Obtaining and Developing Base Flood Elevations in Zone A Areas

NFIP

National Flood Insurance Program
Administered by FEMA

Workshop and Presentation
based on

FEMA 265

Managing Floodplain Development
in
APPROXIMATE ZONE A AREAS

A Guide for Obtaining and Developing Base Flood (100-year) Elevations

Purpose of Workshop

To assist local floodplain officials, surveyors, and engineers develop base flood elevations in Approximate Zone A areas

Workshop will **NOT** show untrained personnel how to use H&H software, complex models, and survey techniques

Workshop will **NOT** show highly trained personnel complex modeling solutions

Workshop Topics

- Define Approximate Zone A Areas
- Provide Sources of Existing Base Flood Elevations
- Show Ways to Develop Base Flood Elevations in Riverine Systems
- Show Ways to Develop Depths in Shallow Flooding Areas
- Summarize Requests for Obtaining Letters of Map Change

Defining Approximate Zone A Areas

The National Flood Insurance Program (NFIP)

- National Flood Insurance Act of 1968
- Administered by the Federal Emergency Management Agency (FEMA)

NFIP REGULATIONS FOR ZONE A AREAS

Requirements for <u>Obtaining</u> BFE Data (areas where BFEs have not been provided by FEMA)

Communities must obtain, review and reasonably utilize any base flood elevation and floodway data available from a Federal, State, or other source…

[44 CFR 60.3 (b) (4)]

Existing data should be used as long as it reasonably reflects flooding conditions expected during the base (100-year) flood, are not known to be scientifically or technically incorrect, and represents the best available data.

NFIP REGULATIONS FOR ZONE A AREAS

Requirements for <u>Developing</u> BFE Data

Require that all new subdivision proposals and other proposed development (including proposals for manufactured home parks and subdivisions) greater than 50 lots or 5 acres, whichever is the lesser, include within such proposals base flood elevation data;

[44 CFR 60.3 (b) (3)]

NFIP REGULATIONS FOR ZONE A AREAS

For large developments greater than 5 acres or 50 lots whichever is the lesser, communities *<u>must</u>*…

- Enforce Section 60.3(b)(3) of the NFIP regulations and require that BFE data be developed for affected lots through a detailed study.
- Follow FEMA's *"Guidelines and Specifications for Flood Hazard Mapping Partners", April 2003*. http://www.fema.gov/fhm/gs_main.shtm
- Review and determine that the study is reasonable and accurate. Methods used are comparable to original FIS.

NFIP REGULATIONS FOR ZONE A AREAS

For large developments greater than 5 acres or 50 lots whichever is the lesser, communities *<u>must</u>*…

(continued)

- Make sure the lowest floor elevation is certified by a licensed land surveyor or registered P.E.
- Make sure that the applicant revises the FIRM, i.e, obtains a Letter of Map Revision from FEMA

NFIP REGULATIONS FOR ZONE A AREAS

For large developments greater than 5 acres or 50 lots whichever is the lesser, communities *<u>must</u>*…

Exceptions

BFE may not be required if…

- Floodplain is contained entirely within an open space lot.
- Actual building sites are CLEARLY outside of the Zone A area.

NFIP REGULATIONS FOR ZONE A AREAS

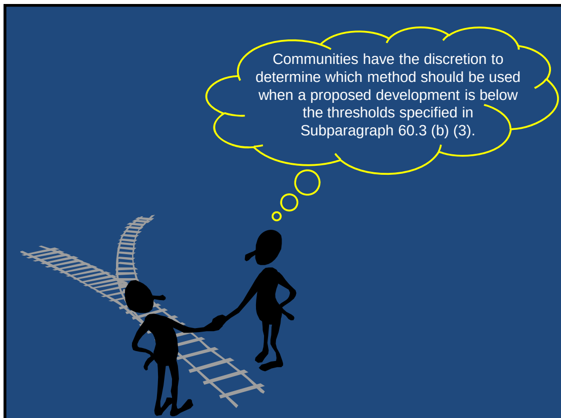
For small developments less than 5 acres or 50 lots with no BFE's determined, communities *must*…

- Determine that construction will be reasonably safe from flooding, properly anchored, and will not have a basement
- Protect building systems from flood damage
- Obtain the elevation of the as-constructed lowest floor and maintain these records with community's files
- Enforce Section 60.3(a)(3) and (a)(4) of the NFIP regulations

NFIP REGULATIONS FOR ZONE A AREAS

For small developments less than 5 acres or 50 lots with no BFE's determined, communities *should*…

- Use the Simplified Method outlined in Section V in FEMA 265 manual to estimate a BFE
- Require that structures be elevated above the Highest Adjacent Grade (HAG) so they are reasonably safe from flooding
- Require that floodproofing measures follow the *Non-Residential Floodproofing – Requirements and Certification*, FIA-TB-3, April 1993
- Use local official's knowledge of flood conditions in area to establish a BFE
- Determine if a previous study was developed by a consultant or agency for the area in question



Advantages of Developing BFE Data…

- Elevating Lowest Floor Elevation (LFE) to or above the BFE will reduce future flood losses, provide savings to individual, community, and the NFIP
- Flood insurance policies are lower cost with an established BFE
- Flood insurance requirement could be removed from the building or property
- Less burden on community officials
- CRS program provides credit points

Sources of Existing Base Flood Elevations

Data Sources for BFE Development

- Preliminary Flood Insurance Study – "Best available data"
- Engineering studies (published or non-published)
- High water marks from last severe storm
- High flow staking conducted from a Federal, State, or Local agency
- Aerial photogrammetry

Local, State, and Federal Sources of BFE Data

Local or Regional Agencies

- Local Public Works Department
- Flood Control Districts
- Levee Improvement Districts
- Local Planning Commissions
- Municipal Water Districts
- River Basin Commissions
- Water Control Board

State Agencies

- **Department of Water Resources**
  - ✓ Division of Floodplain Management
  - ✓ Integrated Regional Water Management-FloodSAFE

  www.fpm.water.ca.gov/contactsdistrict.htm
- **Department of Transportation (Caltrans)**
  www.dot.ca.gov/localoffice.htm
- **Department of Boating and Waterways**
- **Department of Parks and Recreation**

Federal Agencies

- U.S. Army Corps of Engineers
- U.S. Department of Interior, Geological Survey
- U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS)
- U.S. Department of Transportation, Federal Highway Administration

U.S. Army Corps of Engineers

San Francisco District
Technical and Engineering Services Division
333 Market Street
San Francisco, CA 94105
(415) 977-8531
www.spn.usace.army.mil

Sacramento District
Planning Division
1325 J Street
Sacramento, CA 95814
(916) 557-6699
www.spk.usace.army.mil

Los Angeles District
911 Wilshire Blvd
Los Angeles, CA 90017
www.spl.usace.army.mil

U.S. Department of Interior, Geological Survey

http://ca.water.usgs.gov/cgi-bin/admin/contacts.pl

FEMA's Technical evaluation contractor:

FEMA Project Library
c/o Michael Baker, Jr., Inc.
3601 Eisenhower Avenue, Suite 600
Alexandria, Virginia 22304
FAX: (703) 960-9125
Phone: (703) 960-8800

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

Developing Base Flood Elevations

Methods of Developing BFEs

- ❖Simplified Methods
- ❖Detailed Methods

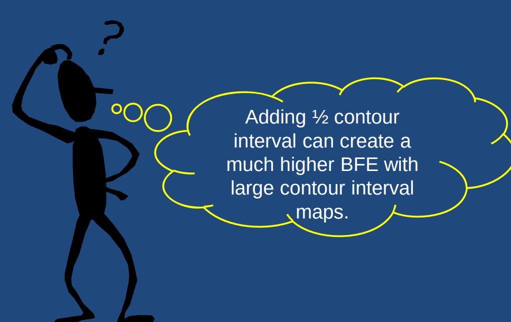
Simplified Method

- ❖Used to develop BFEs in Zone A areas when detailed methods are not necessary.
- ❖Limitations of BFEs using simplified methods
- ❖2 types of Simplified Methods:
  1) Contour Interpolation
  2) Data Extrapolation

Contour Interpolation

Superimposing contour maps with FIRM or FHBM maps to obtain BFE

- ❖Used on riverine systems and level-ponding from lakes
- ❖Assumed accuracy of ½ contour interval of contour map used
- ❖Smaller contour interval, higher accuracy



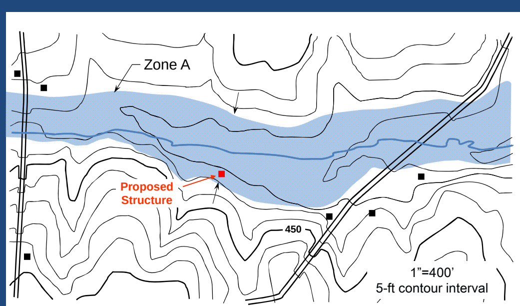
5 Step
Contour Interpolation Method

- ❖ Step 1: Obtain topo map and FIRM
- ❖ Step 2: Enlarge maps (topo or FIRM) until scales are equal
- ❖ Step 3: Superimpose one map over the other
- ❖ Step 4: Check acceptability
- ❖ Step 5: Determine BFE at location of interest

Sources of Topographic Data

Existing topographic surveys
State and local agencies
Digital quad maps **http://drg.casil.ucdavis.edu/**
Digital FIRMs
http://www.fema.gov/fhm/fq_map01.shtm

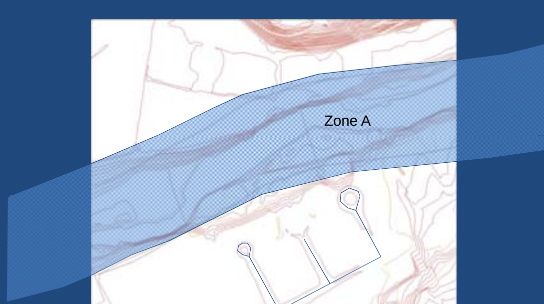
Contour Interpolation Method



Acceptability

- ❖ Floodplain conforms to the contour map
- ❖ Left and right floodplain on riverine systems have same flooding elevation (within ½ contour interval)
- ❖ Lake flooding highest and lowest elevations are within ½ contour interval

Non-conforming maps



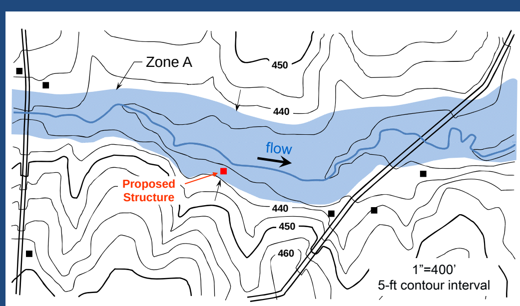
It is important to verify that the FIRM conforms to your contour map to obtain a reliable BFE from this simplified method.

Acceptability

- ❖ Floodplain conforms to the contour map
- ❖ Left and right floodplain on riverine systems have same flooding elevation (within ½ contour interval)
- ❖ Lake flooding highest and lowest elevations are within ½ contour interval

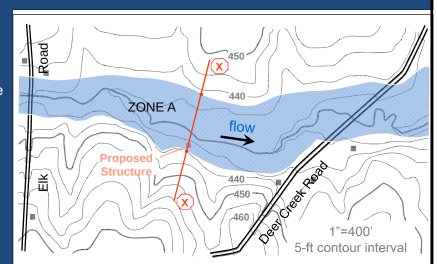
Contour Interpolation Method Rule-of-Thumb
In riverine systems, water surface elevations perpendicular to flow are generally the same elevation. Water surfaces on a lake are level and the elevations throughout the lake are generally the same.

Contour Interpolation Method



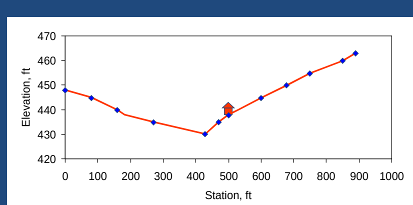
Contour Interpolation Method Example

1. Obtain contour/topo map and appropriate FIRM
2. Make scales equal and select one to be a transparency
3. Overlay transparency and check acceptability
4. If acceptable, add one-half of contour interval to lower elevation to obtain BFE.



Contour Interpolation Method Cross-Section Plot

Sta	Elevation
0	448
80	445
160	440
180	438
270	435
430	430
470	435
500	438
530	440
600	445
680	450
750	455
850	460
890	463



Contour Interpolation Method Acceptability Check

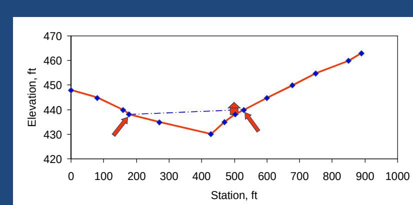
1. Determine where Zone A crosses contour on both left and right banks, interpolate if necessary:

   Left Elev: 438

   Right Elev: 440
2. If difference is less than ½ of contour interval, topo is acceptable

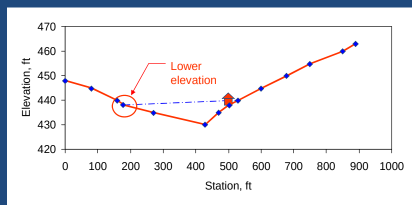
   (440 – 438 = 2 < 2.5)

   Okay!
3. If not less than ½ contour interval, this method cannot be used

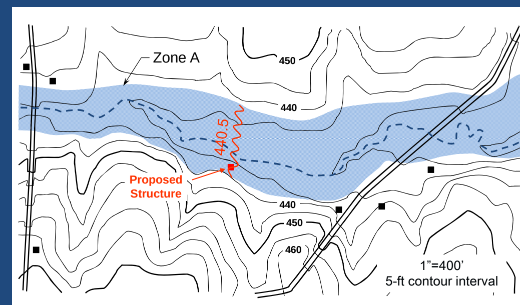


Contour Interpolation Method
BFE Computation

1. Take lower of the two elevations: 438
2. Add ½ of contour elevation
   438 + 2.5 = 440.5
3. BFE = 440.5 ft



Contour Interpolation Method



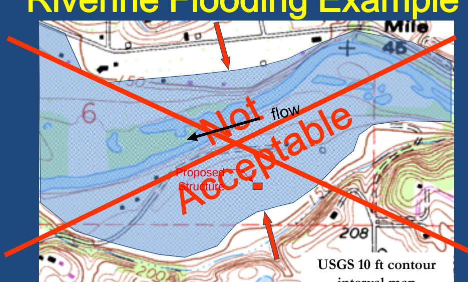
Riverine Systems

- Determine ground elevation on superimposed Zone A boundary (interpolation may be necessary)
- Obtain elevation for both sides of stream (necessary for acceptability)
- Add ½ of map interval to lower elevation to determine BFE

Example

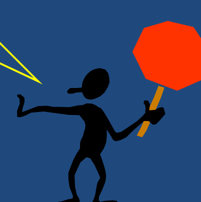
Contour Interpolation Method Not Acceptable

Riverine Flooding Example

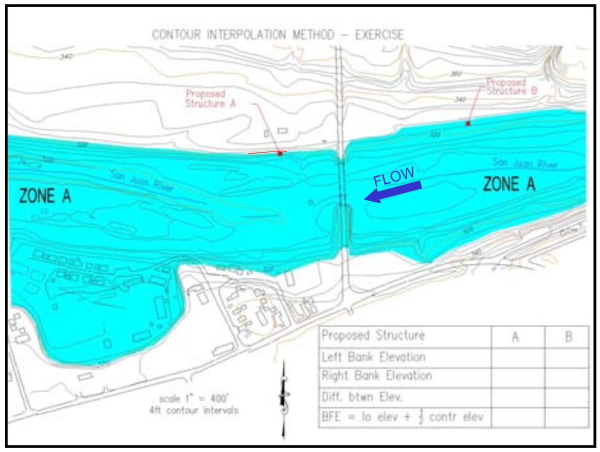


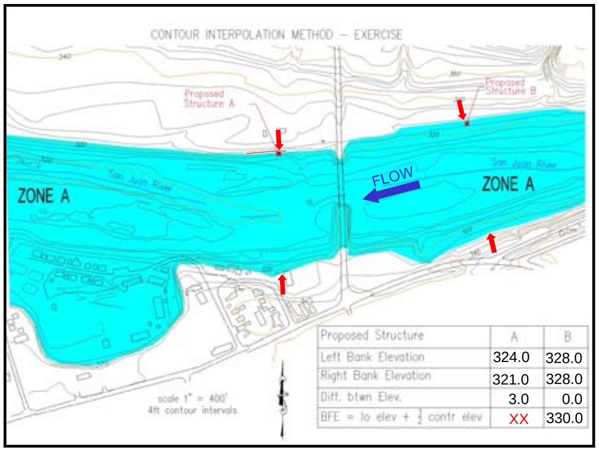
1. Zone A Elevations on:
   Left bank 148
   Right bank 154
2. Difference between elevations = 6'
3. Less than ½ contour interval (5 ft >) NO
4. BFE = Lo elev + ½ contour interval
   ______ + ______ = ______ ft

The example above is an illustration of the contour interpolation method that is not acceptable.



EXERCISE



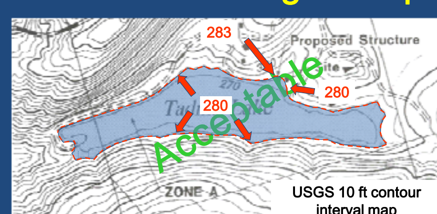


Structure A above is an illustration of the contour interpolation method that is not acceptable.

Lacustrine (Lake) Systems

- Similar to Riverine system
- Find highest and lowest points within the Zone A along entire lake
- Difference between high and low points to be within ½ contour interval to be valid

Lacustrine Flooding Example



1. WS Elevations along perimeter

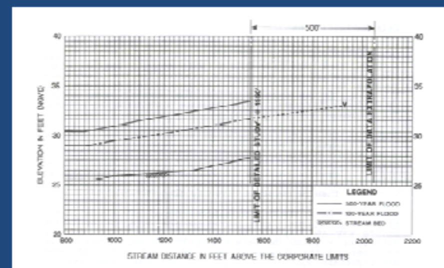
   Hi _283_ Lo _280_
2. Difference between ws elevations = _3_
3. Less than ½ contour interval (5 ft >) _YES_
4. BFE = Lo elev + ½ contour interval

   _280_ + _5_ = _285_ ft

Data Extrapolation

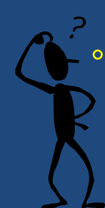
Extrapolate existing 100-yr profile computed by detailed methods to obtain BFE

100-year Profile



Data Extrapolation

- Requires existing 100-yr profile computed by detailed methods
- Only used if site is within 500 ft upstream of a 100-yr flood profile
- Channel width and slope similar to downstream reaches
- Free of backwater effects and slope breaks close to end of study

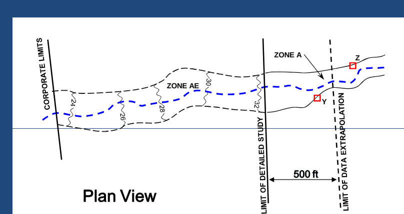


Channel similarities, free of backwater effects, and slope breaks are judgment calls.

3 Step Data Extrapolation Method

- Step 1: Determine location of site on flood profile
- Step 2: Extrapolate last segment of 100-yr water surface slope
- Step 3: Obtain BFE from extended profile

Data Extrapolation Method



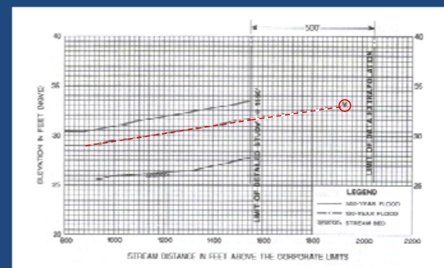
Property Y within 500 ft of extrapolation limit – Obtain BFE from Profile

Property Z beyond 500 ft of extrapolation limit – Cannot obtain BFE from Profile

3 Step Data Extrapolation Method

- Step 1: Determine location of site on flood profile
- Step 2: Extrapolate 100-yr water surface slope
- Step 3: Obtain BFE from extended profile

Data Extrapolation Method

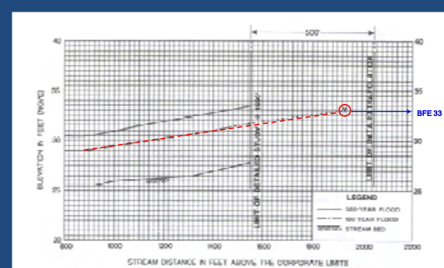


Profile View

3 Step Data Extrapolation Method

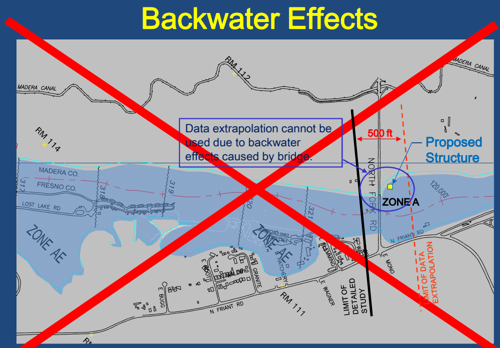
- Step 1: Determine location of site on flood profile
- Step 2: Extrapolate last segment of 100-yr water surface slope
- Step 3: Obtain BFE from extended profile

Data Extrapolation Method



Profile View

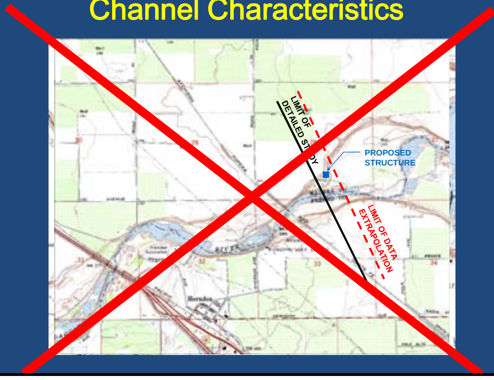
Data Extrapolation
Backwater Effects



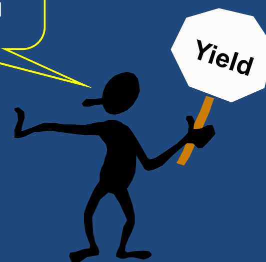
Plan View

Bridge & other structures in a floodplain may create backwater effects and may make data extrapolation unacceptable.

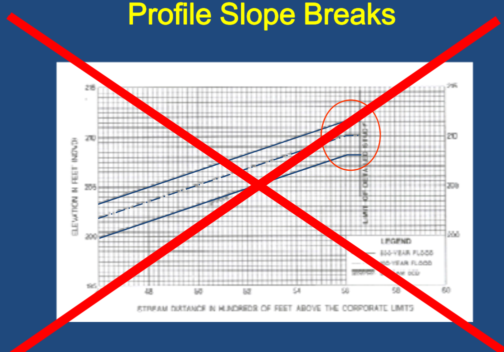
Data Extrapolation
Channel Characteristics



Need to be cautious in using data extrapolation in areas of rapidly changing channel shape.



Data Extrapolation
Profile Slope Breaks

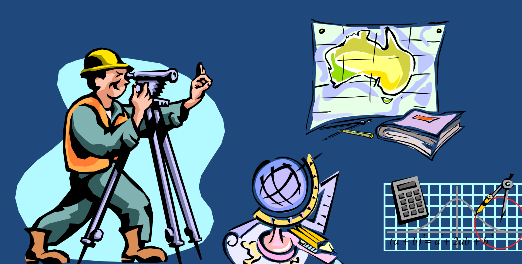


BFE cannot be developed when the profile changes slope too close to limit of detailed study.

Simplified Method
Summary

- Used to develop BFEs in Zone A areas, when detailed methods are not necessary.
- Limitations of BFEs using simplified methods
- 2 types of Simplified Methods:
  1) Contour Interpolation
  2) Data Extrapolation

Detailed Methods



Detailed Methods

- When existing flood and geometry information are not accurate for simplified method
- When required under Subparagraph 60.3
- When an EC certificate is required or desired

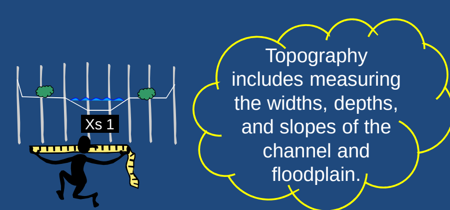
Essential Data Required for a Detailed BFE

- Topography
- Hydrology
- Hydraulics

Topography

Involves the physical vertical and horizontal measurement of the channel and floodplain

- Developing channel shape and slope
- Elevation datum



Channel Cross-Sections

- How many?
- Location
- Topographic Map

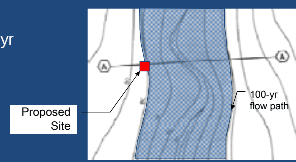
Cross-Sections

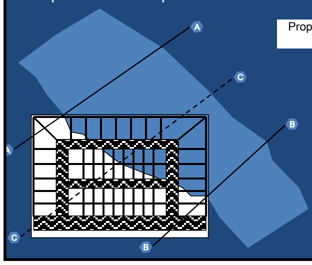
- How many?
  Determined by evaluating size of parcel and the difference in computed water surface elevation
- Location
- Topographic Map

Number of Cross-Section Required

Small parcel - Single lot:

One cross section across 100-yr floodplain through property in question is adequate





Large parcel – Multi-lot:

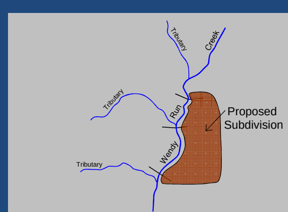
One cross section required at each end. Additional cross sections must be added if difference in the computed 100-yr water surface elevations at the two cross sections is > 1 ft and cross section spacing is > 500 ft

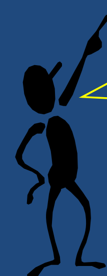
Cross-Sections

- How many?
  Determined by evaluating size of parcel and the difference in computed water surface elevation
- Location
  Need to address the discharge, channel characteristics, and flow path.
- Topographic Map

Cross-Section Location

- Discharge

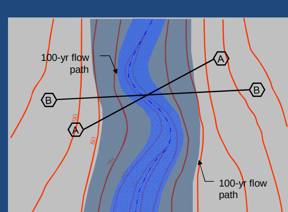


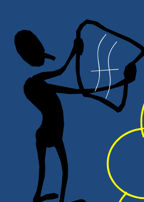


Cross sections should be appropriately located at points of tributary inflows that would have a significant change in the flow.

Cross-Section Location

- Flow Path





The cross-sections need to be oriented perpendicular to the anticipated flow path of the 100-year flood. Do not be fooled by a very small channel that does not have a capacity to carry the 100-year flood.

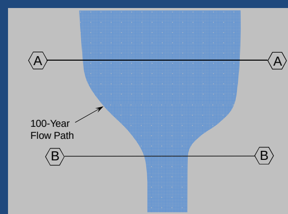
Cross-Section Location

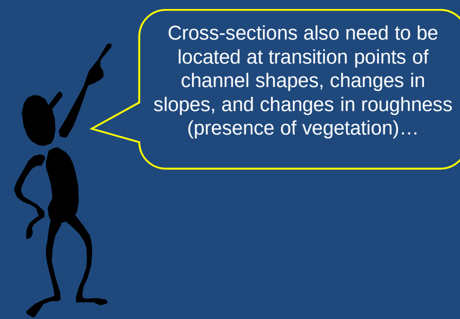
❖

❖

❖ Channel Characteristics

❖





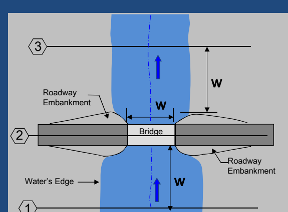
Cross-Section Location

❖

❖

❖

❖ Structures

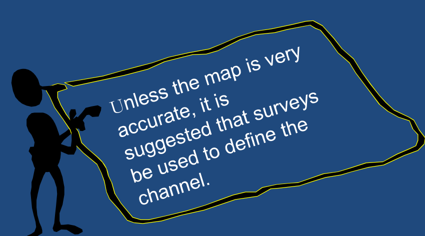


Cross-Sections

❖ How many?
Determined by evaluating size of parcel and the difference in computed water surface elevation

❖ Location
Need to address flow path, channel characteristics , and discharge. Most importantly orientation of cross-section is perpendicular to flow path of anticipated 100-year flood

❖ Topographic Map
Best to use with map scales of 1" = 500' and 4-foot contour intervals at a minimum



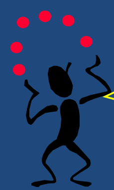
Elevation Datum

❖ Topography to be in same vertical datum as FIRM

❖ FIRM reference marks

❖ Assumed datum needs to be permanent

Note: Surveys need to be certified by a registered engineer or licensed land surveyor to be used to develop a BFE, structure, or lot elevation



All attempts to use a published RM should be made since an assumed datum will not be sufficient to revise a FIRM and will likely not be adequate to lower insurance requirements of a structure.

Hydrology

The development of the magnitude of water as a rate at a specific location.

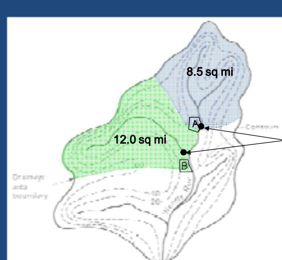
- Discharge-Drainage Area relationships
- Regression Equations
- NRCS TR-55 peak discharge and tabular hydrographs
- Rational method
- HEC-1 & HEC-HMS

Discharge – Drainage Area Relationship

- Preferred method
- Flow data from regional streamflow gages
- Data sources:
  - Summary of discharges table in a FIS
  - USGS
  - Corps of Engineers
  - Local flood control districts
  - Local NFIP coordinators

The gage location, drainage area that a gage captures, and the 100-year flood discharge for a gage needs to be gathered.

Discharge – Drainage Area Example

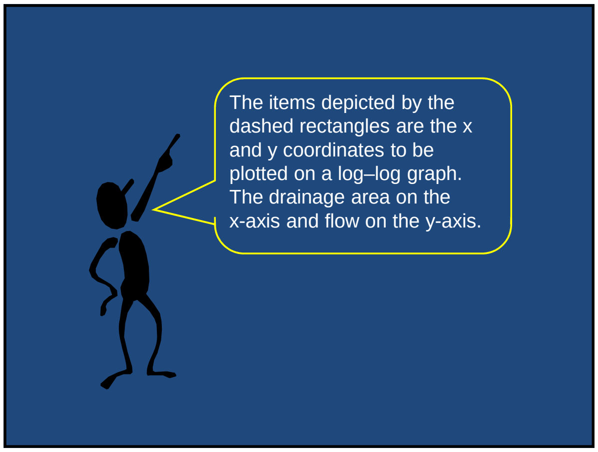


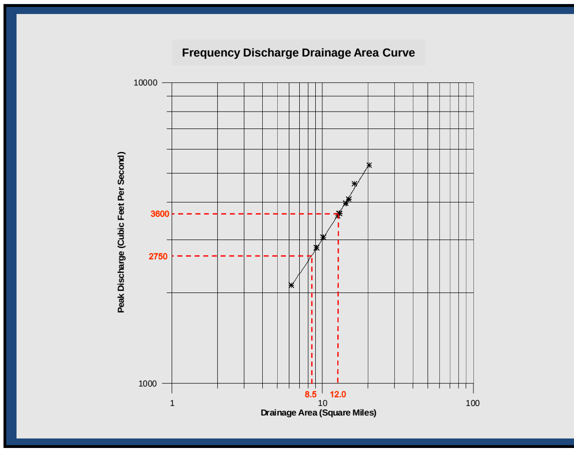
Flows to be obtained for these points

Wendy Run Drainage Basin

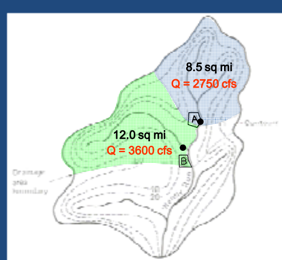
TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
PINE CREEK	X-axis			Y-axis	
At confluence with Saddle River	20.39	2,220	4,165	5,310	9,010
At Calvin Street	16.3	1,907	3,617	4,612	7,300
At Caitlin Avenue	14.9	1,860	3,285	4,090	6,570
ROCK RUN					
Downstream of confluence of Ramsey Brook	12.6	1,640	2,895	3,605	5,795
Upstream of confluence of Ramsey Brook	10.1	1,390	2,455	3,055	4,910
GOOSE CREEK					
Downstream of confluence of Valentine Brook	9.1	1,285	2,270	2,825	4,540
Upstream of confluence of Valentine Brook	6.2	965	1,700	2,120	3,405
COON CREEK					
Downstream of confluence of Allendale Brook	14.3	1,805	3,185	3,965	6,370
Upsteam of confluence of Allendale Brook	12.9	1,670	2,950	3,670	5,900



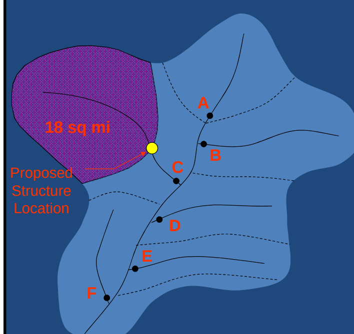


Discharge – Drainage Area Example



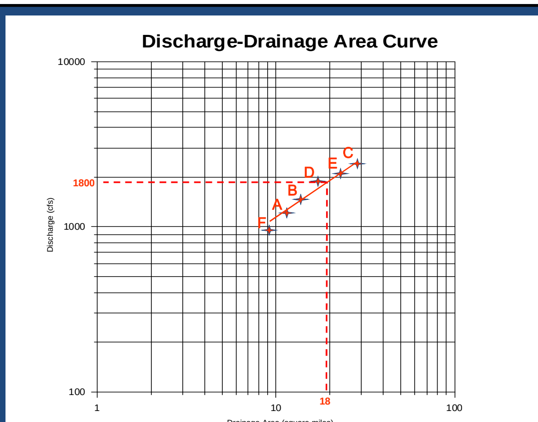
Wendy Run Drainage Basin

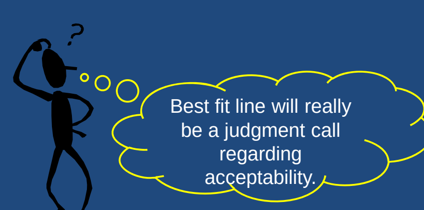
Discharge – Drainage Area Exercise



	D.A. (sq. mi.)	100-yr (cfs)
A	10	1,140
B	12	1,370
C	25	2,260
D	15	1,770
E	20	1,990
F	8	900

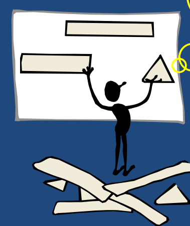
Estimate the 100-yr discharge for the highlighted area using the discharge-drainage area relationships.





Discharge – Drainage Area Issues

- ❖Best fit line through data points
- ❖Watershed characteristics should be similar
- ❖Precipitation
- ❖Method not appropriate for regulated streams
- ❖Watershed size needs to be within data



You should plot the gages on a map to verify that the gages cover the area that you are interested in. Rainfall, topography, and location should match the interested area.

Regression Equations

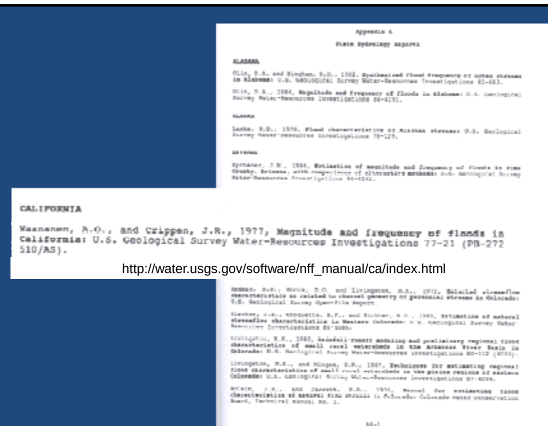
Simple method that incorporates the use of USGS regional analysis and measuring specific watershed characteristics.

❖Typical Equations:

$Q_{100}=102 * A^{0.59}$

$Q_{100}=1.95 * A^{0.83} * P^{1.87} * H^{-0.33}$

A = drainage area, square miles
P = mean annual precipitation, inches
H = altitude index, thousands of feet

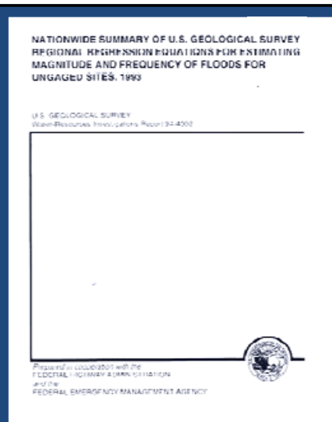


CALIFORNIA

Waananen, A.O., and Crippen, J.R., 1977, Magnitude and frequency of floods in California: U.S. Geological Survey Water-Resources Investigations 77-21 (PB-272 510/AS).

http://water.usgs.gov/software/nff_manual/ca/index.html

Other Useful Reports…



NATIONWIDE SUMMARY OF U.S. GEOLOGICAL SURVEY REGIONAL REGRESSION EQUATIONS FOR ESTIMATING MAGNITUDE AND FREQUENCY OF FLOODS FOR UNGAGED SITES, 1993

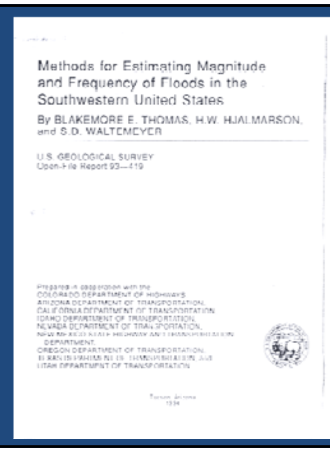
U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 94-4002

Prepared in cooperation with the
FEDERAL HIGHWAY ADMINISTRATION
and the
FEDERAL EMERGENCY MANAGEMENT AGENCY

This publication also includes the National Flood Frequency Program software. A tutorial is available online at FEMA's website. http://www.fema.gov/fhm/ot_nffsr.shtm

Flood-frequency region map for California

Other Useful Reports…



Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States

By BLAKEMORE E. THOMAS, H.W. HJALMARSON, and S.D. WALTEMEYER

U.S. GEOLOGICAL SURVEY
Open-File Report 93—419

COLORADO DEPARTMENT OF HIGHWAYS
ARIZONA DEPARTMENT OF TRANSPORTATION
CALIFORNIA DEPARTMENT OF TRANSPORTATION
IDAHO DEPARTMENT OF TRANSPORTATION
NEVADA DEPARTMENT OF TRANSPORTATION
DEPARTMENT
OREGON DEPARTMENT OF TRANSPORTATION
UTAH DEPARTMENT OF TRANSPORTATION

Regression Equations
Other Sources

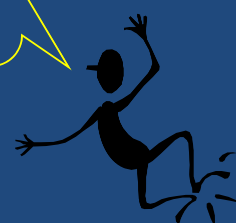
National Flood Frequency Program

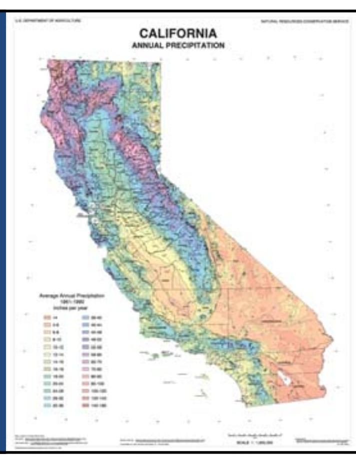
http://water.usgs.gov/software/nff.html

Mean Annual Precipitation Map

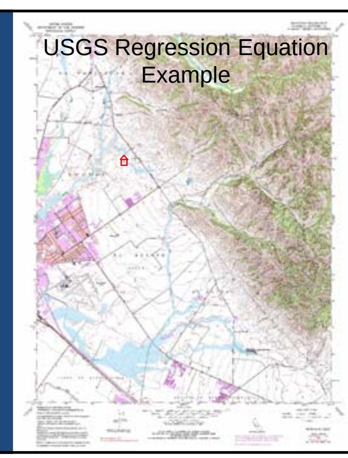
California Annual Precipitation, 1961-1990, U.S.D.A Natural Resources Conservation Service, April 1998

National Flood Frequency Program is a very good way to apply the USGS regional regression equations. The program can be obtained free of charge online.





USGS Regression Equation Example



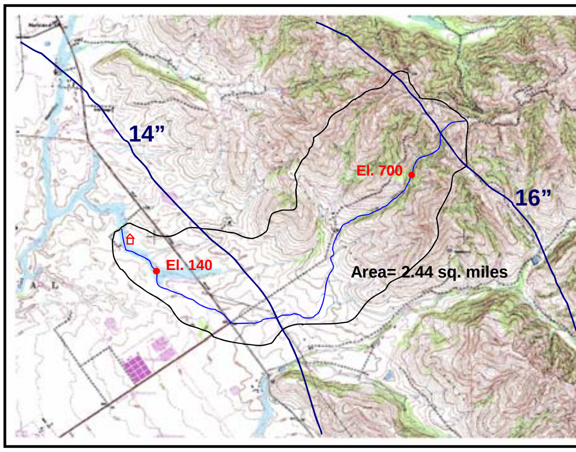
USGS Regression Equation

California -- Central Coast

$Q_{100}=19.7 * A^{0.88} * P^{0.84} * H^{-0.33}$

California -- South Coast

$Q_{100}=1.95 * A^{0.83} * P^{1.87}$



USGS Regression Equation

California -- Central Coast

$Q_{100}=19.7 * A^{0.88} * P^{0.84} * H^{-0.33}$

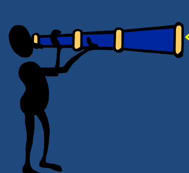
A = 2.44 square miles
P = 15 inches

$$H = \frac{(140 + 700)}{(2*1000)} = 0.42$$

$$Q_{100}=19.7 * 2.44^{0.88} * 15^{0.84} * 0.42^{-0.33} = 559 \text{ cfs}$$

Regression Equations Issues

- Should only be used when no other data is available
- Read publications for any restrictions available for watershed characteristics or when stream is regulated by dams or diversions



Using regional data that corresponds to your area is preferred due to the large areas used in the USGS regression analyses.

Other Methods

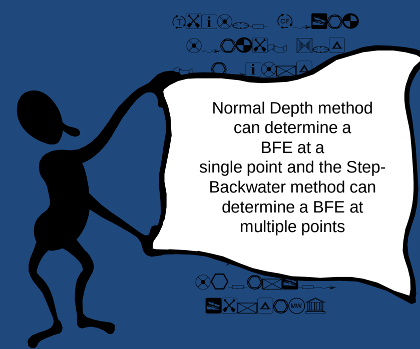
- TR-55 Urban Hydrology for Small Watersheds
  Limited to drainage areas under 2,000 acres (approximately 3 square miles)
- Rational Formula Q = CIA
  Limited to drainage areas up to 640 acres (1 square mile)
- TR-20 & HEC-HMS

Hydraulics

The study of how flows behave given the physical boundaries that it encounters

Normal depth analysis

Step-backwater analysis



Normal Depth

The depth of flow expected for a stream when a flow is relatively uniform, steady, and one-dimensional and is not affected by downstream obstructions or flow changes.

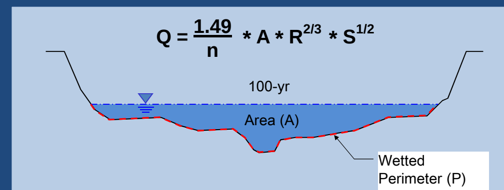
- Also called the "slope-area method" or Manning's equation :

$$Q = \frac{1.49}{n} * A * R^{2/3} * S^{1/2}$$

- Developed manually or by computer

Manning's Equation

Example Cross-section



Area (A) – Cross-sectional area of flow

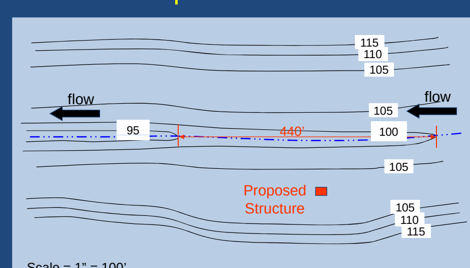
Hydraulic Radius (R) – Cross-sectional area (A) / wetted perimeter (P)

Slope (S) – Energy slope, usually channel bottom is used

Manning's n (n) – Roughness coefficient of the channel and/or floodplain

Manning's Equation

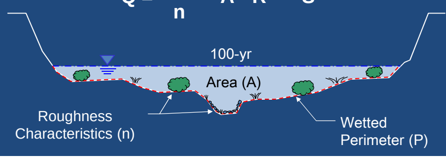
Slope Calculation



Slope = (100'-95') / 440' = 0.0114 ft/ft

Manning's Equation
Roughness Coefficient

$$Q = \frac{1.49}{n} * A * R^{2/3} * S^{1/2}$$



Area (A) – Cross-sectional area of flow

Hydraulic Radius (R) – Cross-sectional area (A) / wetted perimeter (P)

Slope (S) – Energy slope, usually channel bottom is used

Manning's n (n) – Roughness coefficient of the channel and/or floodplain

Manning's n-value

- ❖Coefficient of the channel and floodplain roughness
- ❖Can vary for channel and overbank areas
- ❖Appendix 5, FEMA 265 Handbook

Manning's n-value*

Type of Channel and Description	Minimum	Normal	Maximum
D. NATURAL STREAMS			
D-1. Minor streams (top width at flood stage < 100 ft			
a. Streams on plain			
1. Clean, straight, full stage, no rifts, or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
D-2. Floodplains			
c. Brush			
1. Scatter brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160

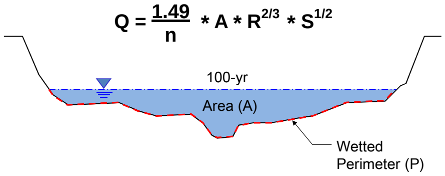
* Partial table taken from FEMA 265 Handbook, Appendix 5, pA5-1 to A5-5

Normal Depth
Hand Calculations

- ❖ Trial and error process
- ❖ Requires a known water surface elevation
- ❖ Need to initially assume Manning's equation variables to calculate a flow

Normal Depth
Hand Calculations

$$Q = \frac{1.49}{n} * A * R^{2/3} * S^{1/2}$$

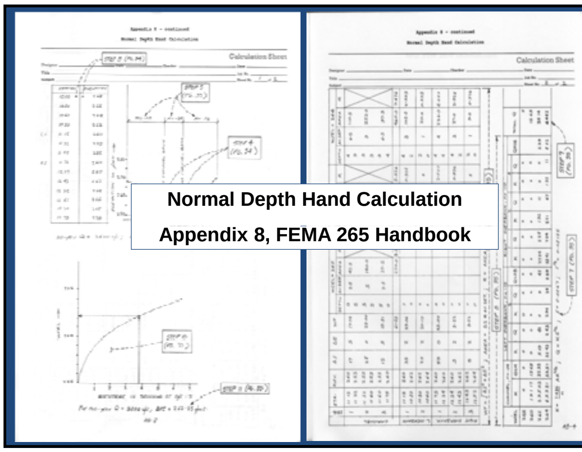


Area (A) – Cross-sectional area of flow

Hydraulic Radius (R) – Cross-sectional area (A) / wetted perimeter (P)

Slope (S) – Energy slope, usually channel bottom is used

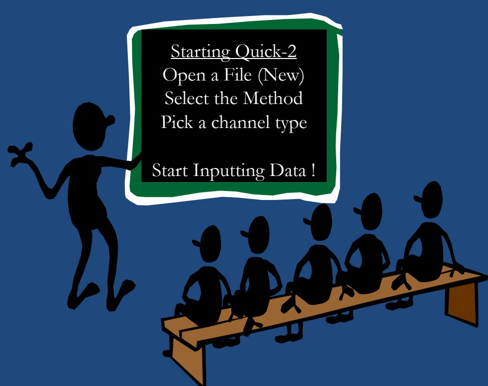
Manning's n (n) – Roughness coefficient of the channel and/or floodplain



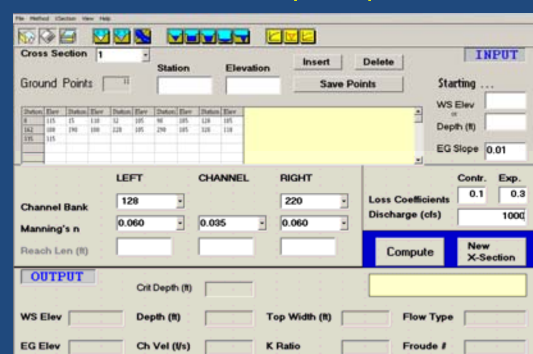
Quick-2 Computer Program

- Used to develop normal depth & step-backwater computations
- User-Friendly
- Download free from FEMA's website:
  - v1: www.fema.gov/mit/tsd/dl_qck2.htm
  - v2: www.fema.gov/mit/tsd/dl_qck22.htm

Quick-2 Program Example

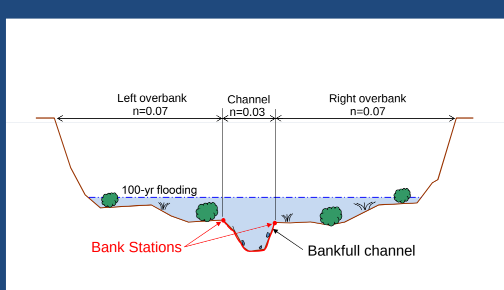


Quick 2 Normal Depth Input Screen

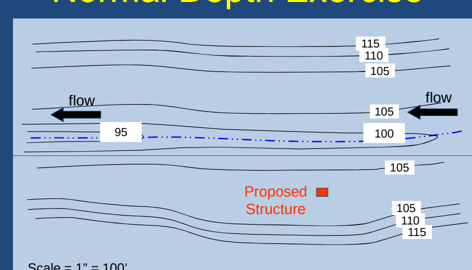


Manning's n-value

Channel Bank Stations



Normal Depth Exercise



Normal Depth Exercise

$Q_{100\text{-}yr}$ = 1,000 cfs   slope = ________ ft/ft

$n_{channel}$= ________ $n_{floodplain}$= ________

Locate and label cross section. Obtain station and elevation data then plot on graph provided. Also, determine slope and Manning's n values. Channel is straight with some cobbles and weeds. Floodplains contain light trees and brush during the summer.

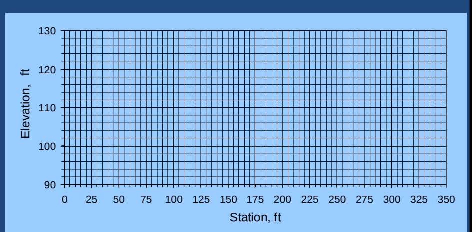
Manning's n-value*

Type of Channel and Description	Minimum	Normal	Maximum
D. NATURAL STREAMS			
D-1. Minor streams (top width at flood stage < 100 ft			
a. Streams on plain			
1. Clean, straight, full stage, no rifts, or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
D-2. Floodplains			
c. Brush			
1. Scatter brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160

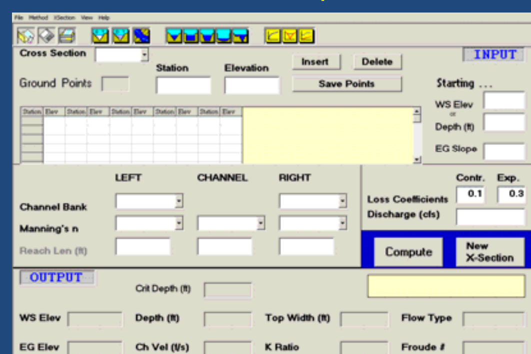
* Partial table taken from FEMA 265 Handbook, Appendix 5, pA5-1 to A5-5

Normal Depth Exercise
Cross-Section Plot

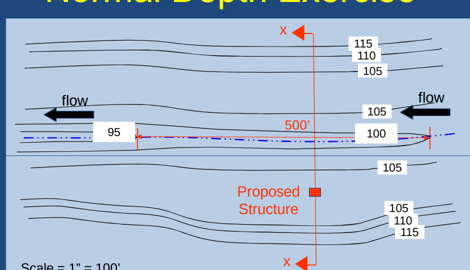
Sta	Elev



Quick 2 Normal Depth Exercise



Normal Depth Exercise



Slope = (100'-95') / 500' = 0.01 ft/ft

Manning's n-value*

Type of Channel and Description	Minimum	Normal	Maximum
D. NATURAL STREAMS			
D-1. Minor streams (top width at flood stage < 100 ft			
a. Streams on plain			
1. Clean, straight, full stage, no rifts, or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
D-2. Floodplains			
c. Brush			
1. Scatter brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160

* Partial table taken from FEMA 265 Handbook, Appendix 5, pA5-1 to A5-5

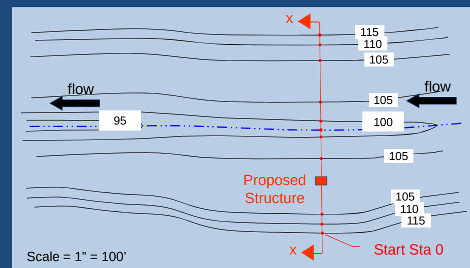
Normal Depth Exercise

$Q_{100\text{-}yr}$ = 1,000 cfs   slope = 0.01 ft/ft

$n_{channel}$ = 0.035 $n_{floodplain}$ = 0.060

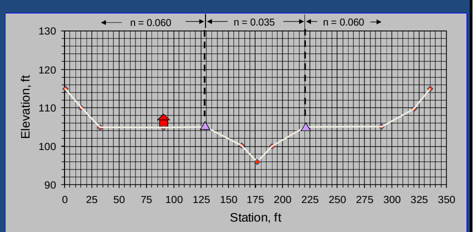
Locate and label cross section. Obtain station and elevation data then plot on graph provided. Also, determine slope and Manning's n values. Channel is straight with some cobbles and weeds. Floodplains contain light trees and brush during the summer.

Normal Depth Exercise

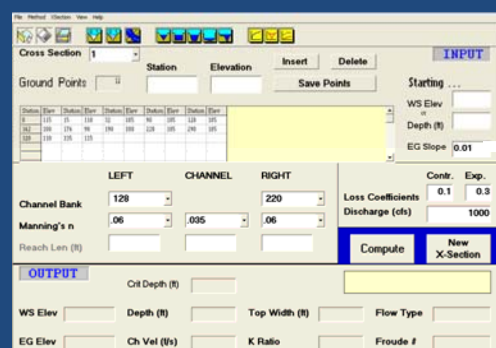


Normal Depth Cross-Section Plot

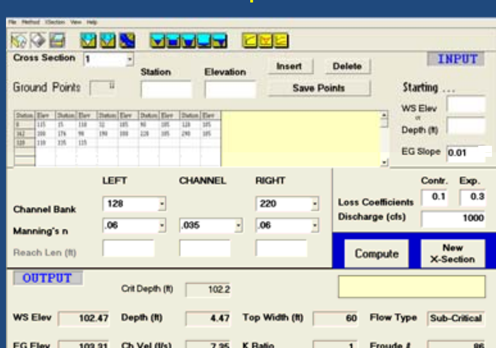
Sta	Elev
0	115
15	110
32	105
90	105
128	105
162	100
176	98
190	100
220	105
290	105
320	110
335	115



Quick 2 Normal Depth Input Screen

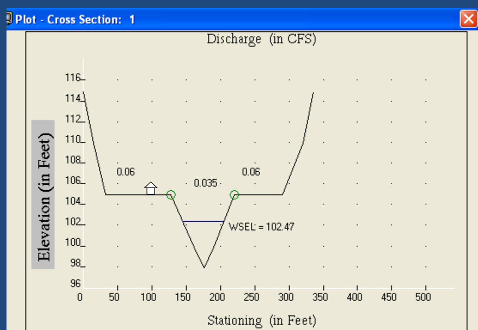


Quick 2 Normal Depth Results Screen



The output needs to be analyzed to make sure that the data looks reasonable. In general, the FLOW TYPE should be sub-critical and the FROUDE # should be below 1.0. Your conveyance number should generally be between 0.5 and 2.0 and velocities need to be reasonable. If these numbers are not within acceptable ranges, the analysis may not be accurate.

Quick 2 Cross-section Results Screen

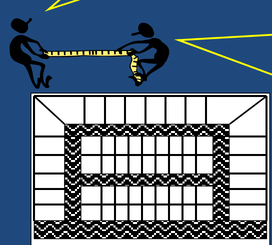


Step-Backwater Analysis

Complex adaptation of the Manning's Equation to account for losses in the flow due to friction, changes in velocity, and shape of flow (losses of energy).

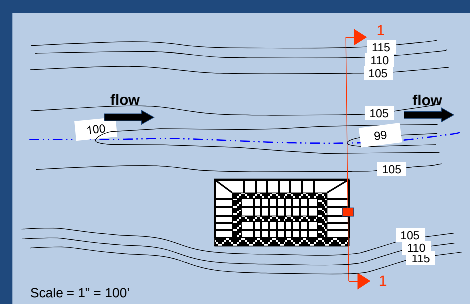
- Used for large lots or multi-lot subdivision
- Requires 2 or more cross-sections
- Cross-section spacing crucial

FEMA does not have a definition of a large lot, but typically if the lot has a length adjacent to the stream of over 200', then a back-water analysis should be performed.

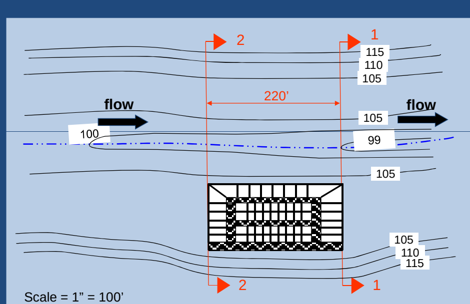


The cross-sections need to be located at the ends of the parcel and additional cross-sections need to be placed if the cross-sections are further than 500' or if the BFE's for the cross-sections differ by more than 1'.

Step Backwater Example

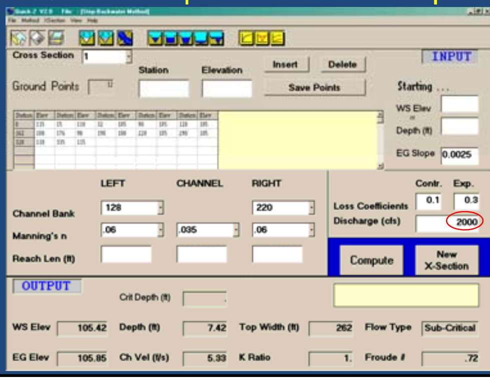


Step Backwater Example

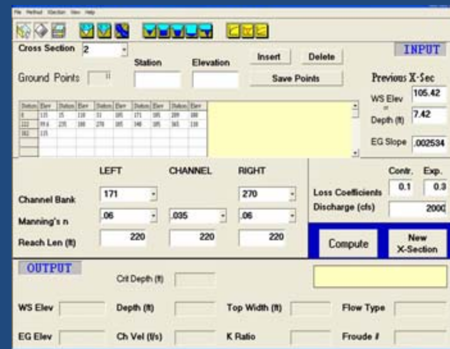


Cross-sections are always numbered going upstream and the cross-section stationing always goes from left-to-right looking downstream (i.e., left bank is station 0.00).

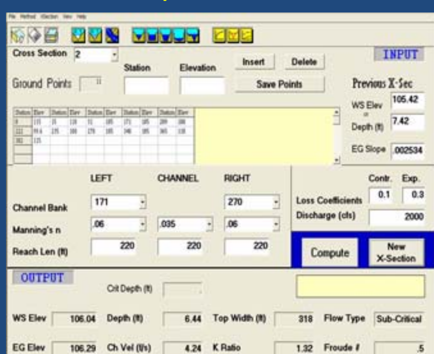
Quick 2 Step-Backwater Example



Quick 2 Step-Backwater Results

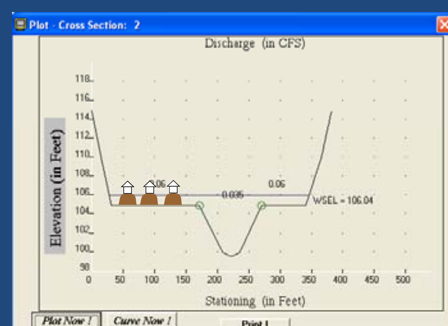


Quick 2 Step-Backwater Results



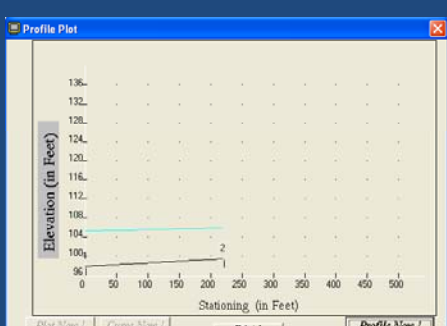
Quick 2 Step-Backwater Results

Cross Section Plot



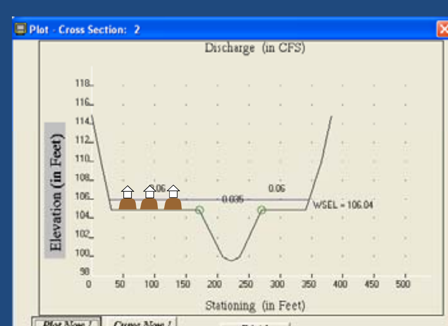
Quick 2 Step-Backwater Results

Profile



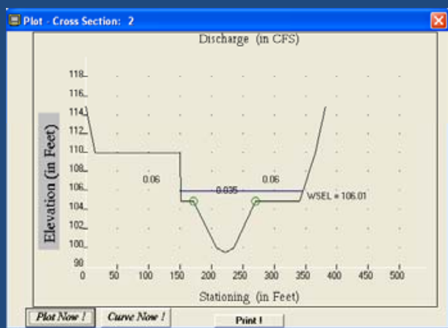
Quick 2 Step-Backwater Results

Cross Section Plot

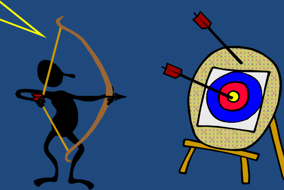


Quick 2 Step-Backwater Results

Cross Section Plot



When a proposed structure will be a significant obstruction within the floodplain, blocking the area out would be appropriate. However, the water surface elevations will generally not be very sensitive.



Hydraulic Guidelines on Using Normal Depth Methods

CHANNEL REACH UNIFORMITY

CHANNEL REACH OBSTRUCTIONS

SUB-CRITICAL FLOW

Hydraulic Guidelines on Using Normal Depth Methods

CHANNEL REACH UNIFORMITY

Channel reach should have a similar cross-sectional shape, slope, and roughness for 500’ downstream of the location and twice the width of the channel upstream of the location

CHANNEL REACH OBSTRUCTIONS

SUB-CRITICAL FLOW

Hydraulic Guidelines on Using Normal Depth Methods

CHANNEL REACH UNIFORMITY

Channel reach should have a similar cross-sectional shape, slope, and roughness for 500’ downstream of the location and twice the width of the channel upstream of the location

CHANNEL REACH OBSTRUCTIONS

Channel reach should be absent of major flow obstructions for 1000’ downstream of the location and twice the width of the channel upstream of the location

SUB-CRITICAL FLOW

Hydraulic Guidelines on Using Normal Depth Methods

CHANNEL REACH UNIFORMITY

Channel reach should have a similar cross-sectional shape, slope, and roughness for 500’ downstream of the location and twice the width of the channel upstream of the location.

CHANNEL REACH OBSTRUCTIONS

Channel reach should be absent of major flow obstructions for 1000’ downstream of the location and twice the width of the channel upstream of the location.

SUB-CRITICAL FLOW

Froude numbers should be lower than 1.0 (hardened channels with high slopes may be an exception).

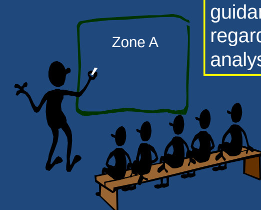
These guidelines should be considered very general and can vary based on channel slope and flow. Engineering judgment needs to be used in applying these guidelines.

Topics Not Covered…

- Manual calculations
- HEC-RAS
- Hydraulics at structures

DWR Assistance

- Floodplain Management team available for local assistance
- Guide local communities whether detailed analysis are adequate
- Staff assistance in reviewing general methods
- Availability develop and perform a detailed study



The Department of Water Resources has floodplain management local assistance staff that can provide some guidance to local communities regarding the adequacy of an analysis for FEMA and NFIP.

Obtaining Letters of Map Change

A BFE developed using **simplified methods**, **cannot** be used to request a letter of map correction. It can be used to ensure that proposed building sites are reasonable safe from flooding and to minimize flood damage within flood-prone areas. With a BFE developed using **detailed methods**, **you can request a Letter of Map Revision (LOMR)** to revise a FIRM map and to get a structure or parcel out of the floodplain

Map Amendments and Revisions

Involves amending and/or revising the existing Flood Insurance Rate Maps based on:

- Errors of the floodplain boundary
- Placement of earth fill
- Construction of new bridges, culverts, levees, and channel improvements that change the effective BFE
- Better technical data
- Physical changes to floodplains, floodways, or flood elevations

LOMA
Letter of Map Amendment

A letter from FEMA stating that an existing structure or parcel of land that has NOT been elevated by fill would not be inundated by the 1% chance flood.

A LOMA applies to pre-FIRM structures only (not subdivisions). The application is to be submitted to FEMA utilizing the MT-EZ forms for a single residential lot or structure.

LOMR
Letter of Map Revision

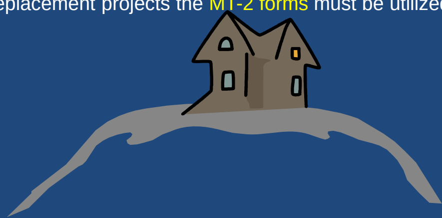
A letter from FEMA officially revising the current FIRM to show changes in the limits of floodplains, floodways, corporate limits, or the flood hazard risk zones.

A LOMR is a letter from FEMA officially revising the current NFIP map to show changes to floodplains, floodways, or flood elevations

LOMR – F
Letter of Map Revision (based on Fill)

A letter from FEMA stating that an existing structure or parcel of land that has been elevated by fill would not be inundated by the 1% chance flood.

LOMR-F is used when structures or lots have been raised by the placement of fill. A LOMR-F application is to be submitted to FEMA utilizing the MT-1 forms for multiple lots or a subdivision. For requests involving 1) The placement of fill or a a structure within a regulatory floodway, 2) Channelization projects, or 3) Bridge/culvert replacement projects the MT-2 forms must be utilized.



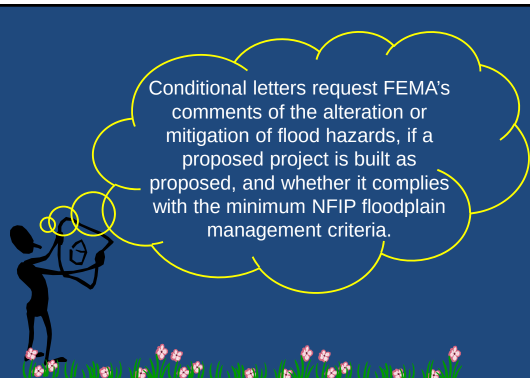
Conditional Letter of Map Amendment or Revision

Proposed Structures or Projects

CLOMA

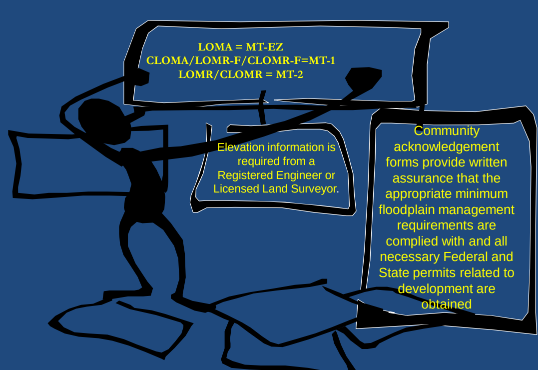
CLOMR - F

CLOMR



Map Amendment or Revision Application Package

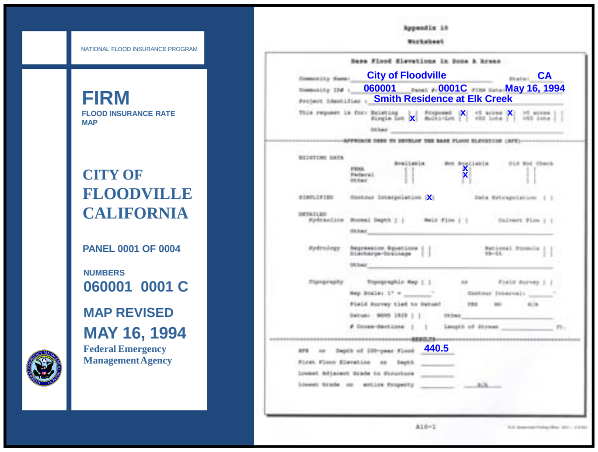
- OBTAIN PROPER FORMS
  (MT-EZ, MT-1, MT-2 forms available online at www.fema.gov)
- PROPERTY INFORMATION
  (Plat map, deed and/or legal description, FIRM or FHBM panel, road map identifying location of lot)
- ENGINEERING/SURVEY INFORMATION
  (BFE information, elevation information form, or elevation certificate, hydrology/hydraulics)
- COMMUNITY ACKNOWLEDGEMENT



Map Amendments and Revisions

"Base Flood Elevations in Zone A Areas" Worksheet

(Appendix 10 in FEMA 265 Handbook)



Map Amendment or Revision Application Info Online

LOMA (MT-EZ) and LOMR-F (MT-1)
Online Tutorials

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

LOMR based on a physical map revision (MT-2)
Forms Online

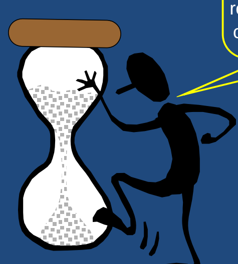
http://www.fema.gov/fhm/dl_mt-2.shtm

The website includes the forms and information that is needed for your request and the tutorial actually helps you fill out the forms.

Map Revision Process & Timelines

- Takes 60 days (LOMA) to 90 days (LOMR) from time application is received to make determination
- Letter of determination issued
- Applications processed on a first-come, first-served basis

If changes in flooding conditions are extensive or if BFEs increase, a physical map revision will be required, which can take 12 months or longer.



Map Revision Costs

- Fees change often, current fees can be obtained at the following website:

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

Map Revision Costs

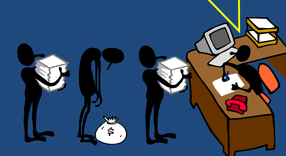
Exemptions

- More detailed information not resulting from manmade changes
- Error correction
- Government-sponsored projects primarily intended for flood loss reduction to existing insurable structures

Free Of Charge

FEMA Requirements for Map Revisions

- When there are physical changes affecting BFEs, a community must notify FEMA within six months by submitting technical or scientific data in a request for a LOMR.
- Revisions are issued by FEMA as either a Physical Map Revision or a Letter of Map Revision (LOMR)



ZONE A Insurance Cost vs. Lowest Floor Elevation above HAG

Single Family - No Basement/Enclosure

No Estimated Base Flood Elevation

Elevation Difference to nearest foot	Coverage Type	Coverage Amount	Basic Insurance Limits	Basic Insurance Rate	Additional Insurance Rate	ICC Coverage	Federal Policy Fee	Annual Premium
+5 or more (above Highest Adjacent Grade)	Structure	100000.00	$60,000	0.40	0.08	$5	$40	$317
		150000.00	$60,000	0.40	0.08	$5	$40	$357
		250000.00	$60,000	0.40	0.08	$4	$40	$436
	Contents*	50000.00	$25,000	0.44	0.12			$140
		75000.00	$25,000	0.44	0.12			$170
		100000.00	$25,000	0.44	0.12			$200
+2 to +4 (above HAG)	Structure	100000.00	$60,000	1.36	0.11	$5	$40	$905
		150000.00	$60,000	1.36	0.11	$5	$40	$960
		250000.00	$60,000	1.36	0.11	$4	$40	$1,069
	Contents*	50000.00	$25,000	0.74	0.13			$218
		75000.00	$25,000	0.74	0.13			$250
		100000.00	$25,000	0.74	0.13			$283
+1 (above HAG)	Structure	100000.00	$60,000	2.60	0.52	$5	$40	$1,813
		150000.00	$60,000	2.60	0.52	$5	$40	$2,073
		250000.00	$60,000	2.60	0.52	$4	$40	$2,592
	Contents*	50000.00	$25,000	1.52	0.22			$435
		75000.00	$25,000	1.52	0.22			$490
		100000.00	$25,000	1.52	0.22			$545

Rates are per $100 of coverage, Effective October 1, 2011

ZONE A Insurance Cost vs. Lowest Floor Elevation above BFE

Single Family - No Basement/Enclosure

With Estimated Base Flood Elevation

Elevation Difference to nearest foot	Coverage Type	Coverage Amount	Basic Insurance Limits	Basic Insurance Rate	Additional Insurance Rate	ICC Coverage	Federal Policy Fee	Annual Premium
+2 or more BFE	Structure	100000.00	$60,000	0.44	0.08	$5	$40	$341
		150000.00	$60,000	0.44	0.08	$5	$40	$381
		250000.00	$60,000	0.44	0.08	$4	$40	$460
	Contents*	50000.00	$25,000	0.38	0.12			$125
		75000.00	$25,000	0.38	0.12			$155
		100000.00	$25,000	0.38	0.12			$185
0 to +1 BFE	Structure	100000.00	$60,000	1.35	0.13	$5	$40	$907
		150000.00	$60,000	1.35	0.13	$5	$40	$972
		250000.00	$60,000	1.35	0.13	$4	$40	$1,101
	Contents*	50000.00	$25,000	1.06	0.14			$300
		75000.00	$25,000	1.06	0.14			$335
		100000.00	$25,000	1.06	0.14			$370
-1 BFE	Structure	100000.00	$60,000	4.25	1.00	$5	$40	$2,995
		150000.00	$60,000	4.25	1.00	$5	$40	$3,495
		250000.00	$60,000	4.25	1.00	$4	$40	$4,494
	Contents*	50000.00	$25,000	2.70	0.33			$758
		75000.00	$25,000	2.70	0.33			$840
		100000.00	$25,000	2.70	0.33			$923

Rates are per $100 of coverage, Effective October 1, 2011

Summary and Closing Remarks

- ❖Parking lot questions
- ❖Evaluations