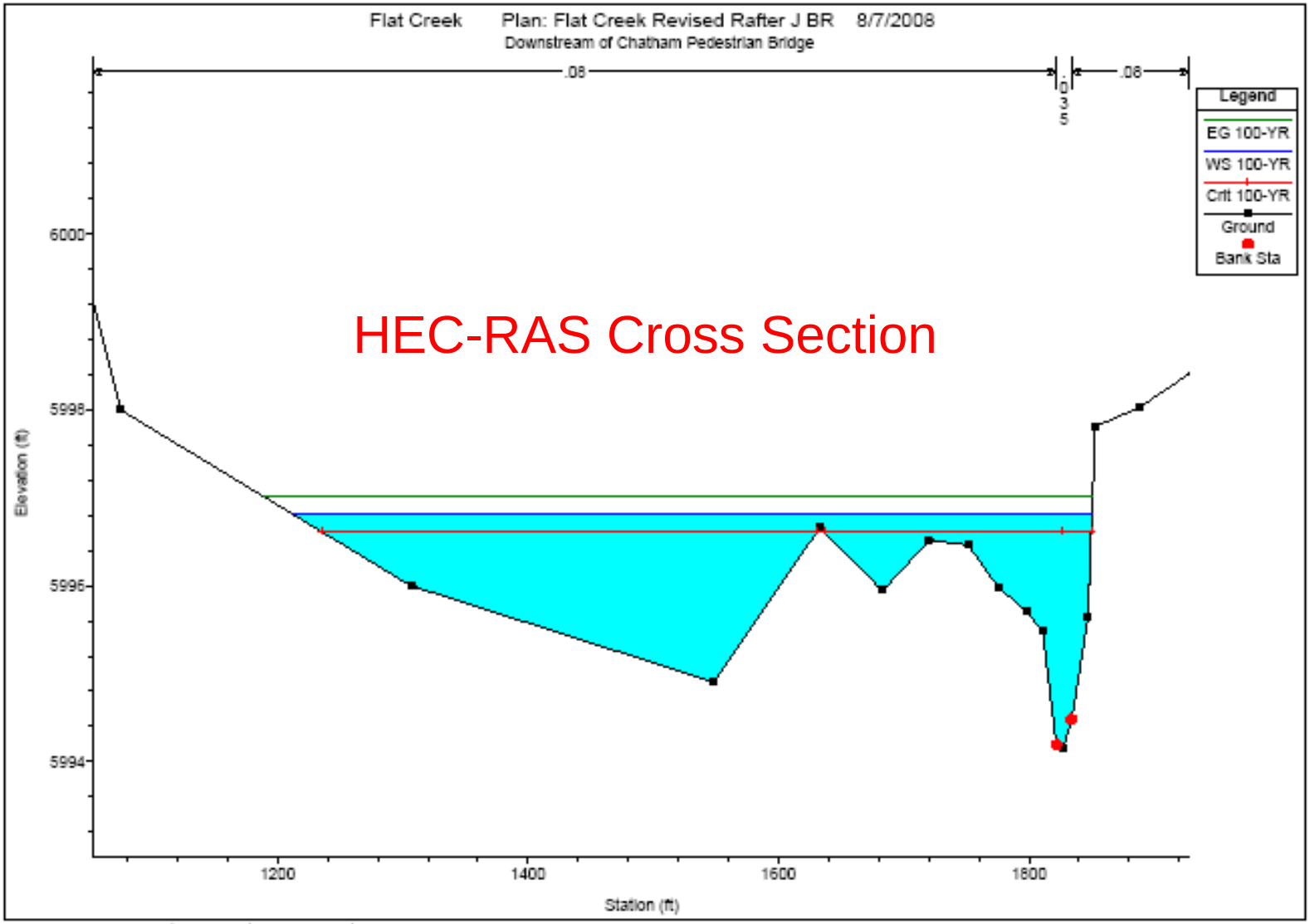
Hydraulics

Stream Channel Cross Section

- Graphical depiction of the stream and floodplain at a specific point along the stream.
- Cross sections are ground surface profiles that represent the geometry of the stream.
- Measured perpendicular to stream flow; figures presented with downstream view
- Required at representative locations: changes in slope, shape, roughness, structures, etc.
- Detailed Study: every 1000’ min (typically)


Legend
Lidar Boundary
Threemile Creek
XS's to be Surveyed
MT National Forest
N
W
E
S
Miles
0
0.35
0.7
1.4
2.1
2.8

Cross Section: 100-year Discharge



1 In Horiz. = 115.5751 ft 1 In Vert. = 1.603296 ft

Hydraulics

Hydraulic Modeling

Hydraulic analysis is usually performed using computer modeling software by Engineers

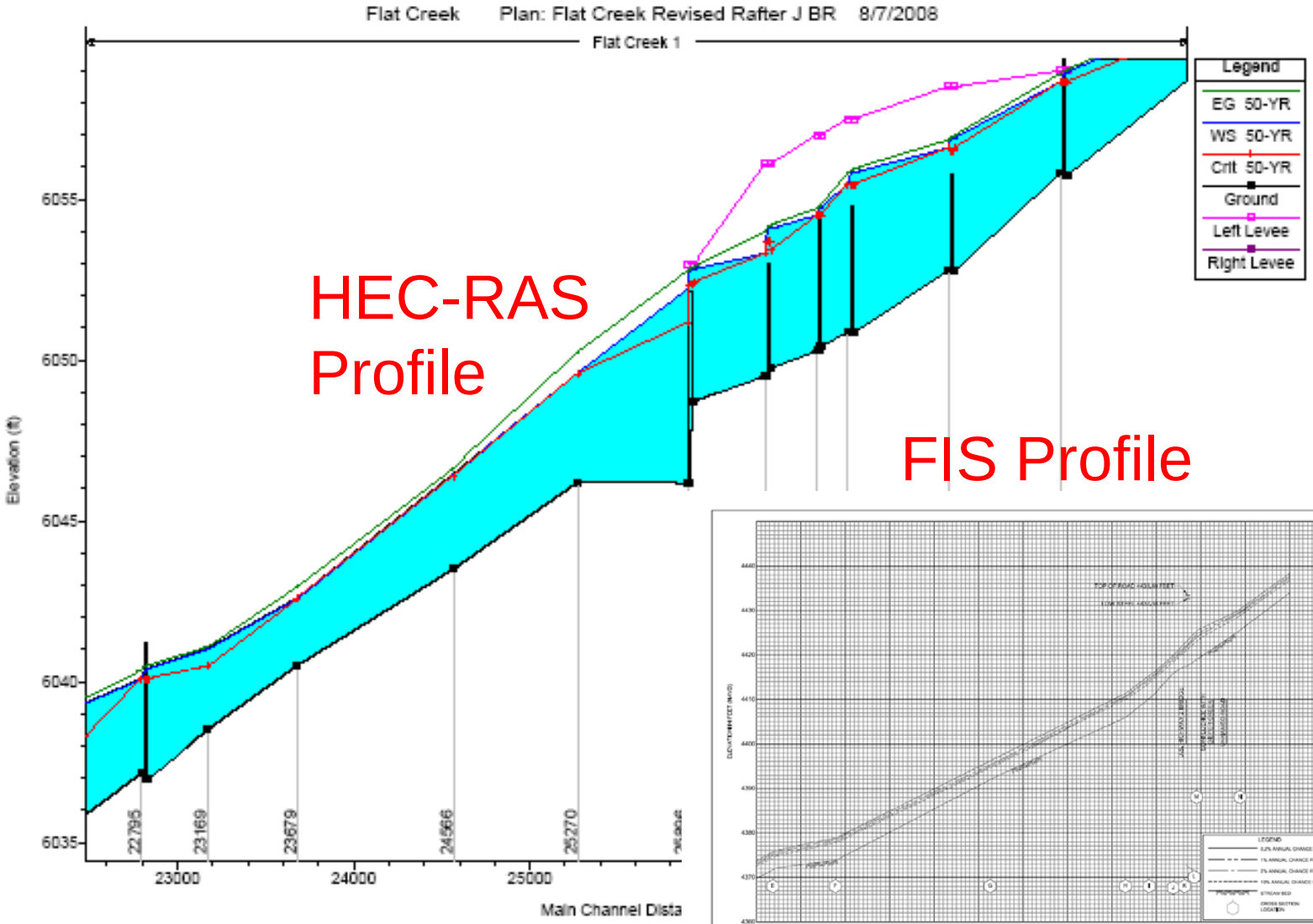
USACE software: HEC-RAS (typical/standard)

Programs must be approved by FEMA

Data output/results include:

- Water surface elevations (BFEs)
- Flood Profiles (for 10,50,100, & 500-year discharges)
- Water velocity & Floodway data

Flood Profile: 100-year Discharge



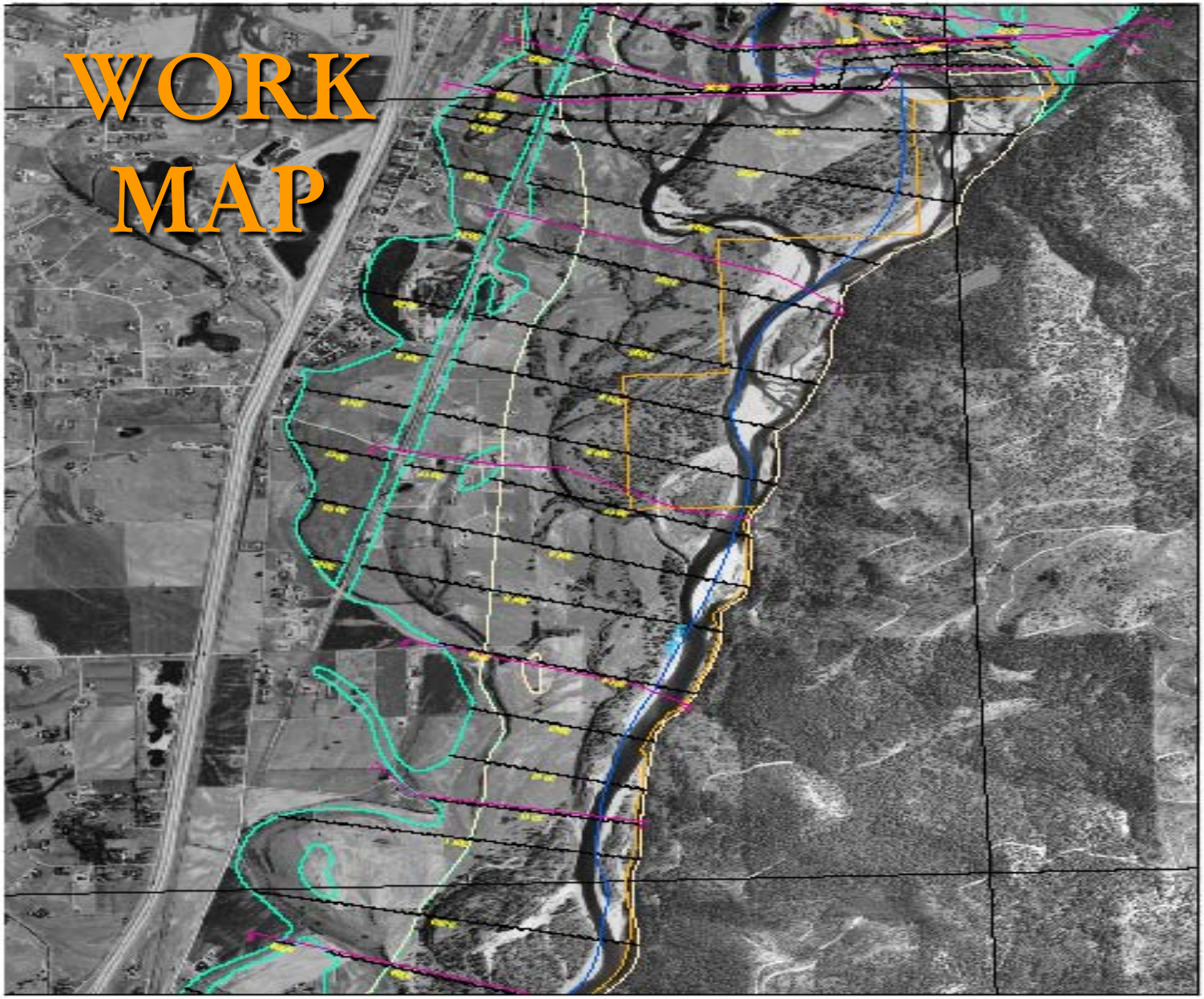
Work Map/DFIRM Production

Work Map & HEC-RAS model developed concurrently

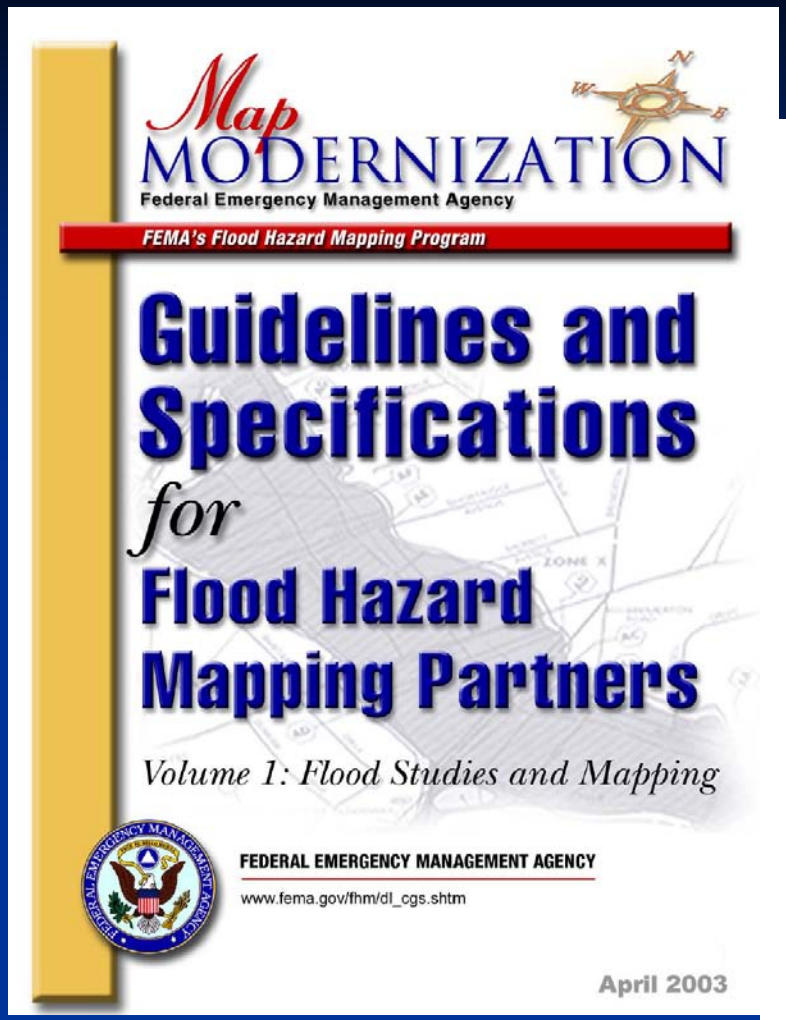
Work Map –

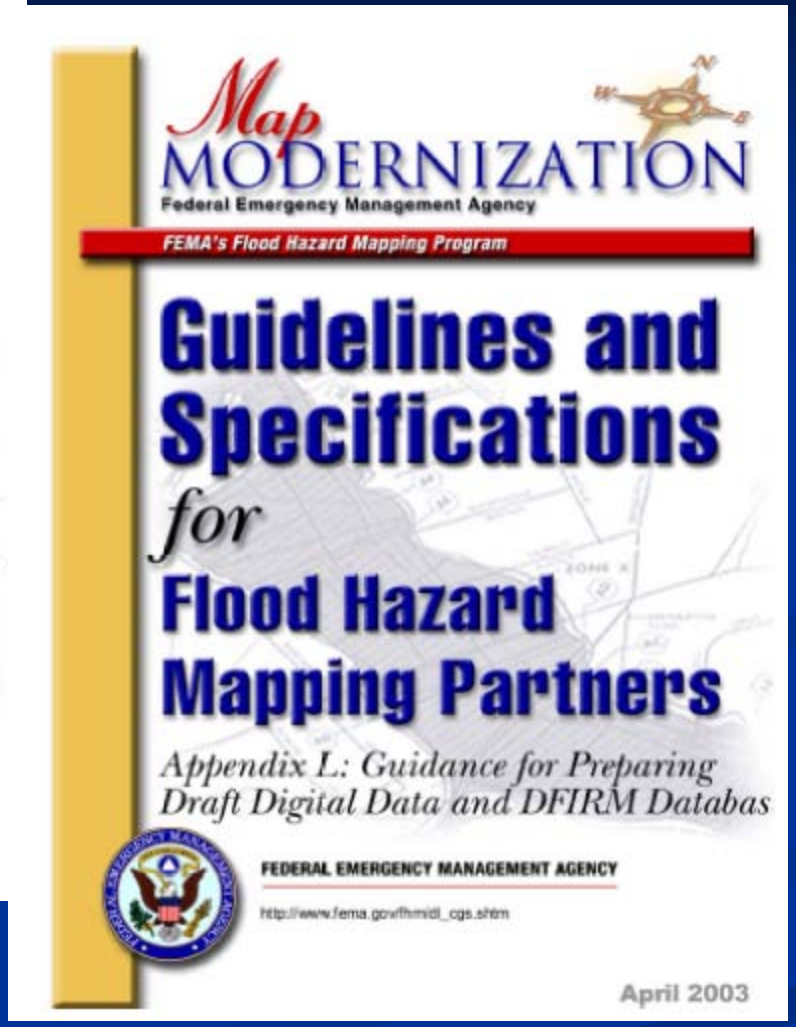
- Serves as the basis for the DFIRM
- Used to layout/align cross sections
- Includes topography/contour data – used to delineate floodplain boundaries between cross sections
- Floodplain & Floodway limits based on Hydraulic analysis results at each cross section.

WORK MAP



Sample DFIRM





http://www.fema.gov/fhm/dl_cgs.shtm

Elevation/Topography Data

Topographic data needed to generate cross sections (hydraulic analysis) and to delineate floodplain boundaries

- Acquired through ground and/or aerial surveying and mapping
- Ground Survey: Typically completed to supplement aerial survey data for structures and bathymetric (below water surface) topography
- Aerial Mapping: Traditional photogrammetry or the newer LiDAR Technology

Floodplain Boundary Standards (FBS)

Help ensure that reliable, accurate, defendable flood hazard maps and data are produced.

- **The Best Available terrain is used to map flood risks**
- **Floodplain boundaries meet quantifiable vertical elevation accuracy standards**

"This single step goes a long way toward alleviating the concern of having boundaries that were improperly drawn on the paper maps simply transferred to the digital maps."

FEMA Data Standards – Local Data

1. Data originating from Community or State (that meet FEMA Standards) will be the first choice.

   Must Meet FEMA Requirements For:

   - Accuracy (horizontal and vertical)
   - Currency (created, updated or reviewed <7 years)
   - Distribution

2. Default base map, if no other local data available, will be USGS - Digital Orthophoto Quads (DOQs)

LiDAR

LIDAR is "LIght Detection And Ranging".

LIDAR is a remote sensing system used to collect detailed topographic data.

What can you do with LIDAR?

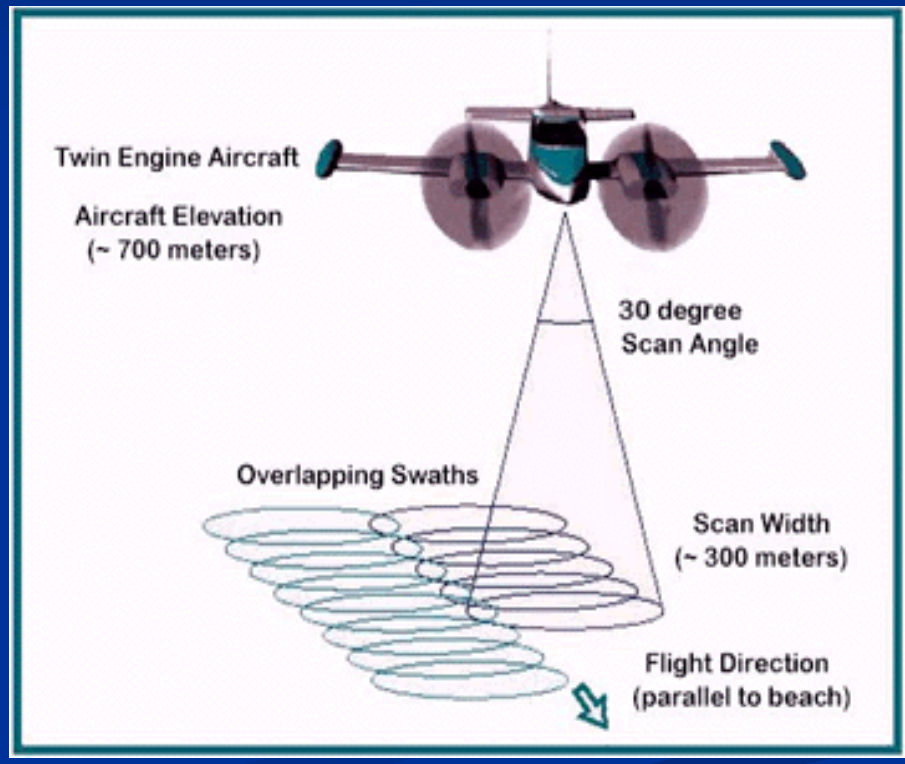
- Topographic Mapping
- Geomorphic Mapping
- Vegetation Mapping
- Habitat Mapping
- Forest Inventory

–Note: Secondary beneficial uses of LiDAR mapping are great and may include water quality studies, wetland delineation, wildlife habitat, geologic mapping and many others.

How Are LIDAR Data Collected?

AirCraft!

LiDAR data are collected with aircraft-mounted lasers and GPS capable of recording elevation measurements at a rate of up to 100,000 pulses per second and having a vertical precision of 6-inches with up to four "returns" per pulse.



RU
R44

LiDAR System

Sensor – directly measure the surface of different features

Measures elevation of terrain features such as the ground surface, trees, and buildings

Use GPS to define aircraft location

Use IMU to define aircraft position

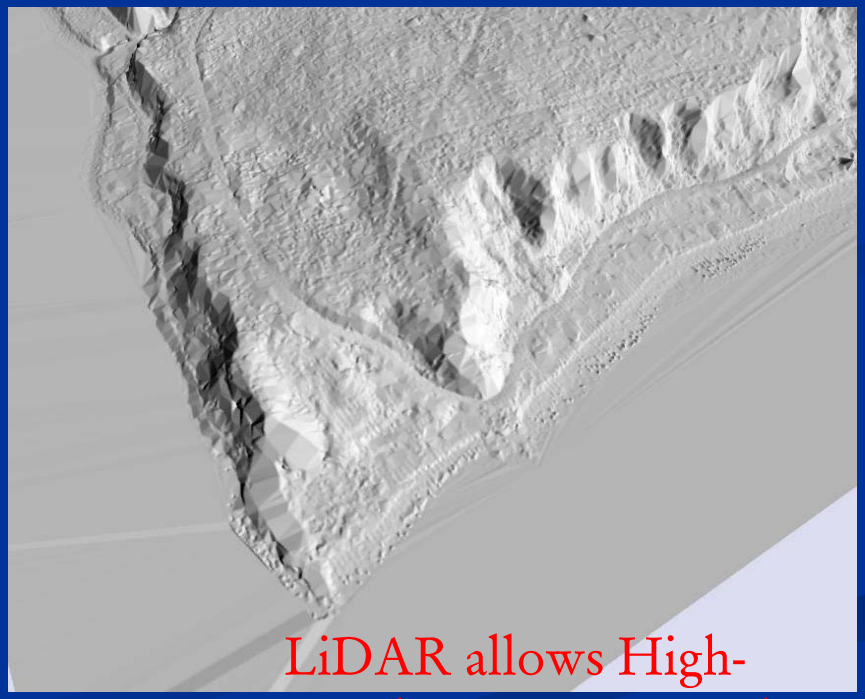
(roll, pitch, and yaw)

LiDAR Advantages & Capabilities

- Collect large data sets quickly & economically
- Data can be collected day or night
- Acquisition in all seasons (leaf on & leaf off)
- Canopy Penetration – better results than traditional photogrammetry
- Highly accurate: capable of 6” horizontal and vertical accuracies

LiDAR

Example of LiDAR Mapping in Puget Sound



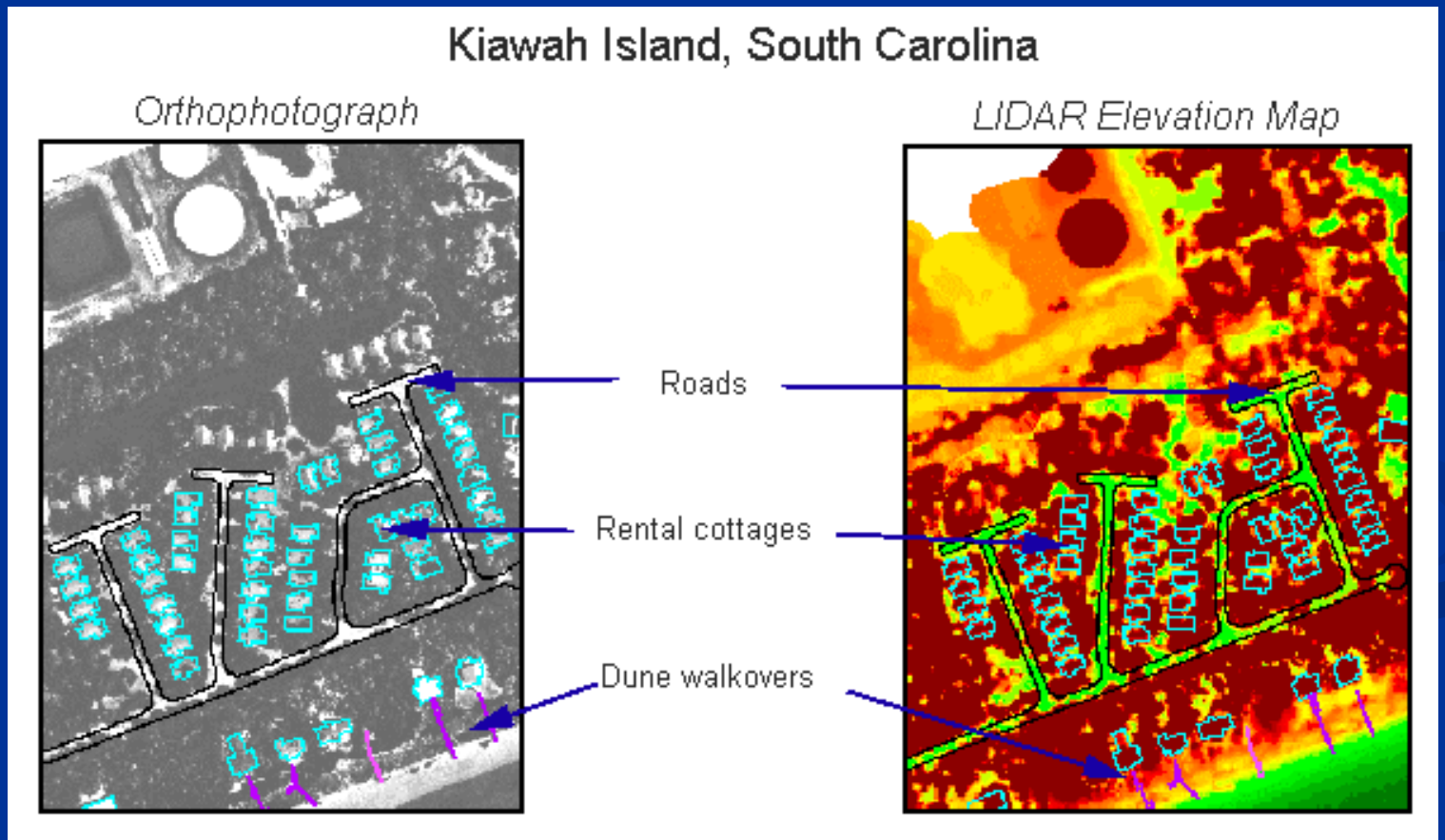
LiDAR allows High-Resolution Topography even in Trees!

Challenges of LiDAR Collection

- Optimal weather conditions necessary for data collection
- Water features generally absorb or scatter laser pulses – thus additional bathymetric data required to support LiDAR collection
- Small projects less economical
- Data processing
- Large data sets cumbersome to store, render, manipulate, and analyze

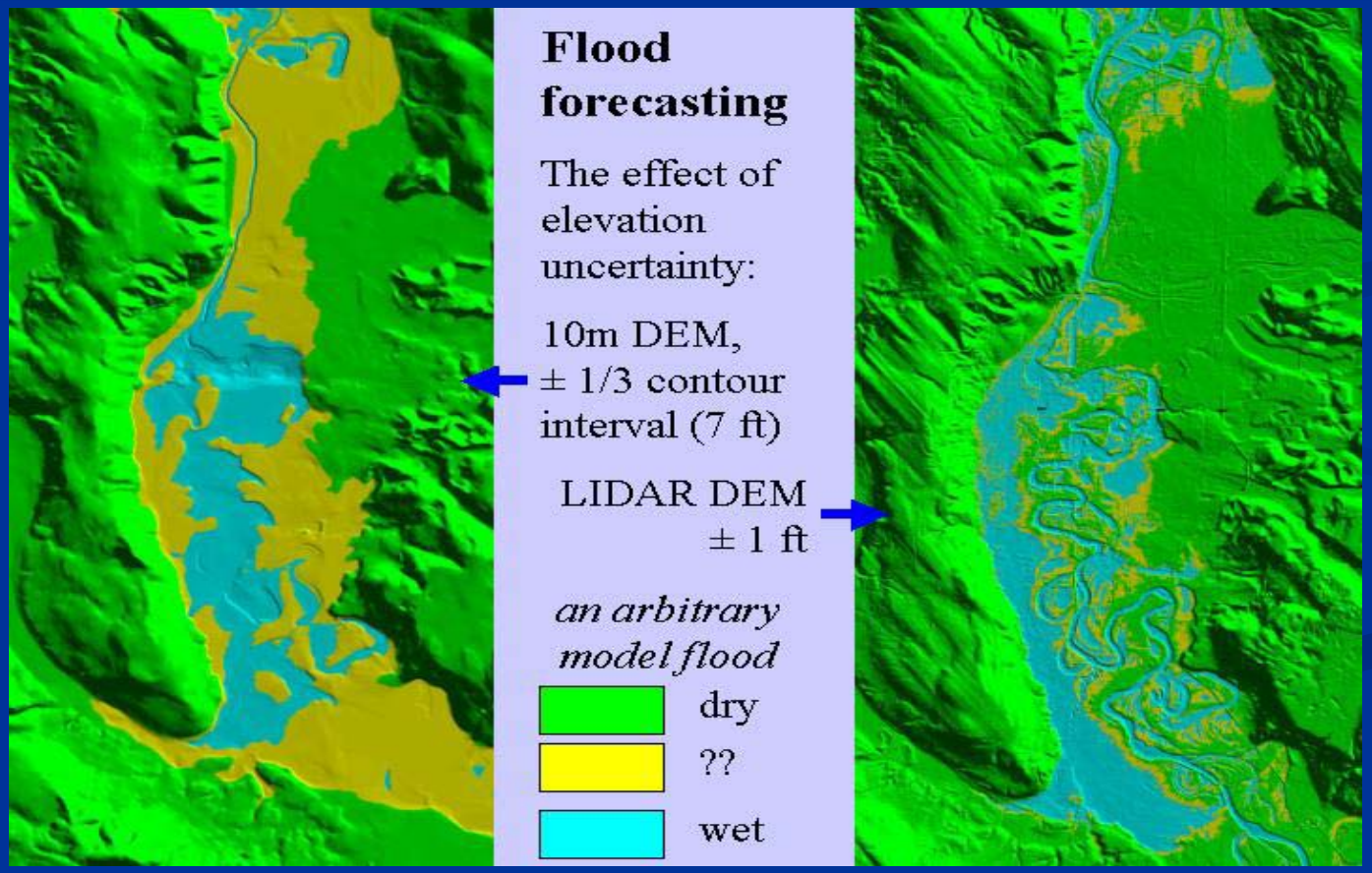
LiDAR Mapping Products

LiDAR is used to collect topographic data while at the same time aerial photography captures vector information and thermal or infrared imaging and then the they can be combined for defining planimetrics, vegetation, and many others.



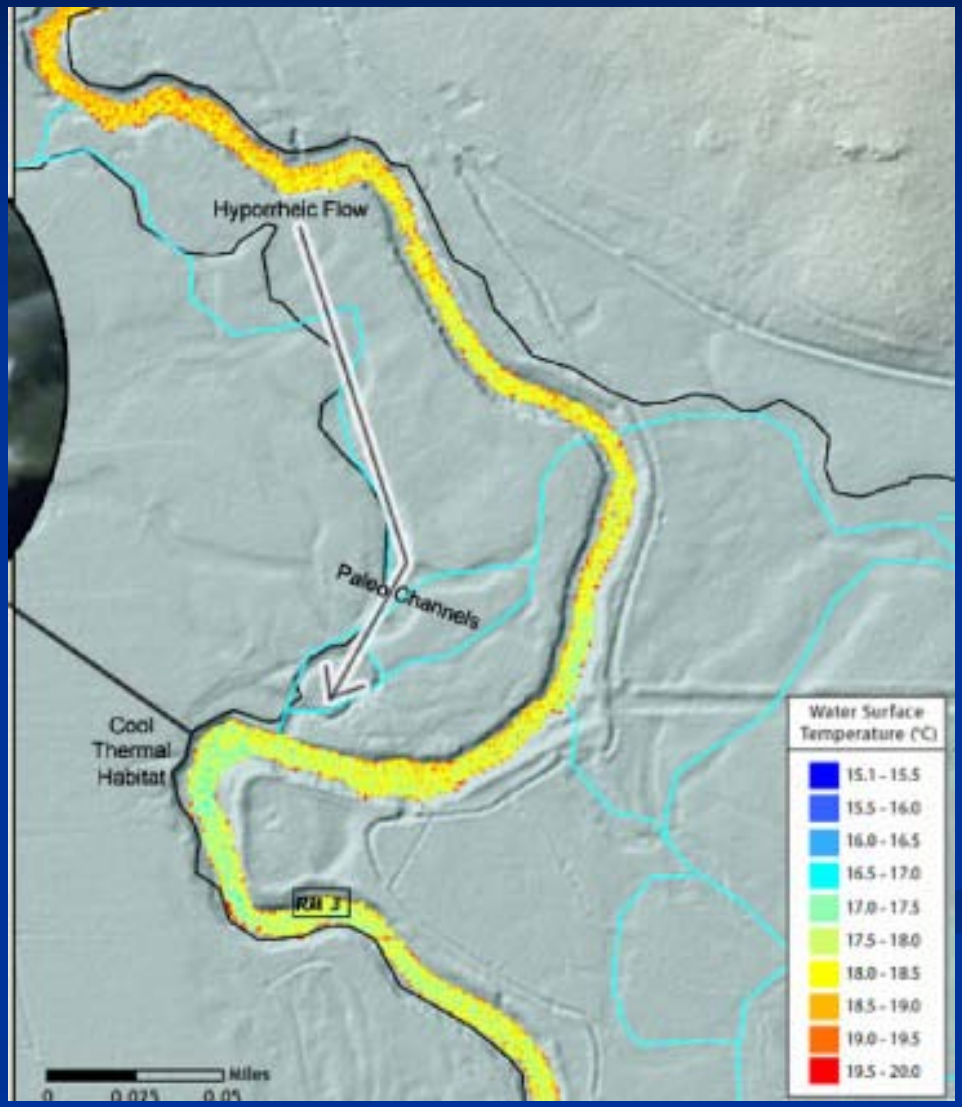
Detailed Flood Mapping

Once LiDAR Data is collected and processed detailed flood mapping can be performed based upon accurate detailed topography and feature mapping.



Secondary LiDAR Products

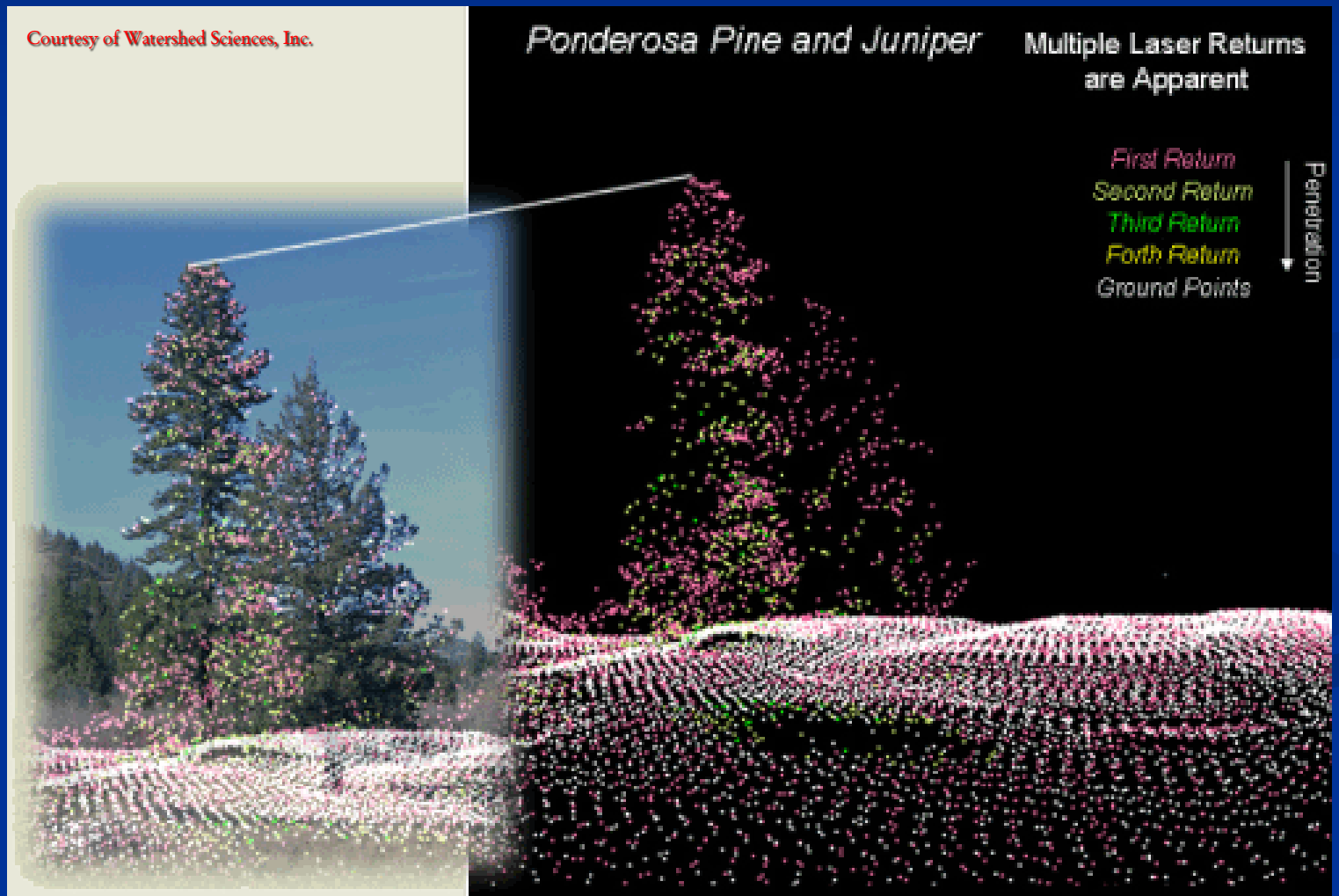
Here Thermal infrared water temperature mapping was registered with a LiDAR bare earth model to define water quality for fisheries



Courtesy of Watershed Sciences, Inc.

Secondary LiDAR Products (cont.)

Multiple "Returns" allow for vegetation and other three-dimensional object extraction from bare earth.



LiDAR Costs

Variable depending on size of acquisition area, accuracies required for project, and products required (i.e. DTM, DSM, contours, etc.)

For the Flathead Basin Project:

- 470 sq.miles, FEMA accuracies for 2' contours, including new digital orthoimagery:
  - Avg of 3 vendor cost estimates: $400,000.00
  - Cost per square mile = $850
  - Cost per acre = $1.33

Questions?

Contact Info

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