TEXAS DEPARTMENT OF TRANSPORTATION

HYDRAULIC DESIGN MANUAL UPDATES

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Chief Hydraulics Engineer

October 12, 2016

Hydraulic Design Manual Updates:

Three critical updates:

- Sheet flow analysis is now required for storm sewer projects.
- Intensity Duration Frequency (IDF) Curves updated.
- Storm sewer and culvert maintenance velocities have increased (from 2 fps to 3 fps)

Hydraulic Design Manual Release

- Hydraulic Design Manual Release Date:

  July 1, 2016

- Effective on all new projects with a Start Date:

  August 1, 2016 or later

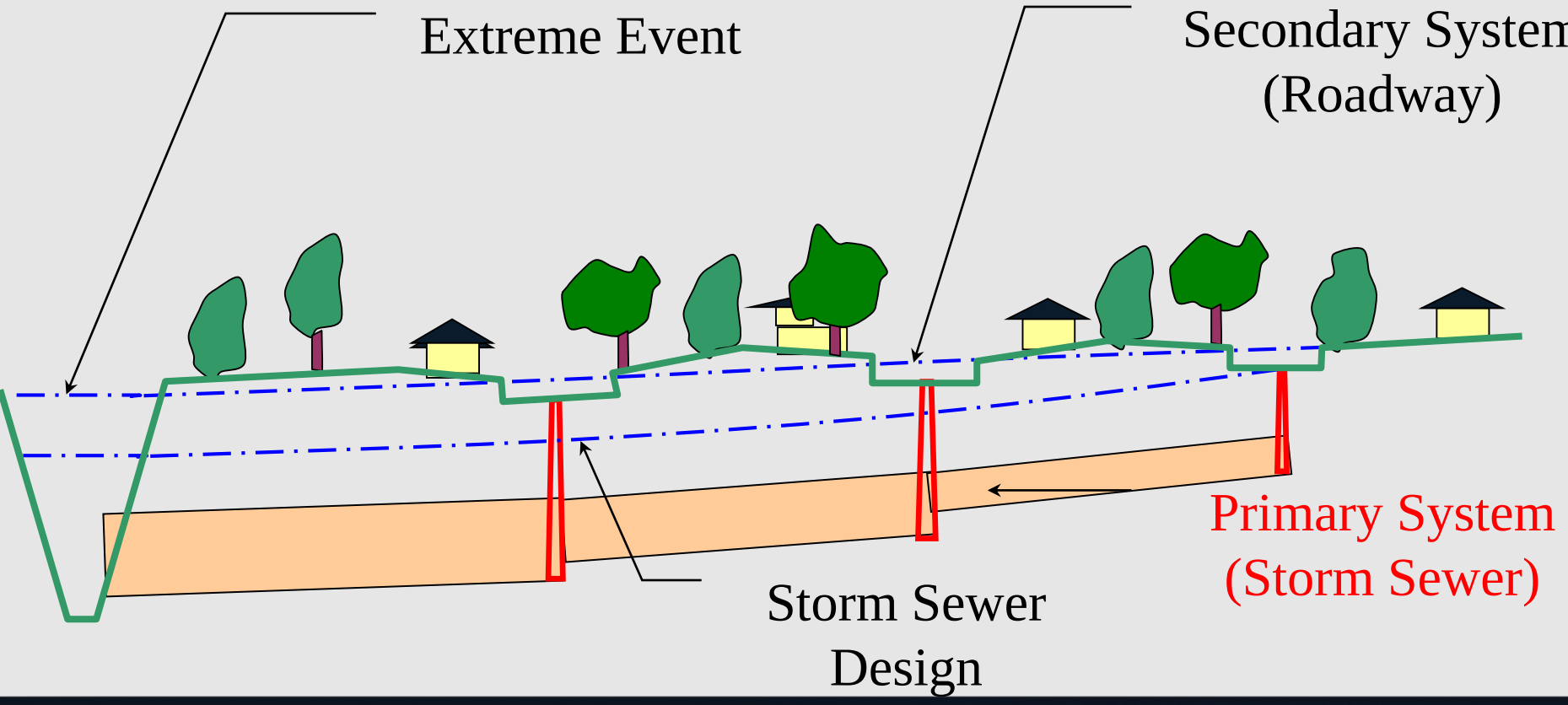
TEXAS DEPARTMENT OF TRANSPORTATION

SHEET FLOW ANALYSIS REQUIRED FOR STORM SEWER PROJECTS

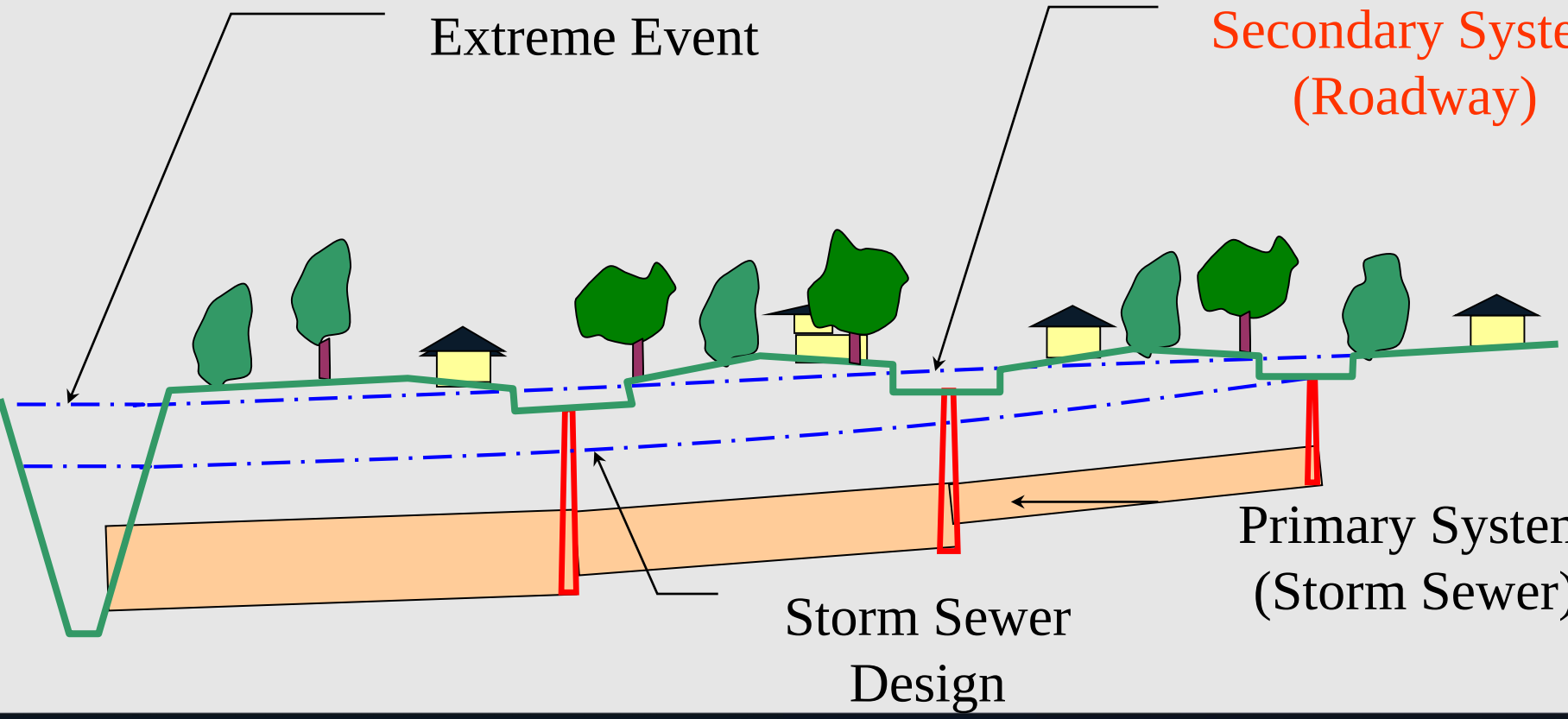
Objective of the Sheet Flow Analysis

- Do not compromise existing sheet flow patterns.
- Insure the roadway provides storm conveyance for the extreme events without significant impacts to adjacent structures.

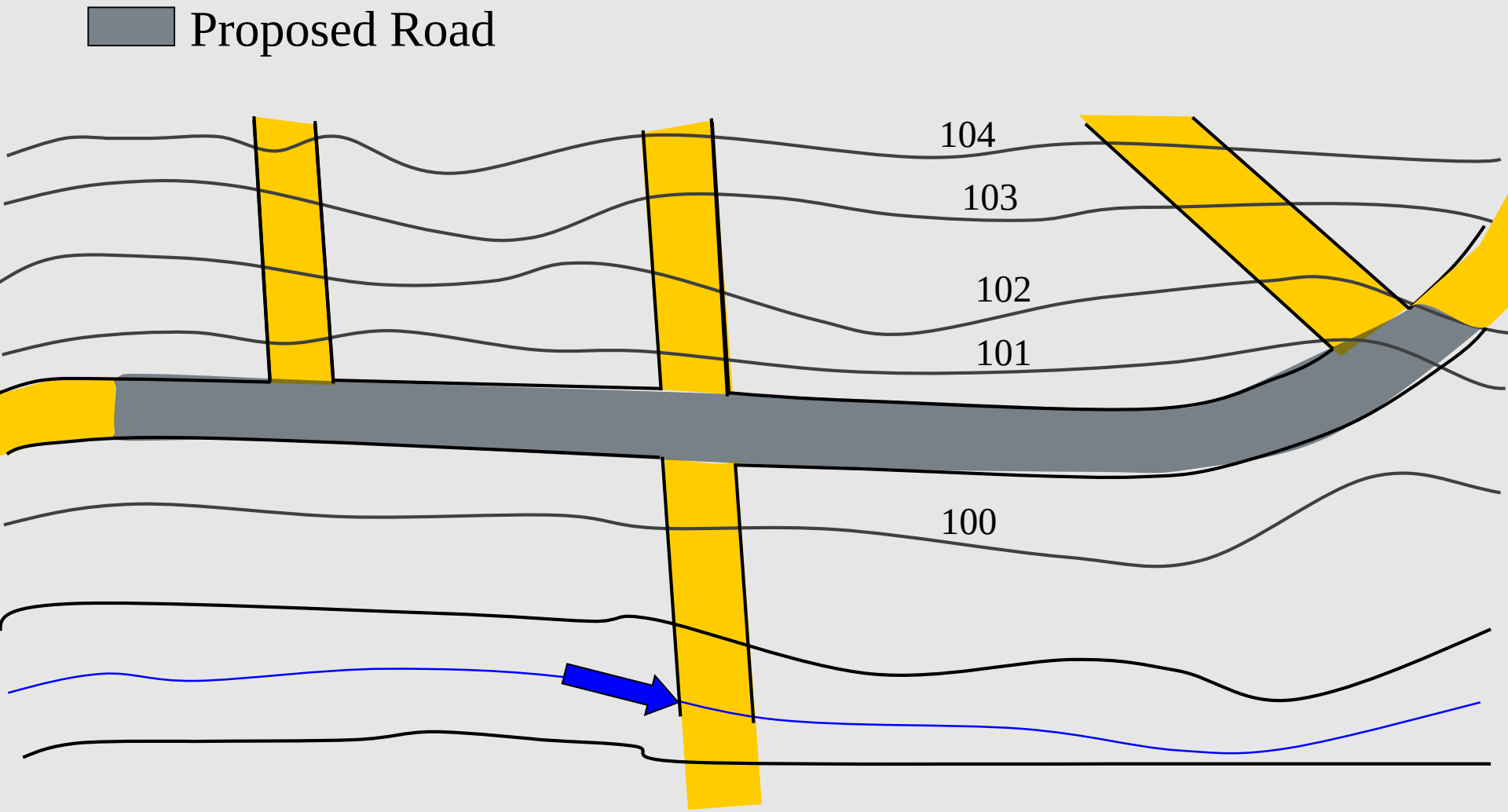
Drainage System (Storm Sewer and Roadway)



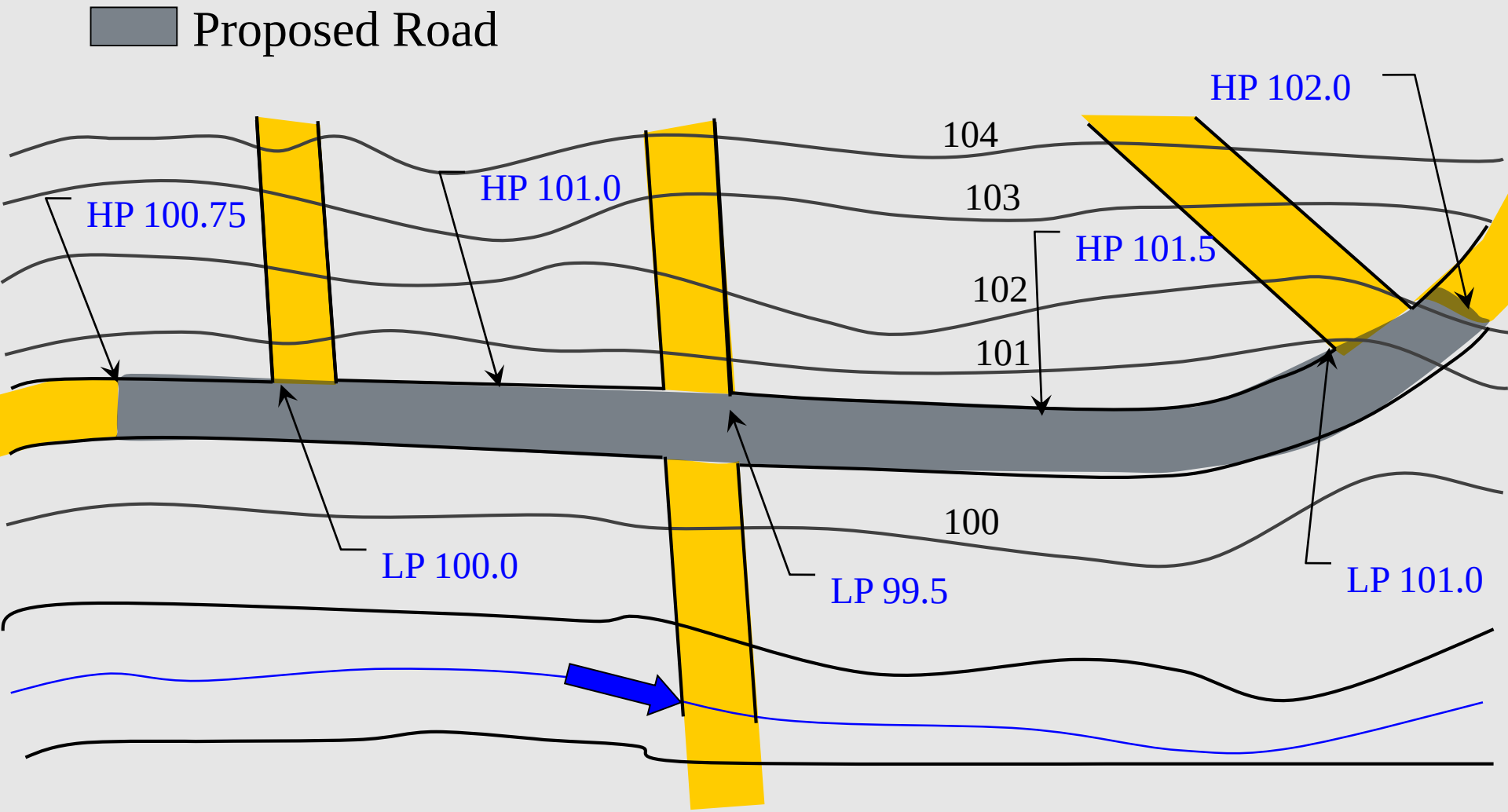
Drainage System (Storm Sewer and Roadway)



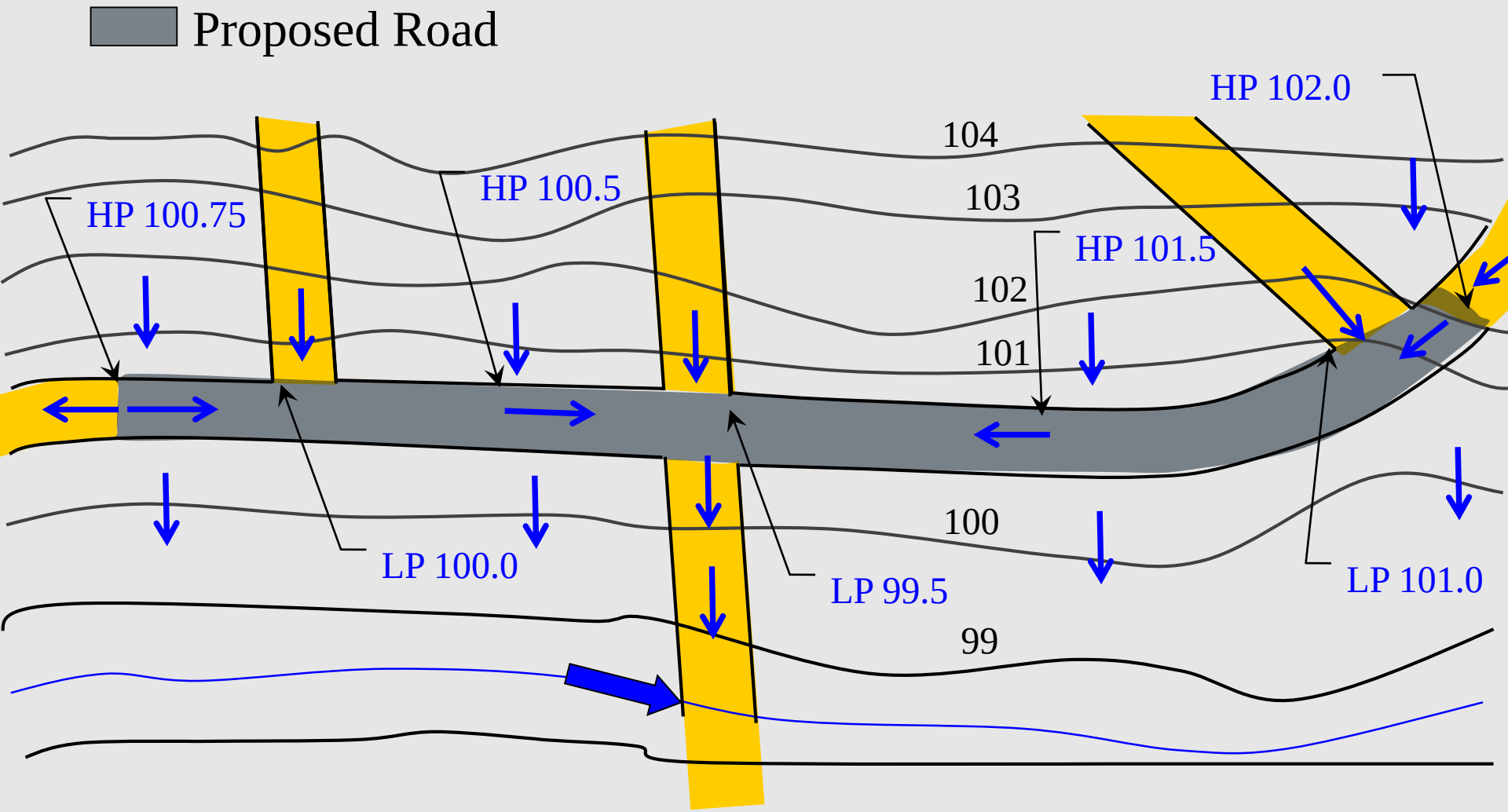
Contour Map



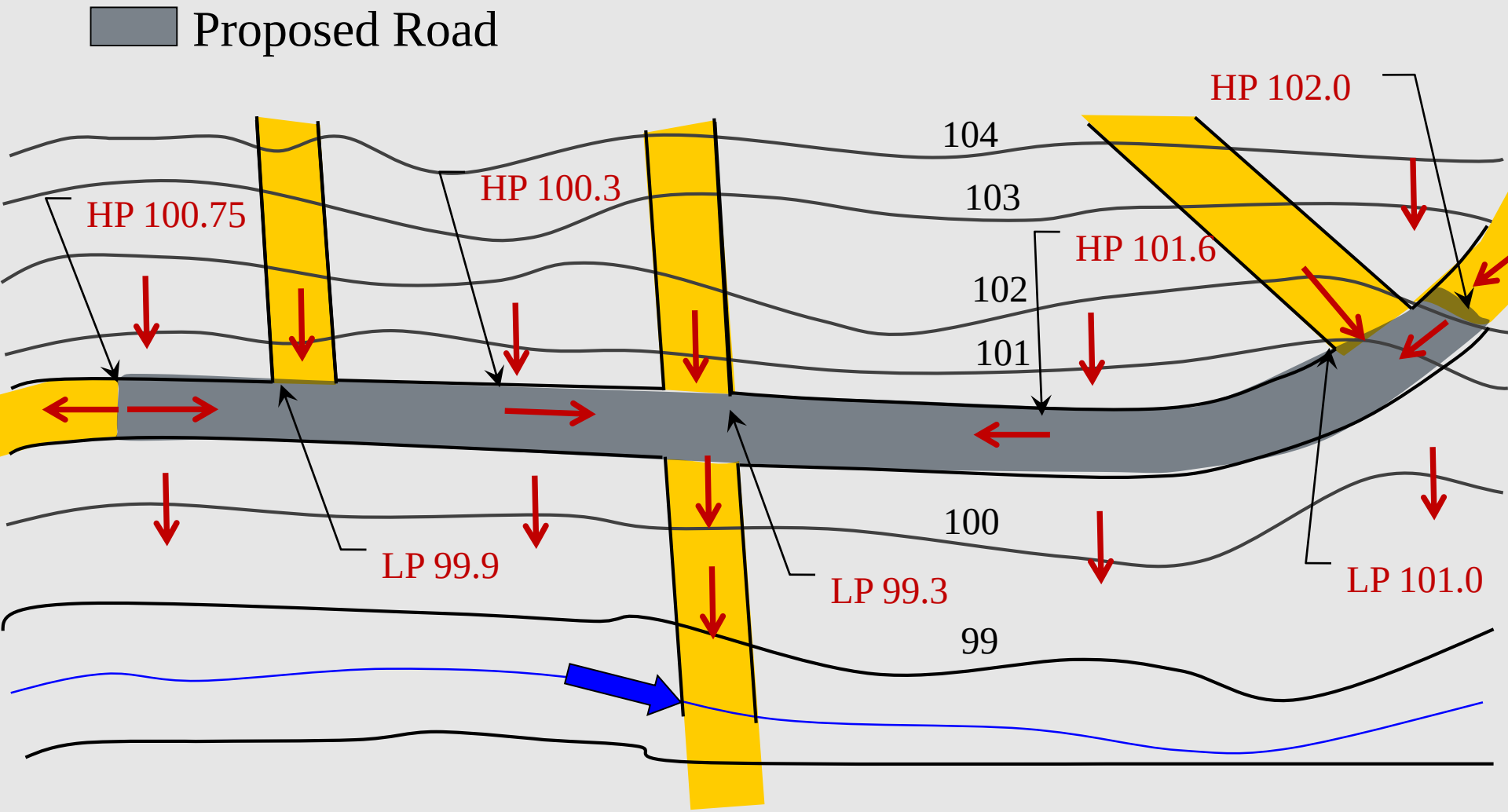
Existing Sheet Flow Map



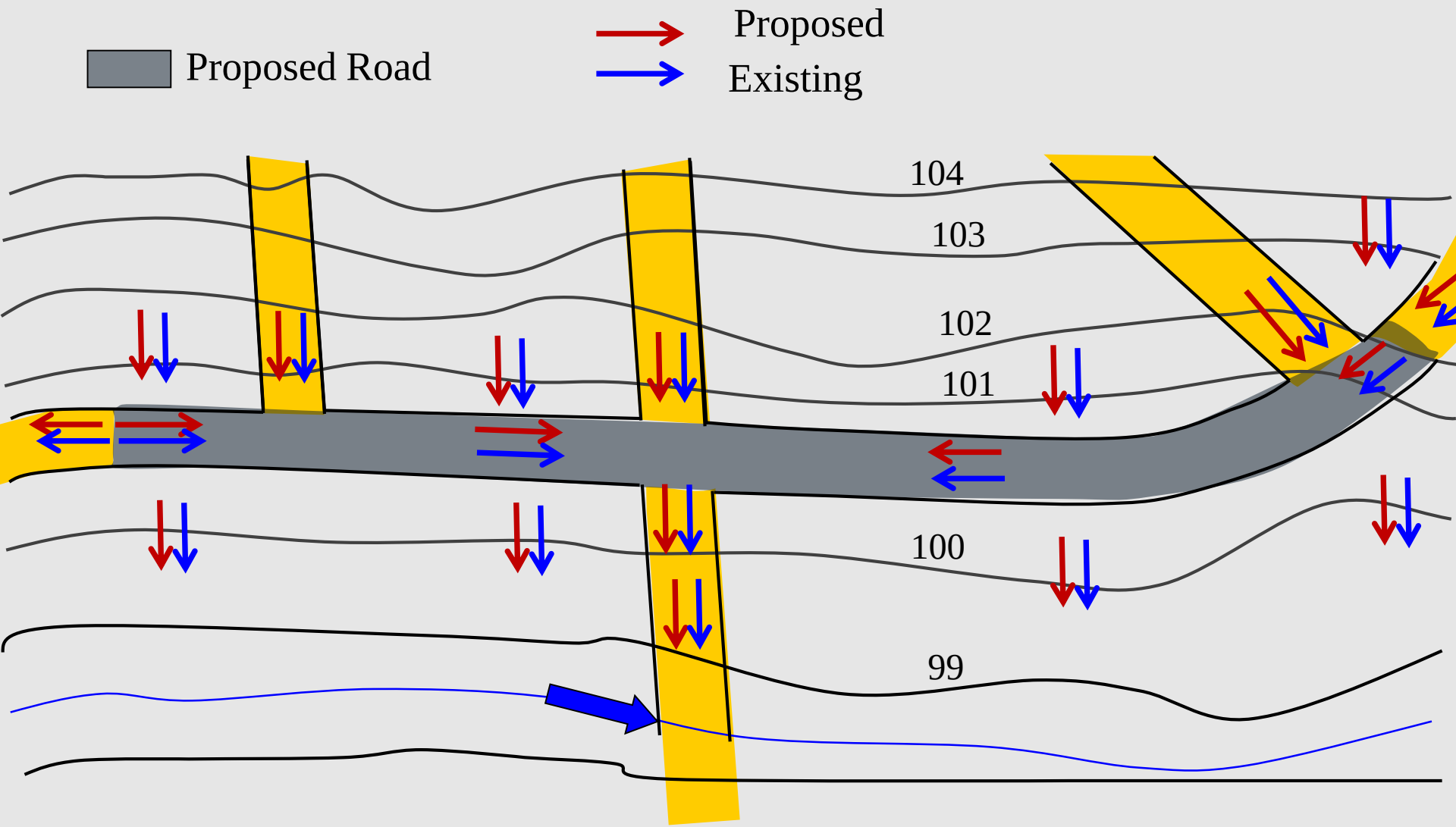
Existing Sheet Flow Map



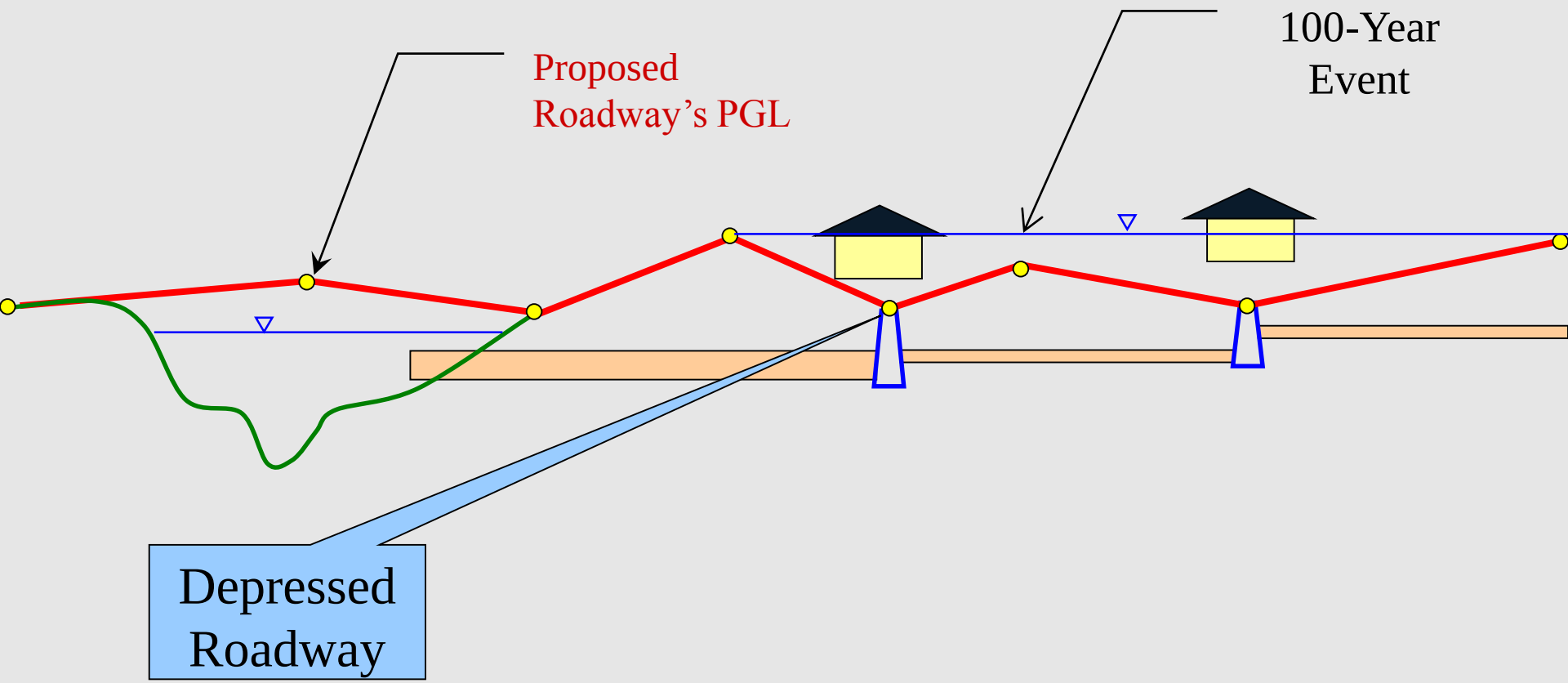
Proposed Sheet Flow Map



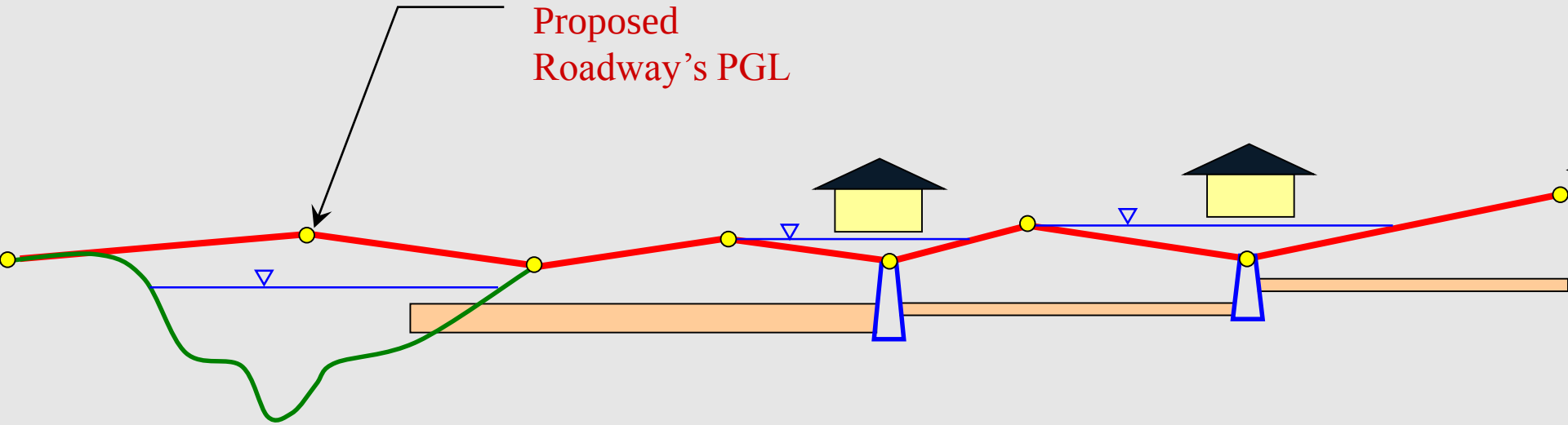
Final Sheet Flow Map



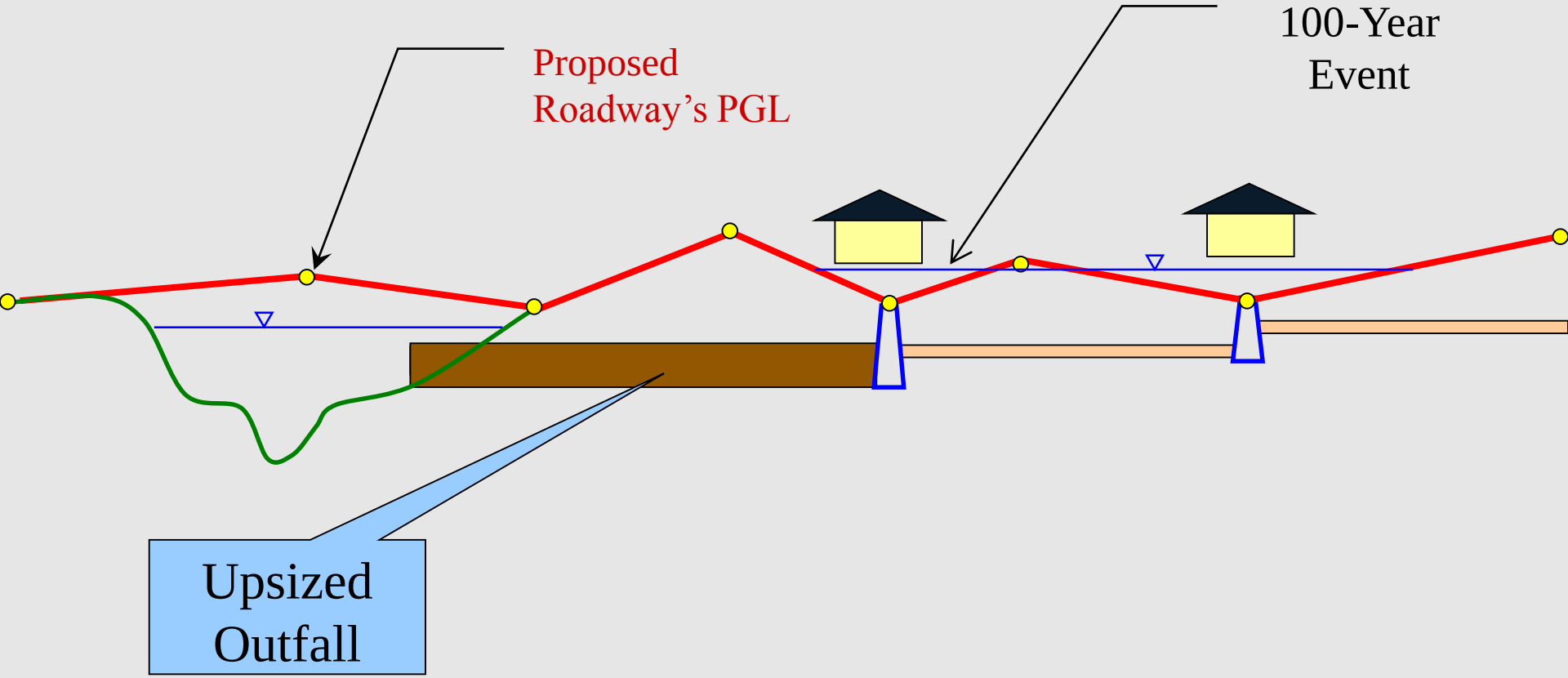
Proposed Profile



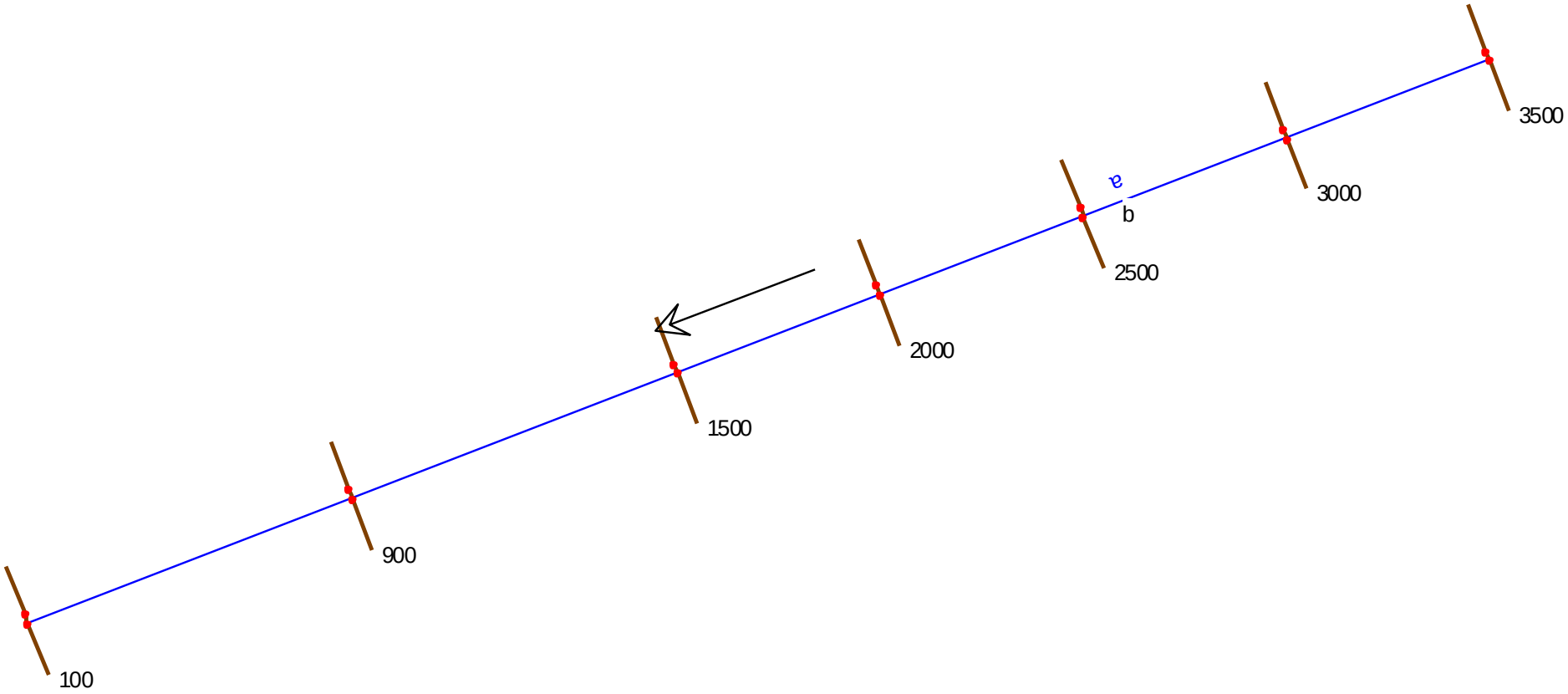
Cascading Profile to Outfall



Proposed Profile



HEC-RAS for Roadway (100-Year Event)



Cross Section Data - street

Exit Edit Options Plot Help

River: a Apply Data Plot Options Keep Prev XS Plots Clear Prev

Reach: b River Sta.: 2500

Description

Del Row Ins Row

Cross Section Coordinates

	Station	Elevation
1	0	103
2	100	102
3	120	101.5
4	120	101
5	132	101.25
6	144	101
7	144	101.5
8	164	102
9	264	103
10		
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33		
34		

Downstream Reach Lengths

LOB	Channel	ROB
500	500	500

Manning's n Values

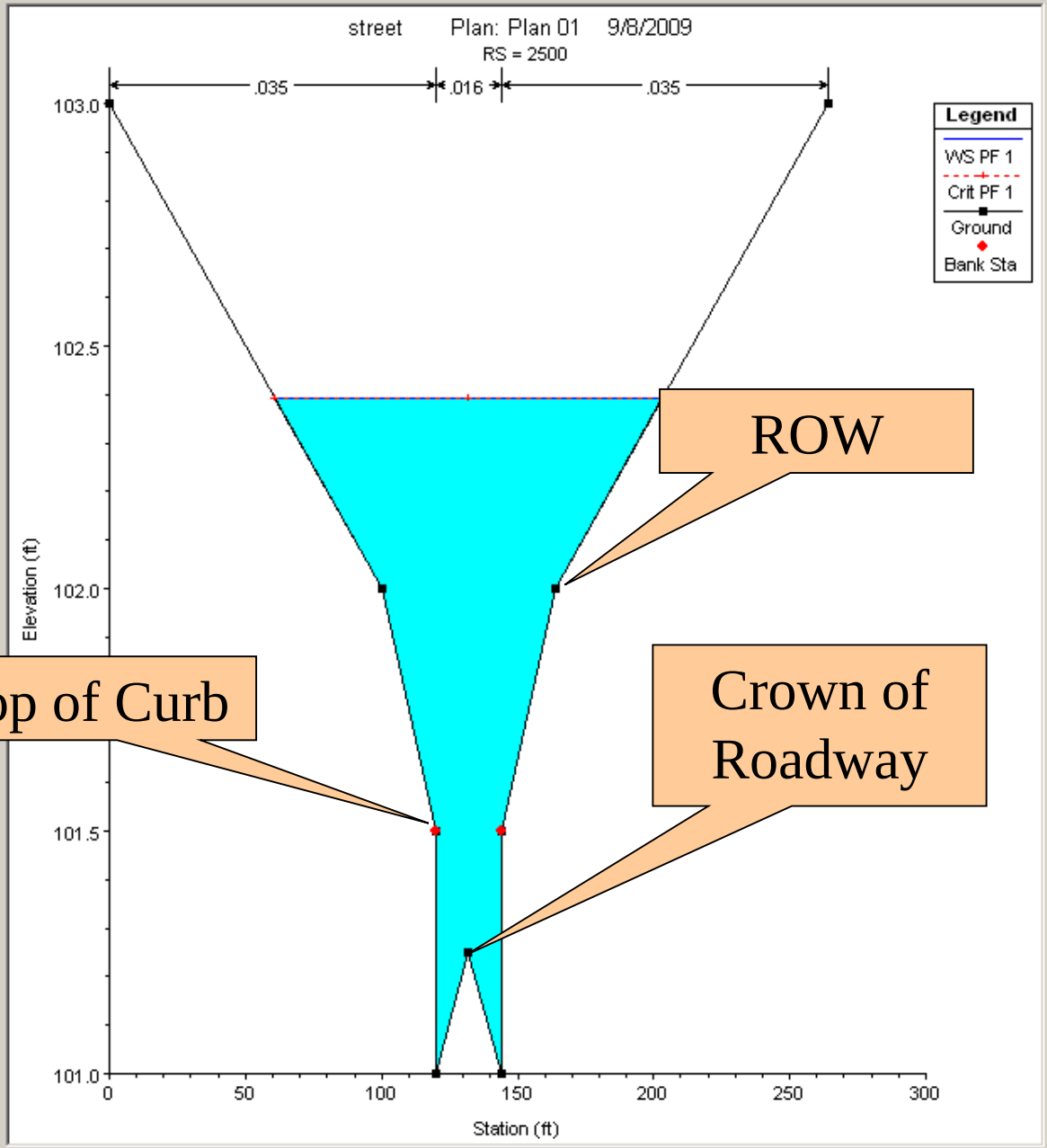
LOB	Channel	ROB
0.035	0.016	0.035

Main Channel Bank Stations

Left Bank	Right Bank
120	144

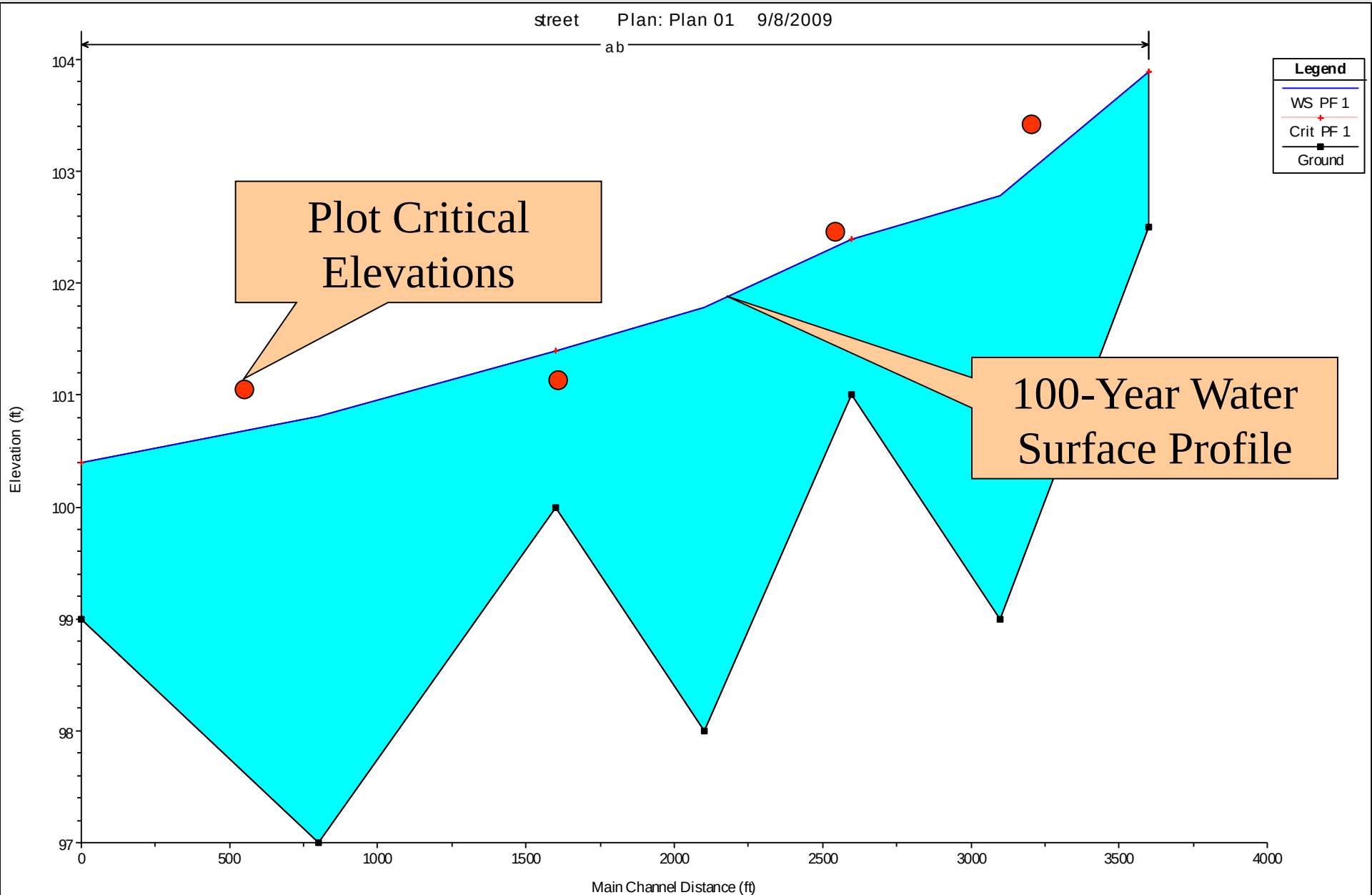
Cont\Exp Coefficient (Steady Flow)

Contraction	Expansion
0.1	0.3

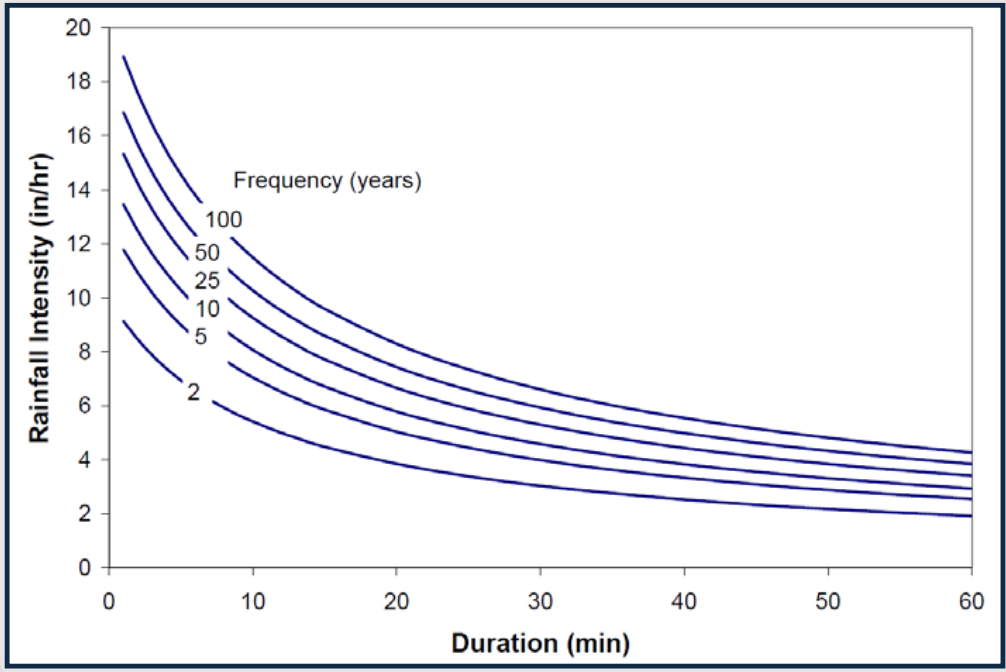


Enter to move to next upstream river station location

HEC-RAS Profile of Roadway



INTENSITY DURATION FREQUENCY CURVES (IDF CURVES)



2015 - E, B, & D coefficients

Intensity-Duration-Frequency Curve (IDF Curves)

- Old IDF curves were based off TP-40 (1960s)
- Last IDF update occurred over 30 years ago (1985).
- The 2015, IDF curves will provide a stopgap measure until the NOAA Atlas 14 Precipitation Frequency data server comes online for Texas.

USGS Atlas of Depth Duration Frequency of Precipitation Annual Maxim for Texas - 2004

USGS
science for a changing world

In cooperation with the Texas Department of Transportation

Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

Scientific Investigations Report 2004–5041
(TxDOT Implementation Report 5–1301–01–1)

U.S. Department of the Interior
U.S. Geological Survey

18 Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

30 Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

Maxima for Texas

0 25 50 100 MILES
0 50 100 200 KILOMETERS

Albers-equal area projection parameters
Central meridian: -96.0
Standard parallel 1: 29.5
Standard parallel 2: 45.5
Latitude of origin: 23.0

Base modified from U.S. Geological Survey digital data at 1:250,000 (2003)

Figure 47. Depth of precipitation for 25-year storm for 1-day duration in Texas.

50,000 (2003)

uration in Texas.

100 MILES
200 KILOMETERS

Intensity-Duration-Frequency (IDF) Curves

Rainfall Intensity-Duration-Frequency Coefficients for Texas

Based on United States Geological Survey (USGS) Scientific Investigations Report 2004–5041
"Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas"

1. Select English or SI Units: English

2. Select or Enter a County: Denton

3. Enter a Time of Conc. Select Units: 15 min

Coefficient	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)
e	0.8014	0.7898	0.7872	0.7828	0.7824	0.7779
b (in.)	48.63	58.72	68.67	79.33	90.90	101.22
d (min)	8.02	7.69	7.67	7.80	7.62	7.36
Intensity (in./hr)	3.94	4.99	5.89	6.86	7.92	9.03

(Spreadsheet Release Date: August 31, 2015; data table reshuffle by Asquith July 14, 2016)

IDF Curves 2015 v2.1

July 14, 2016

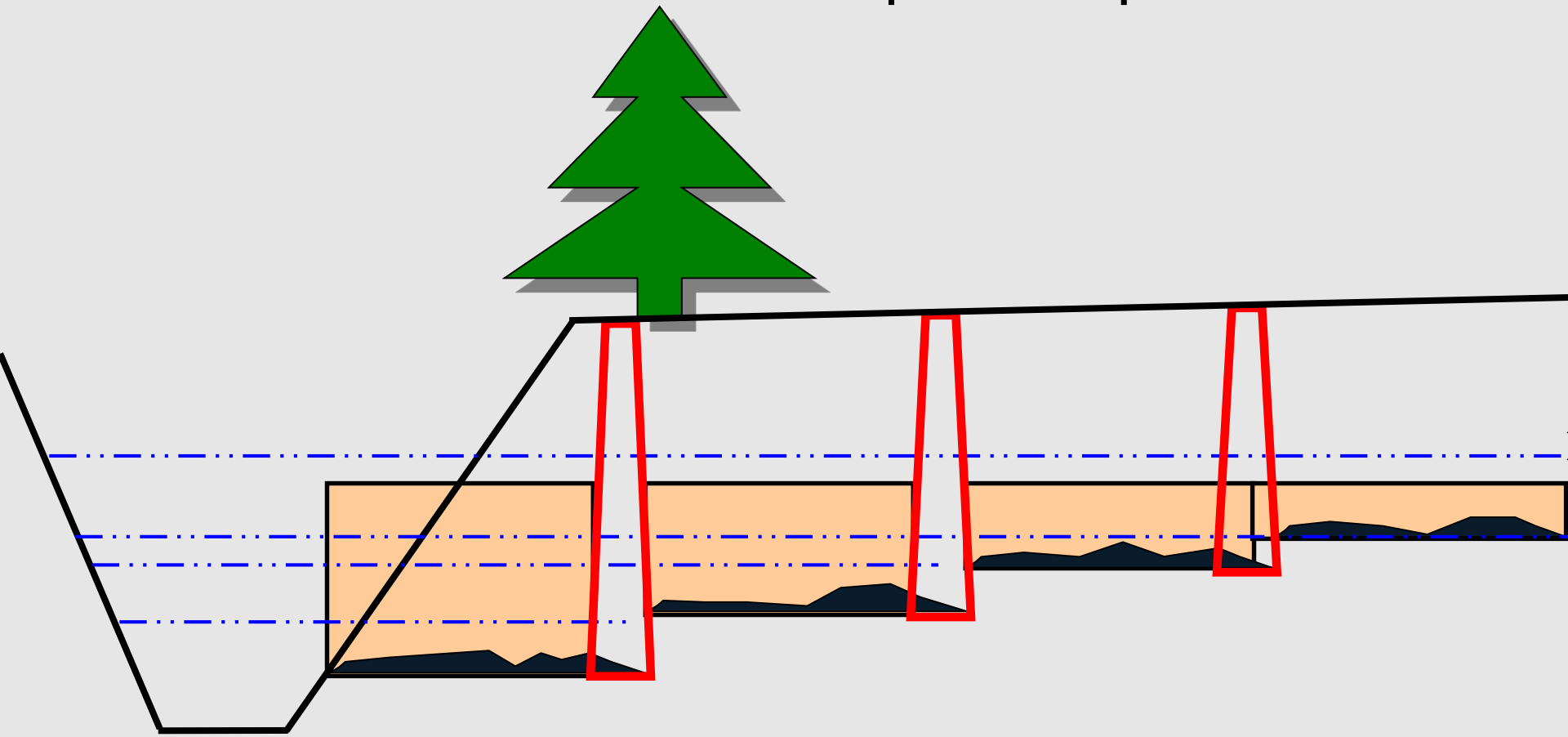
MINIMUM MAINTENANCE VELOCITY

Storm Sewer and Culverts

Increased from 2 fps to 3 fps

Maintenance Velocity

Storm Sewer and Culvert Minimum Maintenance Velocities Increased from 2 fps to 3 fps.



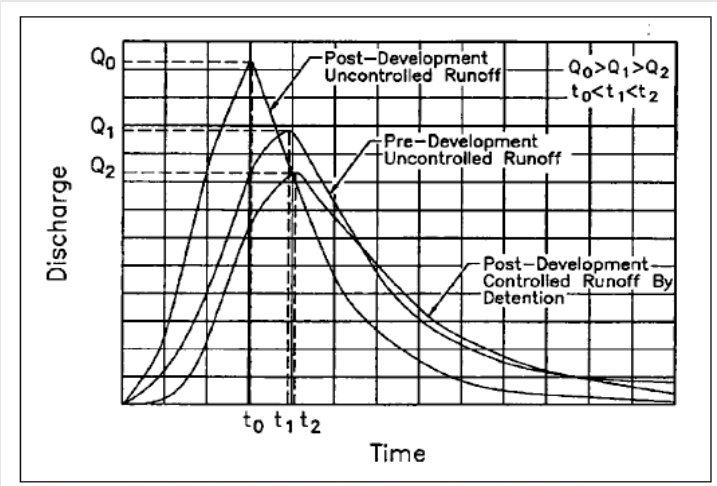

THIS WAY
THAT WAY
ANOTHER WAY
WHAT NEXT?

HYDRAULIC DESIGN MANUAL

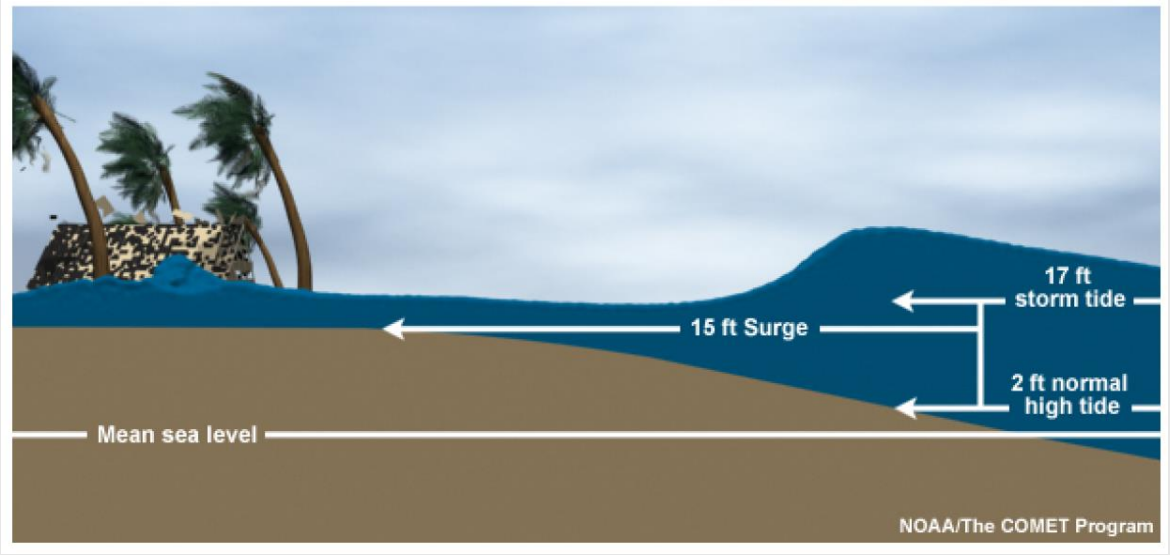
Future Chapters

Proposed New Chapters for 2017

- **Detention**



- **Coastal**



NOAA ATLAS 14 PRECIPITATION DATA FREQUENCY SERVER APRIL 2018

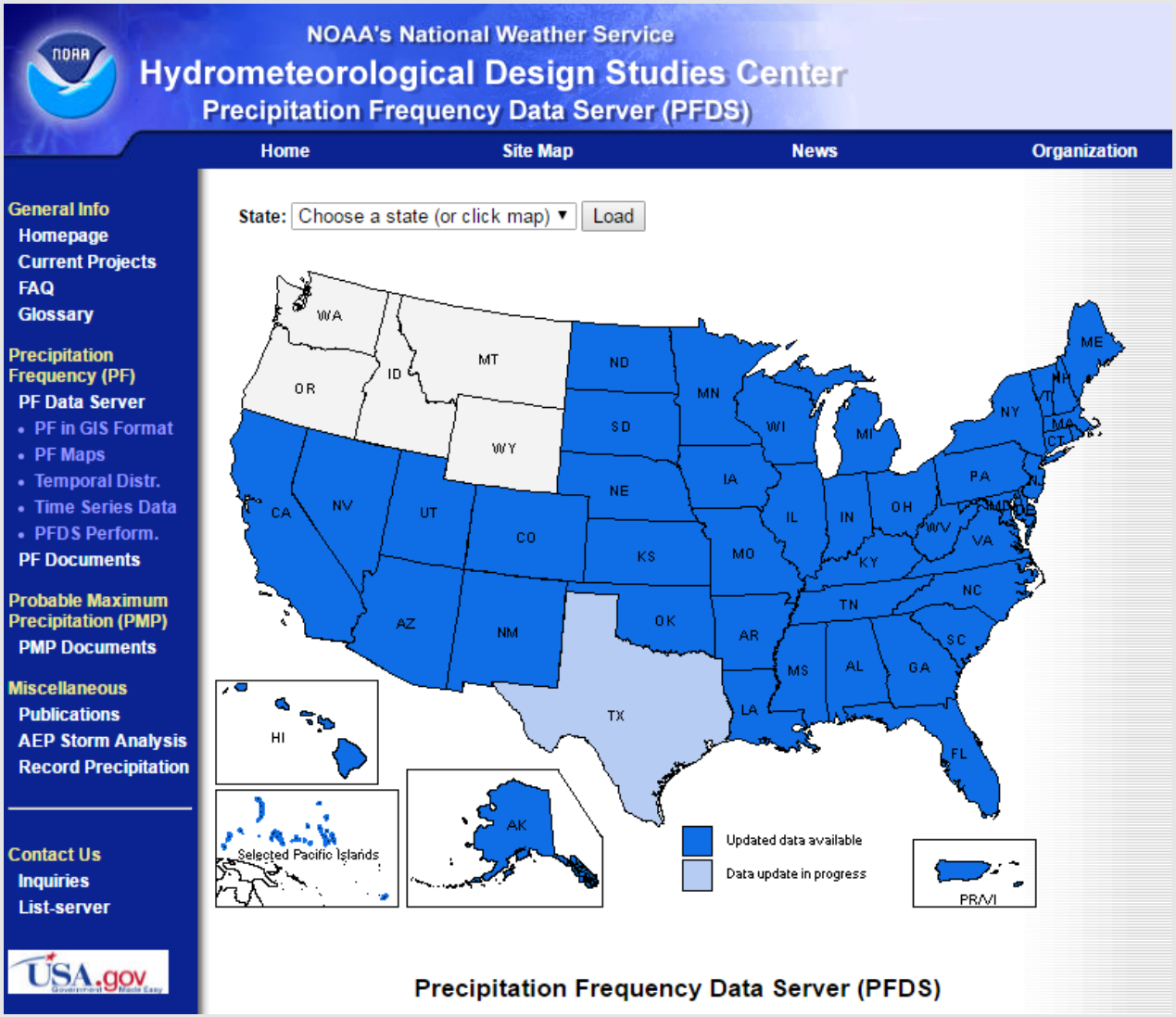
http://hdsc.nws.noaa.gov/hdsc/pfds/

NOAA Atlas 14 Study Contributions

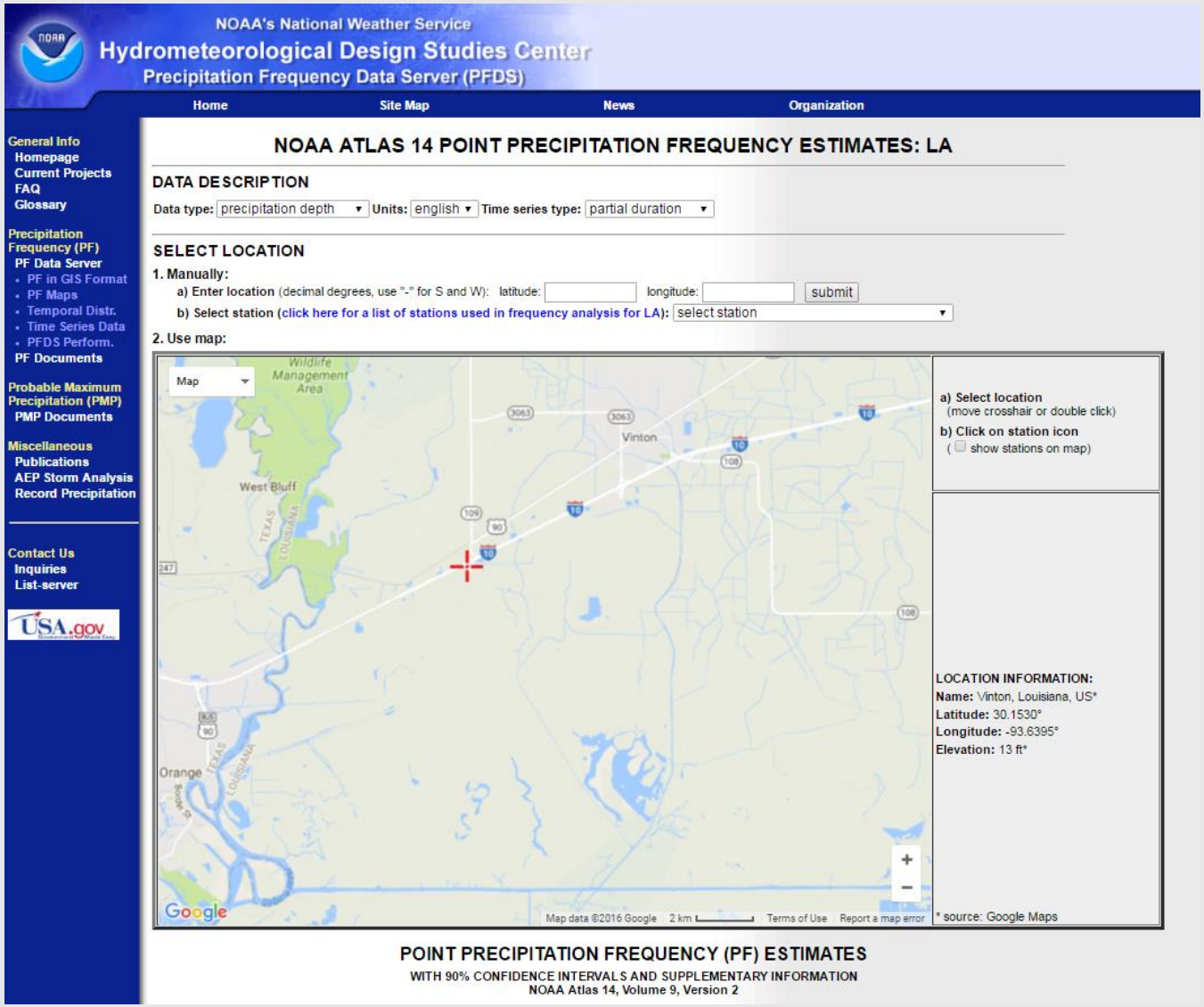
Brazos River Authority	$15,000
City of Austin	$50,000
Harris County Flood Control District	$200,000
Texas Department of Transportation	$740,000
	$1,005,000

Source: http://www.pooledfund.org/Details/Solicitation/1421

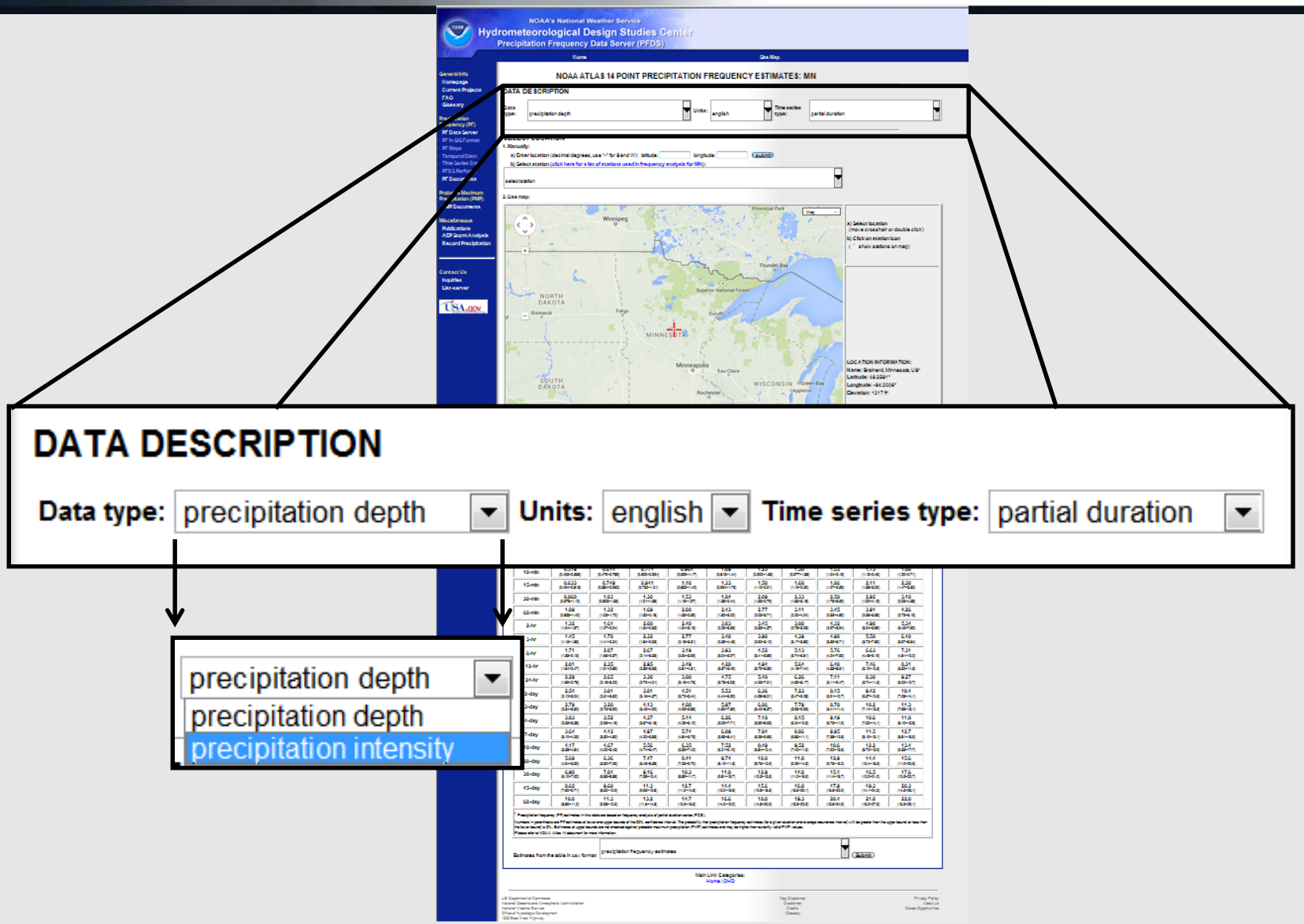
Select a State

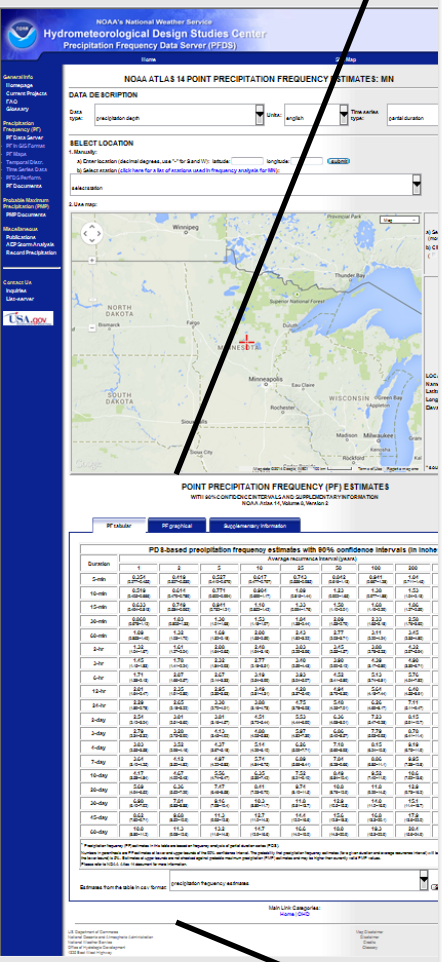


Drag & Drop Crosshair to Location



Data Type:


NOAA's National Weather Service
Hydrometeorological Design Studies Center
Precipitation Frequency Data Server (PFDS)
NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: MN
DATA DESCRIPTION
Data type: precipitation depth
Units: english
Time series type: partial duration
DATA DESCRIPTION
Data type: precipitation depth
Units: english
Time series type: partial duration
precipitation depth
precipitation depth
precipitation intensity



POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 9, Version 2

PF tabular | PF graphical | Supplementary information

Print Page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	7.03 (5.65-8.82)	7.97 (6.41-10.0)	9.50 (7.61-12.0)	10.8 (8.57-13.6)	12.5 (9.61-16.3)	13.8 (10.4-18.4)	15.1 (11.0-20.8)	16.4 (11.5-23.4)	18.1 (12.3-26.7)	19.4 (12.8-29.2)
10-min	5.15 (4.14-6.46)	5.84 (4.69-7.33)	6.95 (5.57-8.76)	7.87 (6.27-9.97)	9.13 (7.03-12.0)	10.1 (7.61-13.5)	11.0 (8.06-15.2)	12.0 (8.43-17.1)	13.3 (8.98-19.5)	14.2 (9.39-21.4)
15-min	4.19 (3.36-5.25)	4.74 (3.81-5.96)	5.66 (4.53-7.12)	6.40 (5.10-8.11)	7.42 (5.72-9.73)	8.20 (6.19-11.0)	8.98 (6.56-12.4)	9.76 (6.85-13.9)	10.8 (7.30-15.9)	11.6 (7.64-17.4)
30-min	3.11 (2.50-3.90)	3.51 (2.82-4.41)	4.18 (3.35-5.26)	4.75 (3.78-6.01)	5.54 (4.28-7.30)	6.17 (4.66-8.27)	6.81 (4.98-9.40)	7.47 (5.25-10.7)	8.36 (5.67-12.4)	9.05 (5.98-13.6)
60-min	2.09 (1.68-2.62)	2.35 (1.89-2.95)	2.81 (2.25-3.53)	3.21 (2.56-4.07)	3.82 (2.97-5.08)	4.32 (3.28-5.84)	4.86 (3.57-6.76)	5.43 (3.83-7.81)	6.24 (4.24-9.27)	6.89 (4.55-10.4)
2-hr	1.31 (1.06-1.64)	1.47 (1.19-1.84)	1.76 (1.42-2.20)	2.03 (1.62-2.55)	2.44 (1.91-3.23)	2.78 (2.13-3.75)	3.16 (2.34-4.38)	3.57 (2.54-5.11)	4.15 (2.85-6.14)	4.63 (3.08-6.93)
3-hr	0.986 (0.800-1.22)	1.11 (0.900-1.38)	1.34 (1.08-1.67)	1.56 (1.25-1.96)	1.90 (1.50-2.53)	2.20 (1.69-2.96)	2.52 (1.88-3.50)	2.88 (2.06-4.12)	3.39 (2.33-5.01)	3.81 (2.54-5.68)
6-hr	0.591 (0.482-0.729)	0.682 (0.555-0.842)	0.850 (0.690-1.05)	1.01 (0.815-1.26)	1.26 (0.998-1.66)	1.47 (1.14-1.97)	1.70 (1.27-2.35)	1.96 (1.41-2.79)	2.33 (1.61-3.42)	2.63 (1.77-3.90)
12-hr	0.343 (0.282-0.421)	0.409 (0.335-0.502)	0.529 (0.432-0.650)	0.639 (0.519-0.790)	0.807 (0.643-1.06)	0.949 (0.737-1.26)	1.10 (0.829-1.51)	1.27 (0.918-1.79)	1.51 (1.05-2.20)	1.70 (1.15-2.51)
24-hr	0.202 (0.167-0.246)	0.242 (0.199-0.295)	0.315 (0.259-0.385)	0.382 (0.312-0.469)	0.484 (0.388-0.632)	0.571 (0.446-0.754)	0.665 (0.503-0.904)	0.767 (0.558-1.08)	0.913 (0.640-1.32)	1.03 (0.702-1.51)
2-day	0.119 (0.098-0.143)	0.139 (0.115-0.168)	0.177 (0.146-0.215)	0.213 (0.175-0.260)	0.269 (0.218-0.349)	0.317 (0.250-0.417)	0.369 (0.282-0.500)	0.427 (0.313-0.596)	0.510 (0.360-0.735)	0.578 (0.396-0.840)
3-day	0.086 (0.071-0.103)	0.101 (0.084-0.122)	0.128 (0.107-0.155)	0.154 (0.127-0.188)	0.194 (0.157-0.250)	0.227 (0.179-0.297)	0.264 (0.202-0.355)	0.304 (0.223-0.422)	0.361 (0.256-0.517)	0.407 (0.280-0.589)
4-day	0.068 (0.057-0.082)	0.080 (0.067-0.097)	0.102 (0.085-0.123)	0.122 (0.101-0.149)	0.153 (0.124-0.197)	0.179 (0.142-0.234)	0.208 (0.159-0.278)	0.238 (0.176-0.330)	0.282 (0.200-0.403)	0.318 (0.219-0.458)
7-day	0.045 (0.038-0.054)	0.052 (0.044-0.062)	0.065 (0.054-0.078)	0.077 (0.064-0.093)	0.096 (0.078-0.122)	0.111 (0.089-0.144)	0.128 (0.099-0.171)	0.147 (0.109-0.203)	0.174 (0.124-0.247)	0.196 (0.136-0.281)
10-day	0.035 (0.029-0.042)	0.040 (0.034-0.048)	0.049 (0.041-0.059)	0.058 (0.048-0.070)	0.071 (0.058-0.091)	0.082 (0.066-0.106)	0.095 (0.073-0.126)	0.108 (0.080-0.148)	0.127 (0.091-0.179)	0.142 (0.099-0.203)
20-day	0.023 (0.019-0.027)	0.026 (0.022-0.030)	0.031 (0.026-0.037)	0.035 (0.030-0.042)	0.042 (0.034-0.053)	0.048 (0.038-0.061)	0.053 (0.041-0.070)	0.060 (0.044-0.081)	0.068 (0.049-0.095)	0.075 (0.053-0.107)
30-day	0.018 (0.015-0.021)	0.020 (0.017-0.024)	0.024 (0.020-0.028)	0.027 (0.023-0.033)	0.032 (0.026-0.040)	0.036 (0.028-0.045)	0.039 (0.031-0.051)	0.043 (0.032-0.058)	0.048 (0.035-0.067)	0.052 (0.037-0.074)
45-day	0.014 (0.012-0.017)	0.016 (0.014-0.019)	0.019 (0.016-0.022)	0.022 (0.018-0.025)	0.025 (0.020-0.030)	0.027 (0.022-0.034)	0.030 (0.023-0.038)	0.032 (0.024-0.043)	0.035 (0.026-0.049)	0.038 (0.027-0.053)
60-day	0.012 (0.010-0.014)	0.014 (0.012-0.016)	0.016 (0.014-0.019)	0.018 (0.015-0.022)	0.021 (0.017-0.025)	0.023 (0.018-0.028)	0.025 (0.019-0.032)	0.027 (0.020-0.035)	0.029 (0.021-0.040)	0.031 (0.022-0.043)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

TEXAS DEPARTMENT OF TRANSPORTATION

CLIMATE CHANGE GUIDANCE 2018 ±

Presidential Executive Order 13690
January 30, 2015

Establish Federal Flood Risk Management Standard (FFRMS) (amends EO 11988).

Describes 3 approaches to achieve “Future Flood” standards:

- Freeboard Value Approach (FVA).
- Use 500-year floodplain elevation and extent (0.2PFA).
- Climate-Informed Science Approach (CISA).

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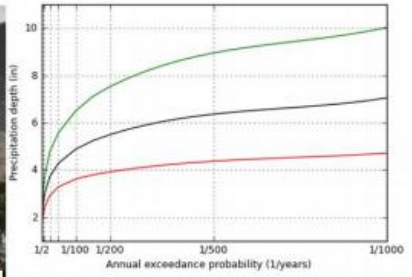
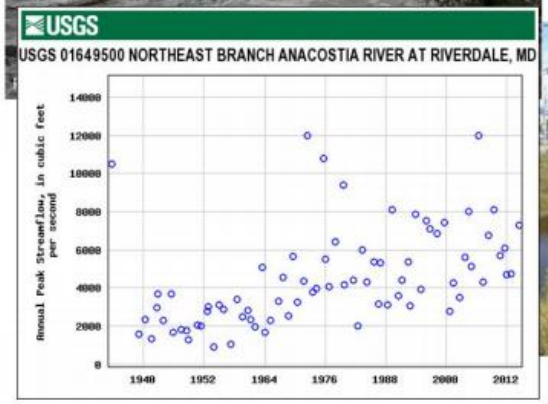
FHWA HEC-17 2nd Edition June 2016

Publication No. FHWA-HIF-16-018
June 2016

U.S. Department of Transportation
Federal Highway Administration

Hydraulic Engineering Circular No. 17, 2nd Edition





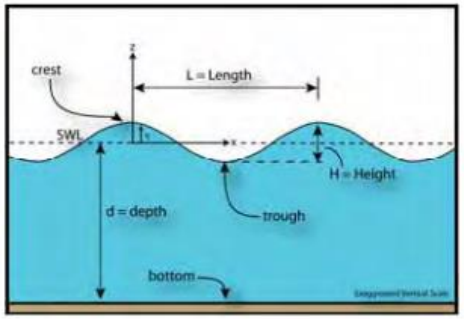
Highways in the River Environment- Floodplains, Extreme Events, Risk, and Resilience

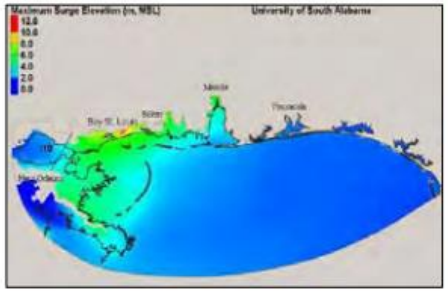
FHWA HEC-25 Volume 2 October 2014

U.S. Department of Transportation
Federal Highway Administration

Publication No. FHWA-NHI-07-096
June 2008

Hydraulic Engineering Circular No. 25





Highways in the Coastal Environment

Second Edition

Question & Answers

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