HY8 Culvert Analysis

- HY-8 Version 7.2 Build Date January 17, 2012
- Federal Highway Administration

http://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/index.cfm

SIMPLE

Simple to use

Use for simple culverts and bridges

Normally it would not be used for complicated projects, such as bridges with piers or when precise stream profiles are needed. Also, it will not run with an open channel without a structure

Sample Problem

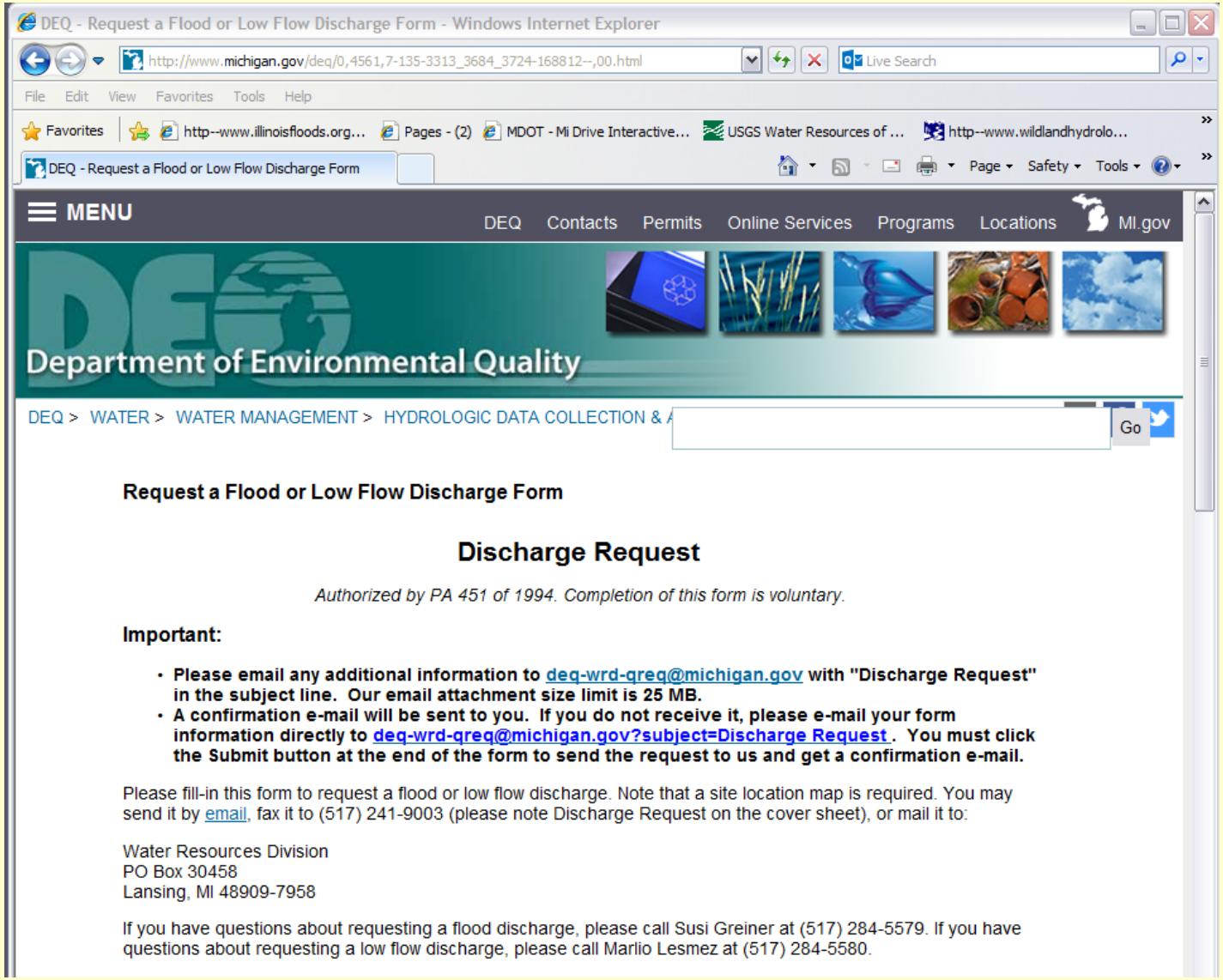
- Replace an existing culvert with a larger culvert
- **Issue**: CRC wants to replace the existing culvert with a longer culvert. The proposed design increases the size of the culvert as well. Will the larger culvert offset the fact that the culvert will be longer?
- **Existing Culvert:**
  - Length-- 32'.
  - CMP, 42" diameter
  - Low point of road: el 588.20
  - Width of road: 18 feet
  - Stream bottom sandy but stony
  - Stream banks weedy with small brush
  - Stream bottom elevation 579.00
- **Proposed Culvert:**
  - Length– 54'.
  - Concrete Elliptical, 60"x38"
  - Road elevations and width will remain the same

Data Acquisition

Flood Discharge Information

Obtained from DEQ-WRD Hydrologic Studies and Dam Safety Unit

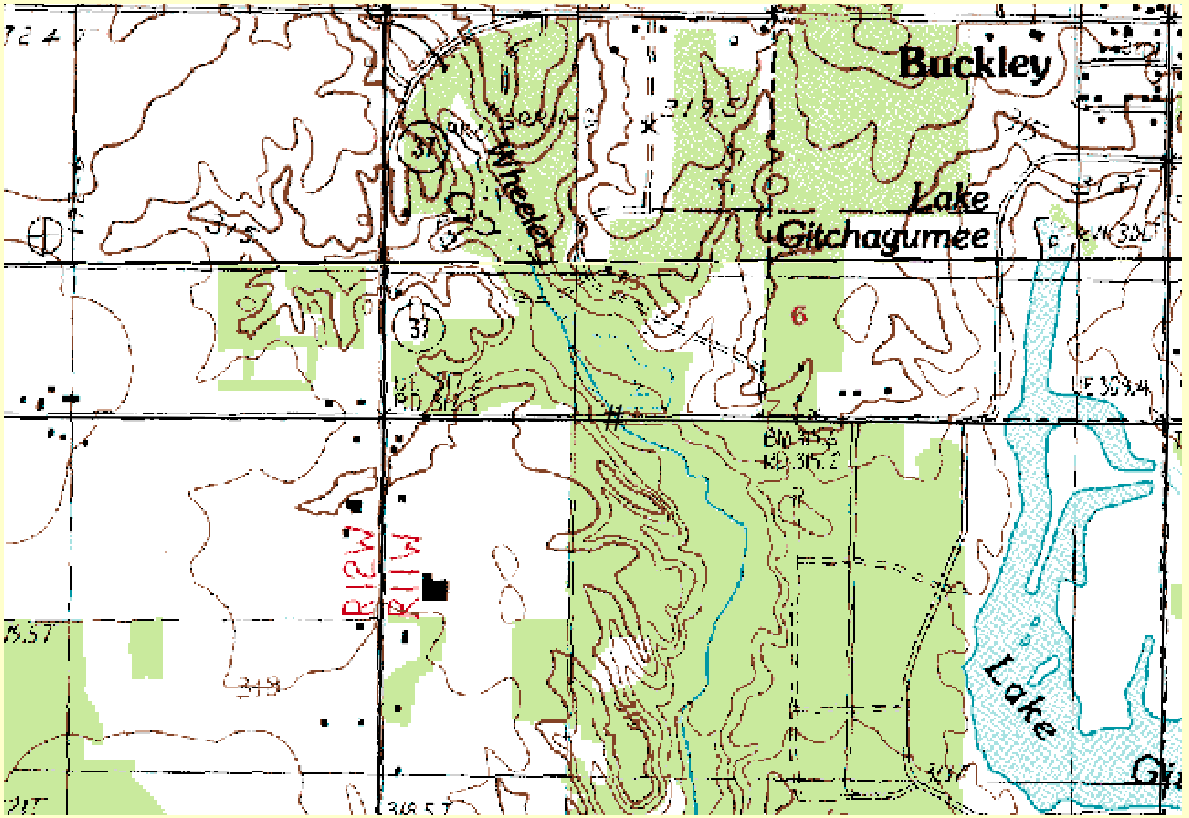
http://www.michigan.gov/deq/0,4561,7-135-3313_3684_3724-168812--,00.html


DEQ - Request a Flood or Low Flow Discharge Form - Windows Internet Explorer
http://www.michigan.gov/deq/0,4561,7-135-3313_3684_3724-168812--,00.html
Live Search
File Edit View Favorites Tools Help
Favorites
http--www.illinoisfloods.org...
Pages - (2)
MDOT - Mi Drive Interactive...
USGS Water Resources of ...
http--www.wildlandhydrolo...
DEQ - Request a Flood or Low Flow Discharge Form
Page Safety Tools
MENU
DEQ Contacts Permits Online Services Programs Locations MI.gov
Department of Environmental Quality
DEQ > WATER > WATER MANAGEMENT > HYDROLOGIC DATA COLLECTION &
Go
Request a Flood or Low Flow Discharge Form
Discharge Request
Authorized by PA 451 of 1994. Completion of this form is voluntary.
Important:
• Please email any additional information to deq-wrd-qreq@michigan.gov with "Discharge Request" in the subject line. Our email attachment size limit is 25 MB.
• A confirmation e-mail will be sent to you. If you do not receive it, please e-mail your form information directly to deq-wrd-qreq@michigan.gov?subject=Discharge Request . You must click the Submit button at the end of the form to send the request to us and get a confirmation e-mail.
Please fill-in this form to request a flood or low flow discharge. Note that a site location map is required. You may send it by email, fax it to (517) 241-9003 (please note Discharge Request on the cover sheet), or mail it to:
Water Resources Division
PO Box 30458
Lansing, MI 48909-7958
If you have questions about requesting a flood discharge, please call Susi Greiner at (517) 284-5579. If you have questions about requesting a low flow discharge, please call Marlio Lesmez at (517) 284-5580.

Data Acquisition

Channel Slope

Obtained from survey data or topo maps
Measure distance along stream between contours
Channel Slope = rise/run



Data Acquisition

Manning's n (Channel)

- Several references for Manning's n for various stream conditions
- "Open Channel Hydraulics", Chow 1959 contains an extensive compilations of n values
- References typically provide color photo with tables of calibrated n values for a range of flows.

Data Acquisition

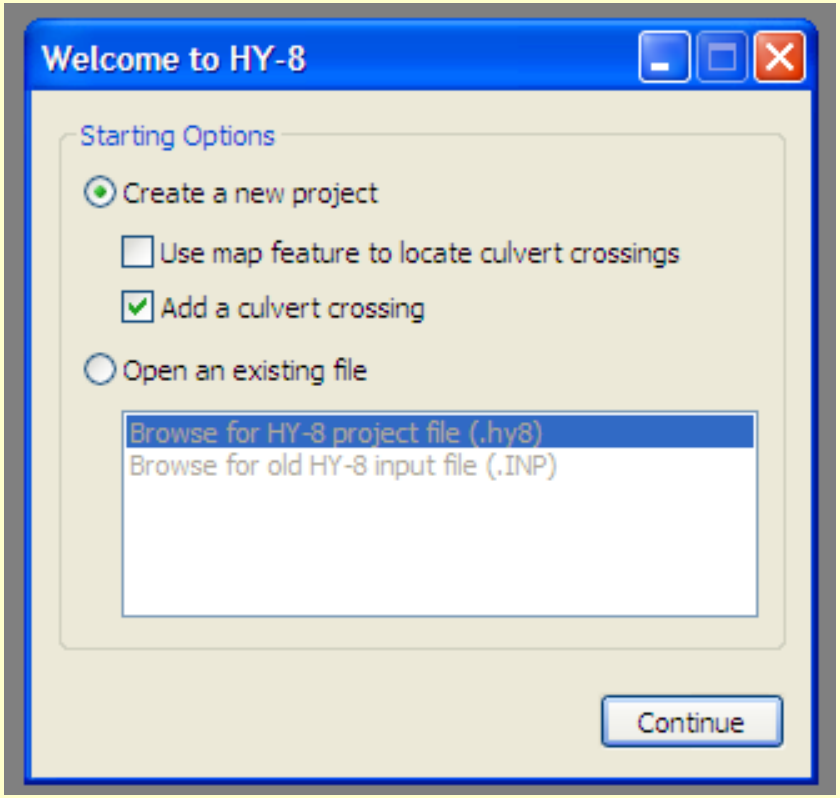
Project Survey and Design Data

Stream Channel Shape and Streambed Invert Elevation

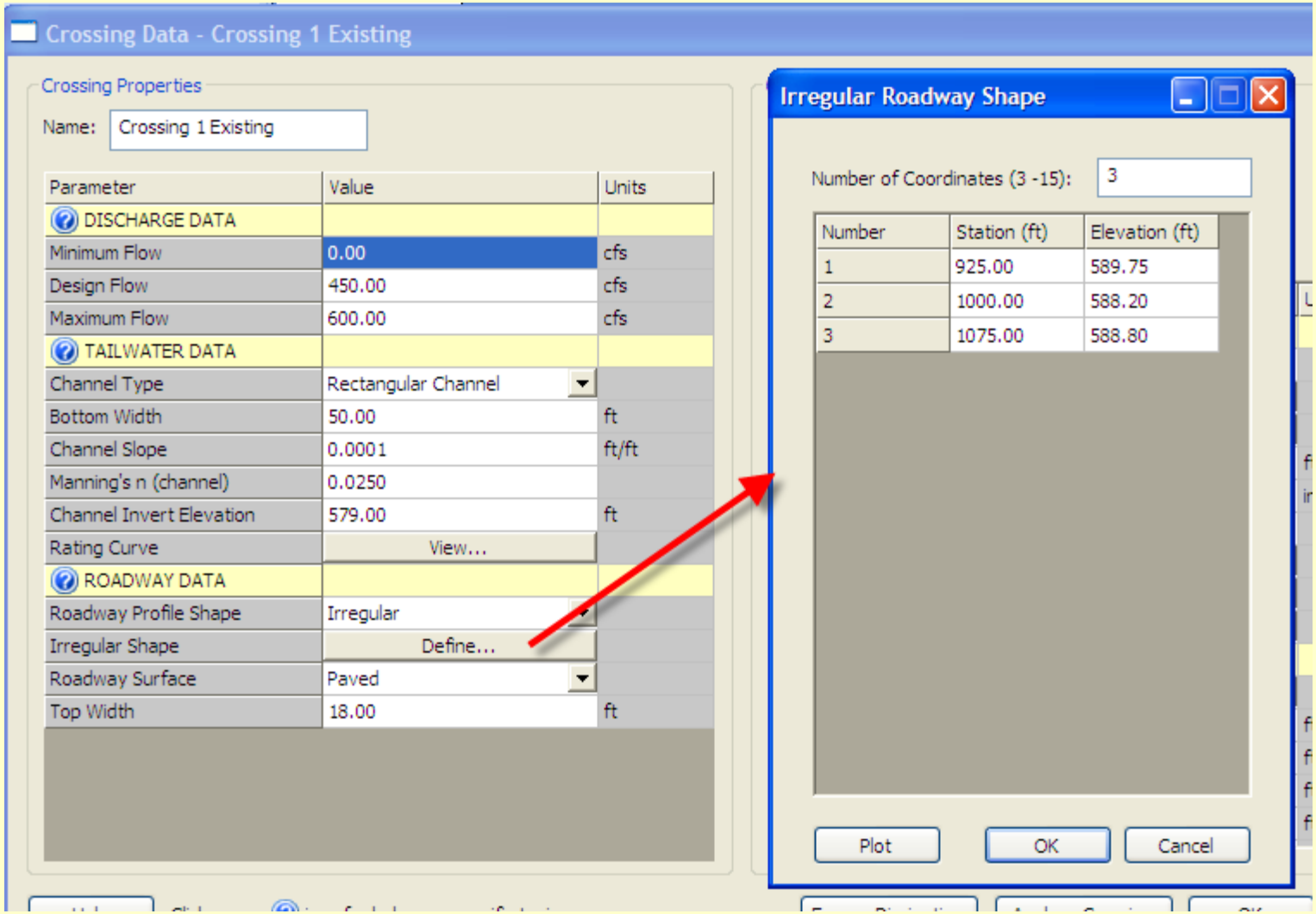
Culvert Inlet Conditions, Culvert dimensions & Type

Existing and Proposed Road Grade, Width, Crest Length

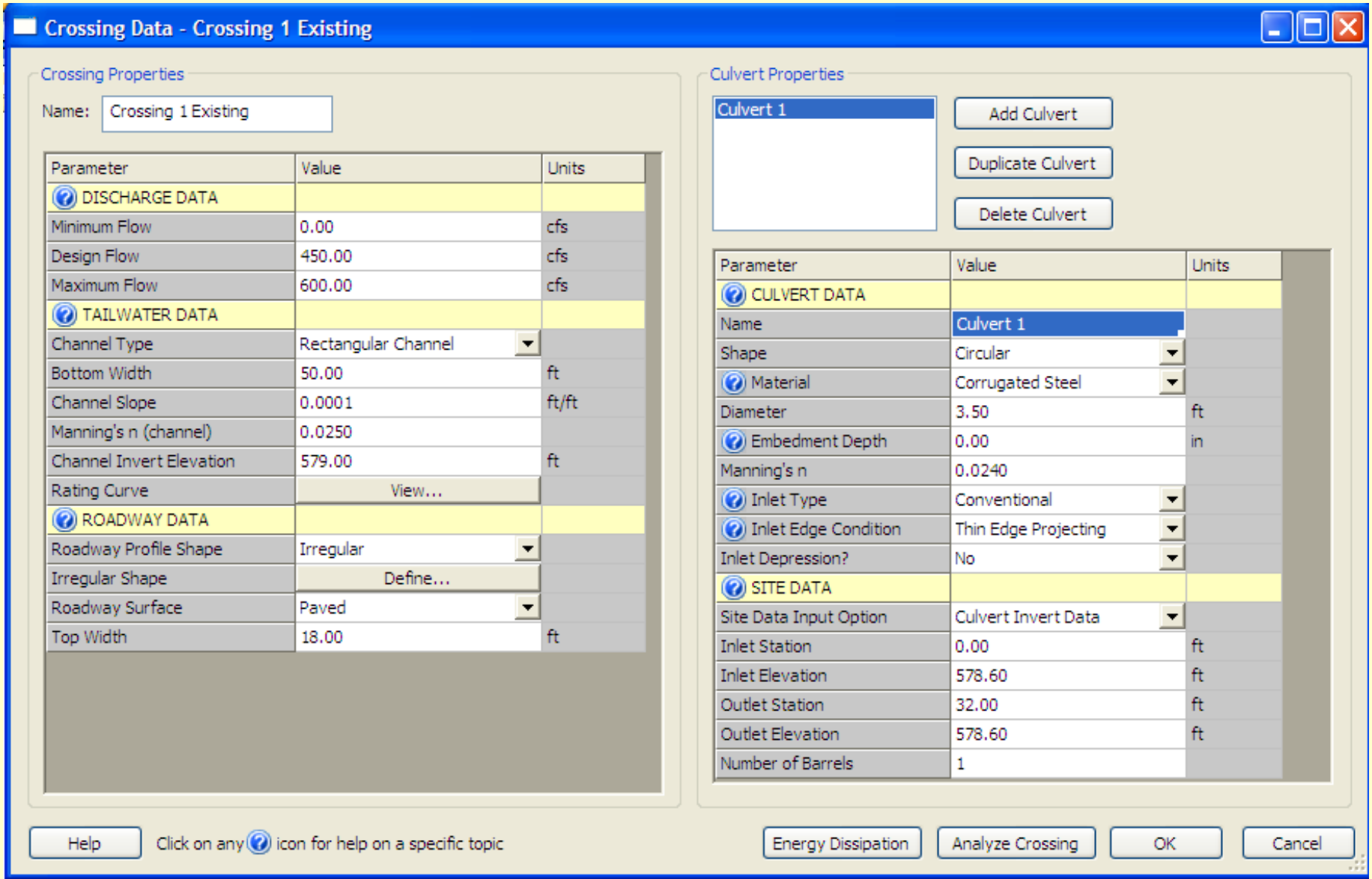
Start Project



Data Input

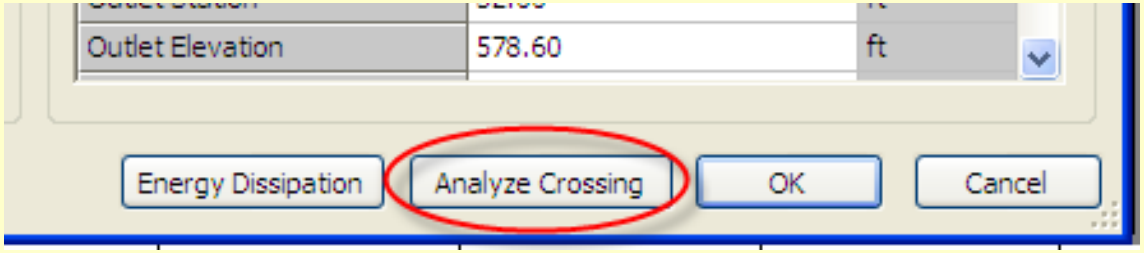

Crossing Data - Crossing 1 Existing
Crossing Properties
Name: Crossing 1 Existing
Parameter
Value
Units
DISCHARGE DATA
Minimum Flow
0.00
cfs
Design Flow
450.00
cfs
Maximum Flow
600.00
cfs
TAILWATER DATA
Channel Type
Rectangular Channel
Bottom Width
50.00
ft
Channel Slope
0.0001
ft/ft
Manning's n (channel)
0.0250
Channel Invert Elevation
579.00
ft
Rating Curve
View...
ROADWAY DATA
Roadway Profile Shape
Irregular
Irregular Shape
Define...
Roadway Surface
Paved
Top Width
18.00
ft
Irregular Roadway Shape
Number of Coordinates (3 -15):
3
Number
Station (ft)
Elevation (ft)
1
925.00
589.75
2
1000.00
588.20
3
1075.00
588.80
Plot
OK
Cancel

Data Input

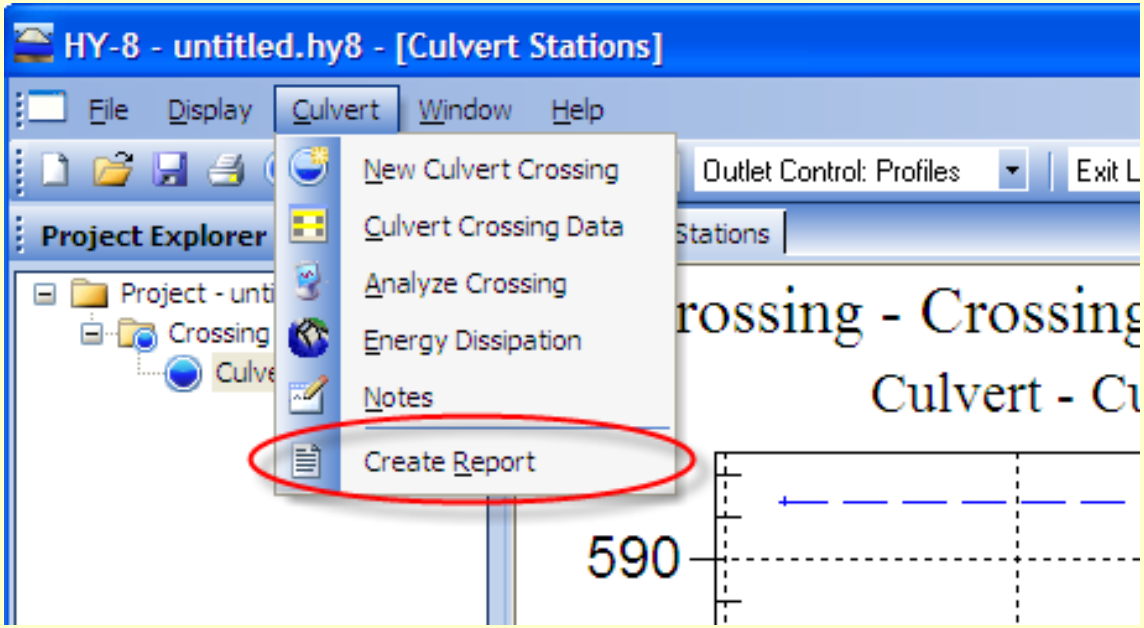

Crossing Data - Crossing 1 Existing
Crossing Properties
Name: Crossing 1 Existing
Parameter | Value | Units
DISCHARGE DATA
Minimum Flow | 0.00 | cfs
Design Flow | 450.00 | cfs
Maximum Flow | 600.00 | cfs
TAILWATER DATA
Channel Type | Rectangular Channel
Bottom Width | 50.00 | ft
Channel Slope | 0.0001 | ft/ft
Manning's n (channel) | 0.0250
Channel Invert Elevation | 579.00 | ft
Rating Curve | View...
ROADWAY DATA
Roadway Profile Shape | Irregular
Irregular Shape | Define...
Roadway Surface | Paved
Top Width | 18.00 | ft
Culvert Properties
Culvert 1
Add Culvert
Duplicate Culvert
Delete Culvert
Parameter | Value | Units
CULVERT DATA
Name | Culvert 1
Shape | Circular
Material | Corrugated Steel
Diameter | 3.50 | ft
Embedment Depth | 0.00 | in
Manning's n | 0.0240
Inlet Type | Conventional
Inlet Edge Condition | Thin Edge Projecting
Inlet Depression? | No
SITE DATA
Site Data Input Option | Culvert Invert Data
Inlet Station | 0.00 | ft
Inlet Elevation | 578.60 | ft
Outlet Station | 32.00 | ft
Outlet Elevation | 578.60 | ft
Number of Barrels | 1
Help
Click on any icon for help on a specific topic
Energy Dissipation
Analyze Crossing
OK
Cancel

Analyze Crossing

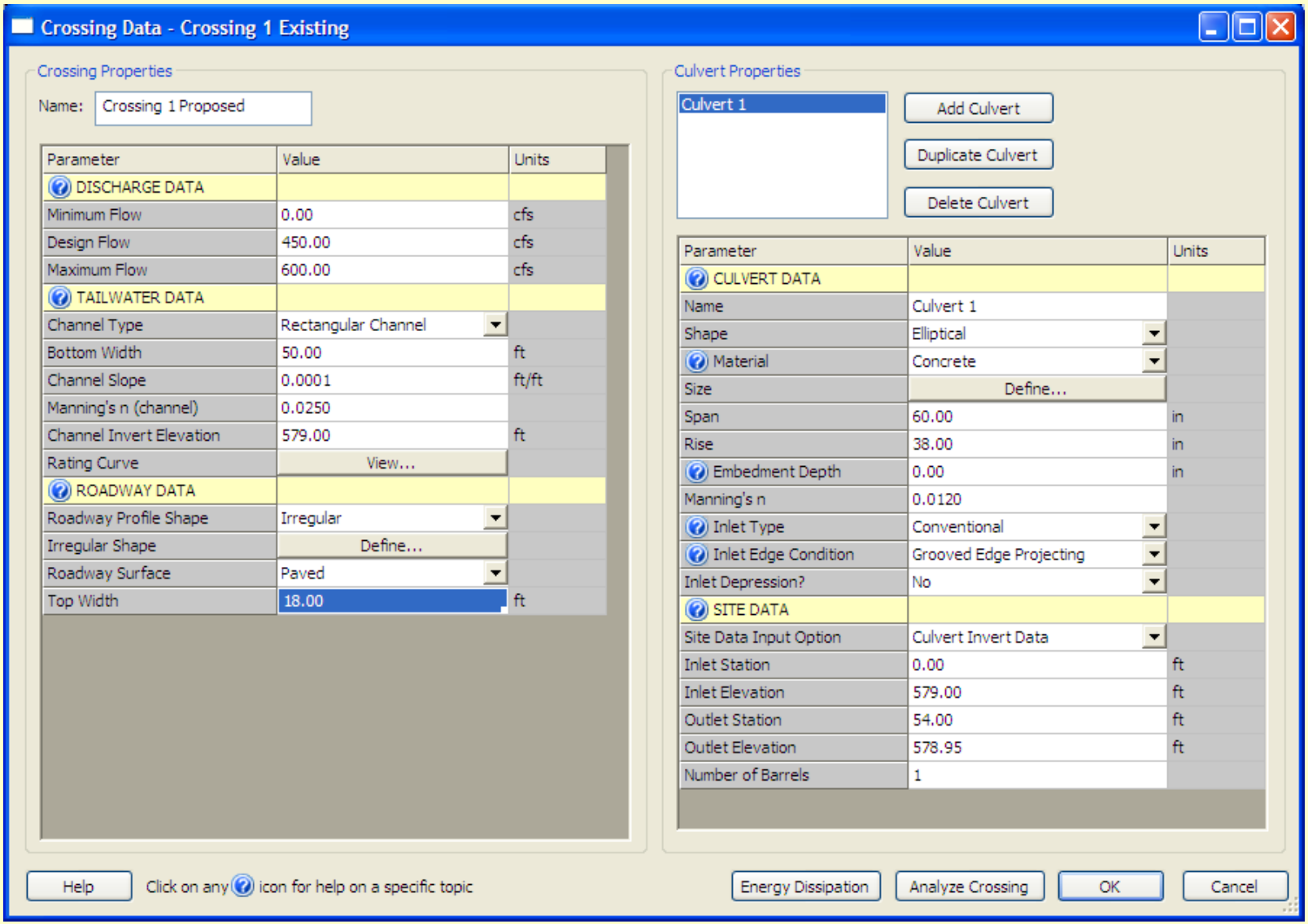
After data entry is complete, click “Analyze Crossing”



Create Report



Proposed Design



Calculations & Output

- Total flow through the Culverts
- Flow through individual culverts
- Weir flow
- Pressure and Weir Flow
- Tailwater Elevations *(See HY-8 Help----Limitations)*
- Headwater Elevations
- Outlet velocities *(See HY-8 Help----Limitations)*
- And More….

Culvert Flow

- Cross-section of the culvert
- Slope of the culvert
- “N” value of the culvert
- Manning's equation
- Uses direct step method

Inlet Control vs. Outlet Control

- Computes inlet control headwater elevation, flow passes through critical depth at the culvert entrance and is supercritical in the barrel. The headwater elevation is a function of the entrance size, shape, and inlet type.
- Computes outlet control headwater elevation, the flow in the barrel is subcritical, and the energy equation may be used to find the upstream headwater depth, including entrance & exist losses, and friction losses.
- Uses the higher answer of the two

Weir Flow

- Coefficient of discharge
- Roadway width
- Roadway surface
- Defined roadway

Pressure and Weir Flow

- Calculates weir flow
- Uses a built-in submergence factor
- Balances weir and pressure flows at resulting the same headwater elevation.

Analysis

Make sure it makes sense and data was input correctly!

Headwater

- How does it compare to what you expect?
- How does it compare to existing high water marks?
- How does it compare to the tailwater?

Tailwater

- How does it compare to what you expect?
- How does it compare to existing high water marks?

Analysis Continued

Culverts

- How much flow per culvert?
- What are outlet velocities?
- Is it reasonable?
- Check inverts and lengths.

Weir Flow

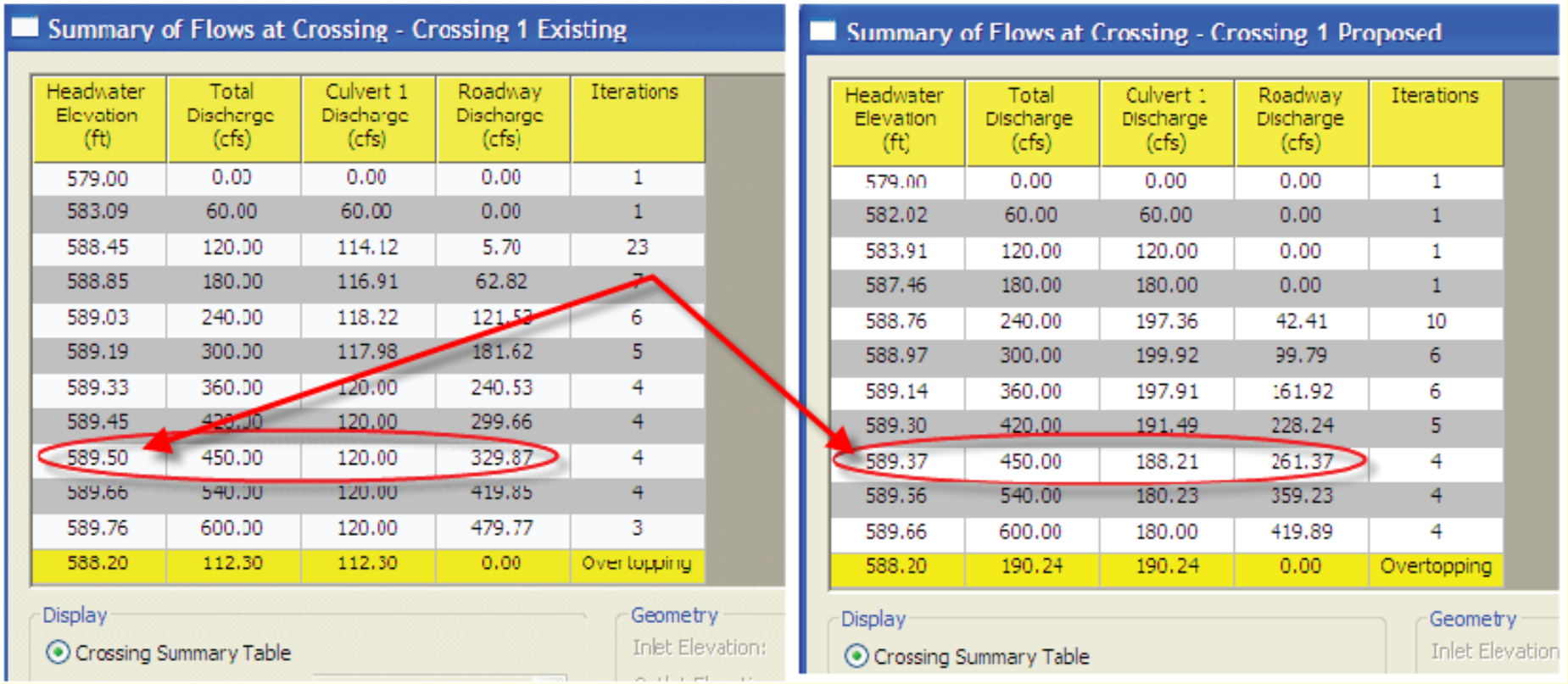
- How much water?
- Can it really get there?

Compare

- How does output compare between existing and proposed?

Compare

Proposed = equal or greater hydraulic capacity



Summary of Flows at Crossing - Crossing 1 Existing

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
579.00	0.00	0.00	0.00	1
583.09	60.00	60.00	0.00	1
588.45	120.00	114.12	5.70	23
588.85	180.00	116.91	62.82	7
589.03	240.00	118.22	121.53	6
589.19	300.00	117.98	181.62	5
589.33	360.00	120.00	240.53	4
589.45	420.00	120.00	299.66	4
589.50	450.00	120.00	329.87	4
589.66	540.00	120.00	419.85	4
589.76	600.00	120.00	479.77	3
588.20	112.30	112.30	0.00	Overtopping

Display

Crossing Summary Table

Geometry

Inlet Elevation:

Summary of Flows at Crossing - Crossing 1 Proposed

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
579.00	0.00	0.00	0.00	1
582.02	60.00	60.00	0.00	1
583.91	120.00	120.00	0.00	1
587.46	180.00	180.00	0.00	1
588.76	240.00	197.36	42.41	10
588.97	300.00	199.92	99.79	6
589.14	360.00	197.91	161.92	6
589.30	420.00	191.49	228.24	5
589.37	450.00	188.21	261.37	4
589.56	540.00	180.23	359.23	4
589.66	600.00	180.00	419.89	4
588.20	190.24	190.24	0.00	Overtopping

Display

Crossing Summary Table

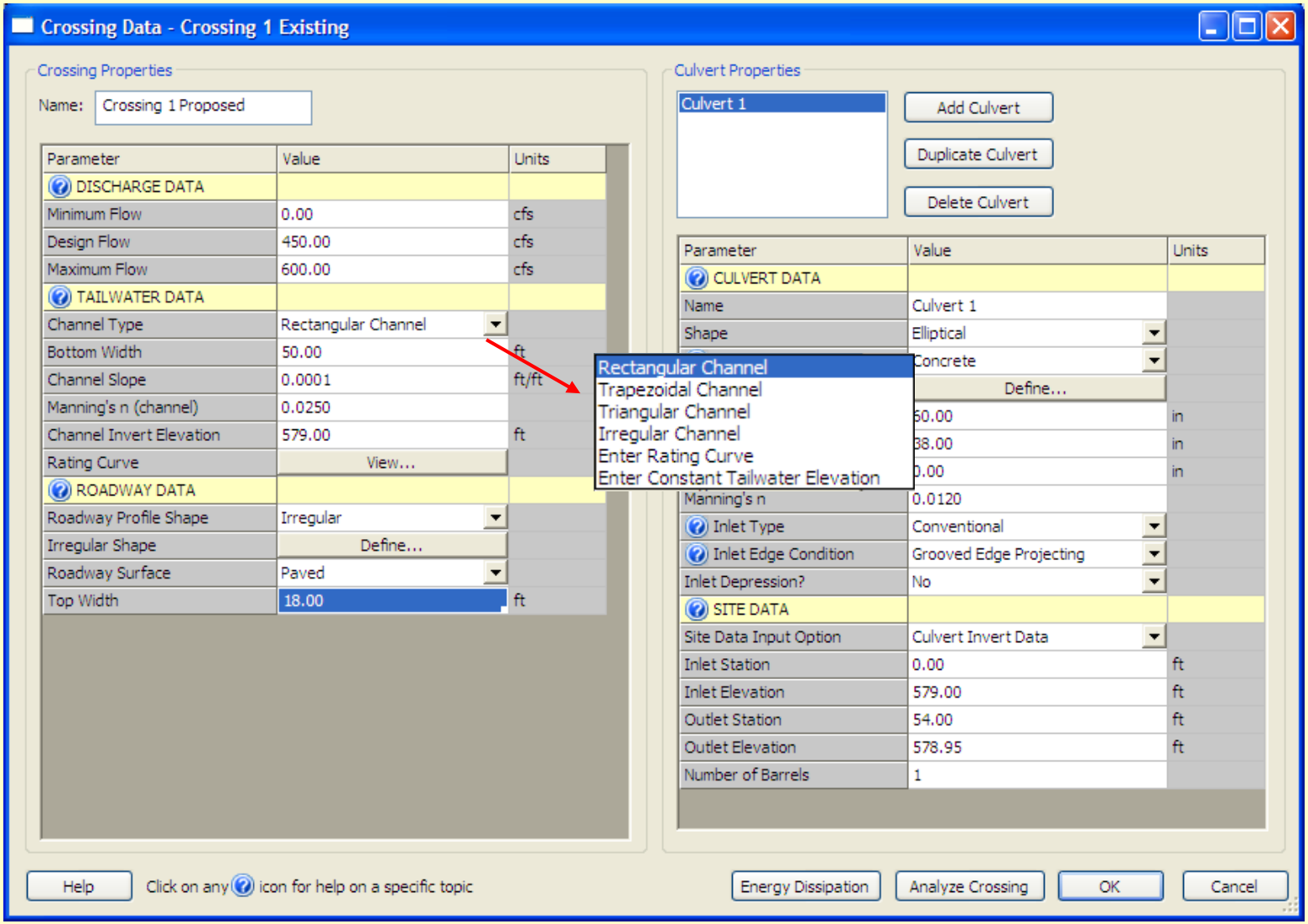
Geometry

Inlet Elevation

“Advanced” Options

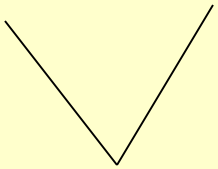
- Channel Shape and attributes
- Irregular Roadway Profiles
- Culvert Shapes
- Multiple Culverts
- Recessed Culverts
- Simple Bridges

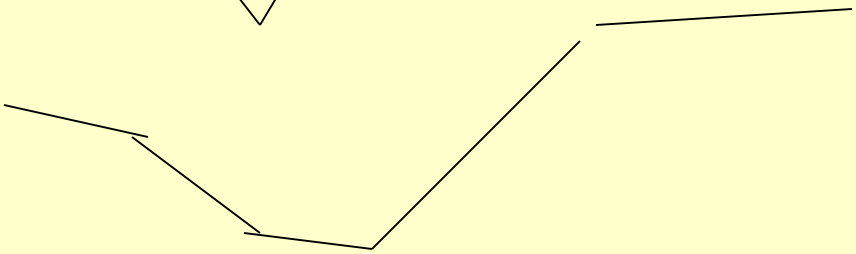
Channel Cross Section Shapes



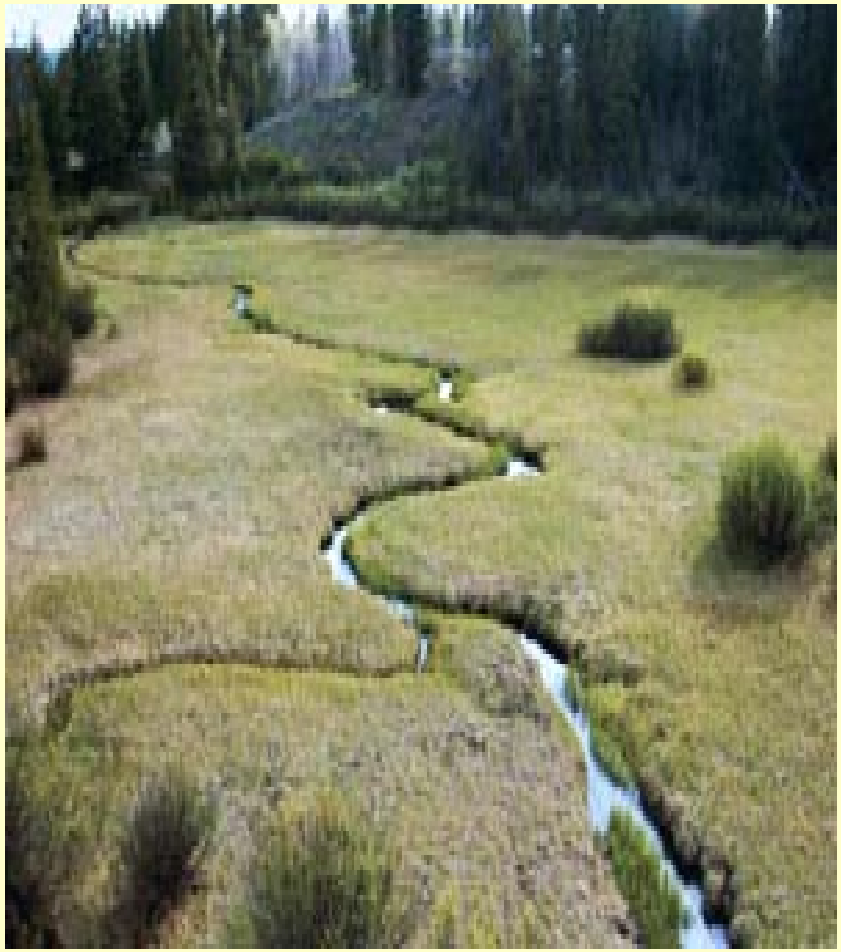
Standard Channel Cross-Section Shapes

- Trapezoidal
- Rectangular
- Triangular
- User defined



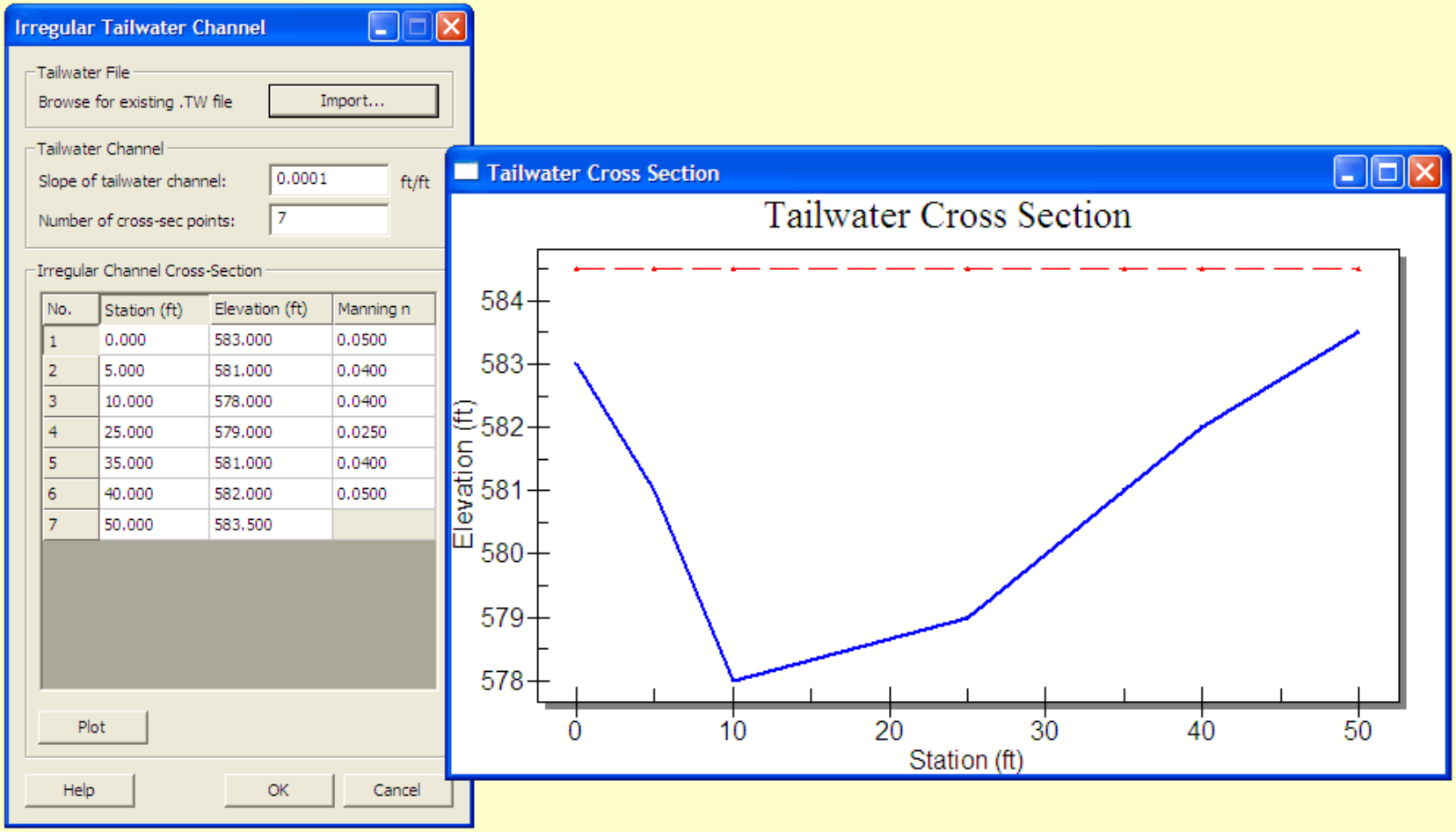


User-defined Channel Cross Sections



- 15 coordinates only
- Specify overbank and channel areas
- Mannings “n” values
- Input stations and elevations
- Channel slopes

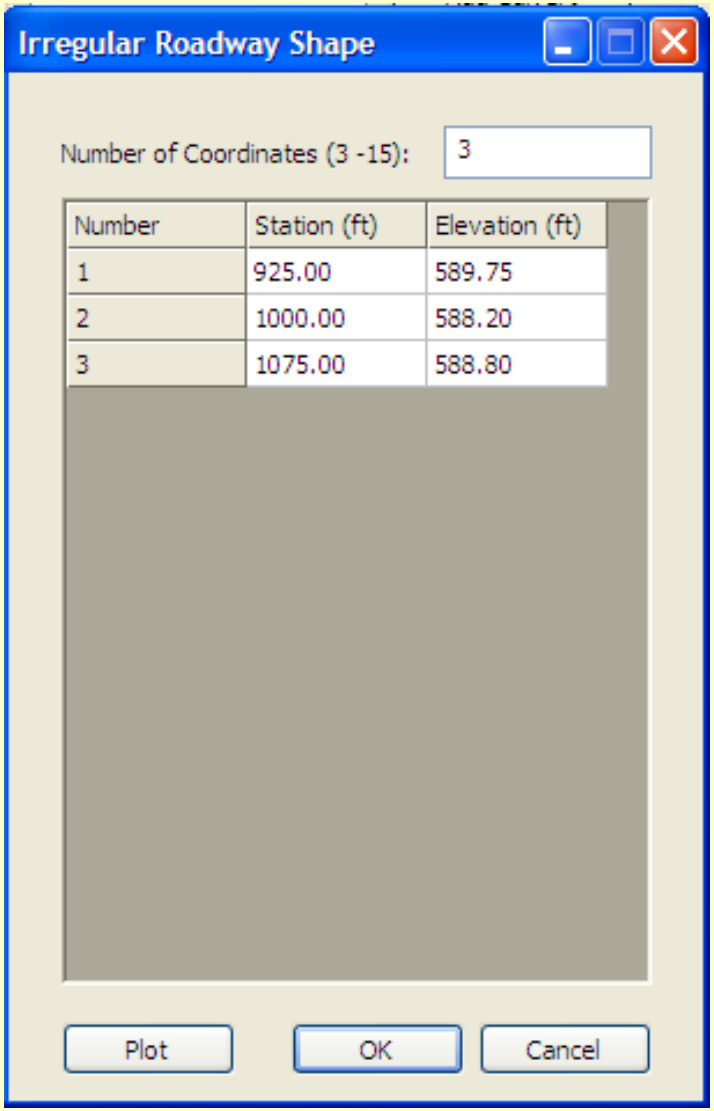
User Defined Channel Cross Sections



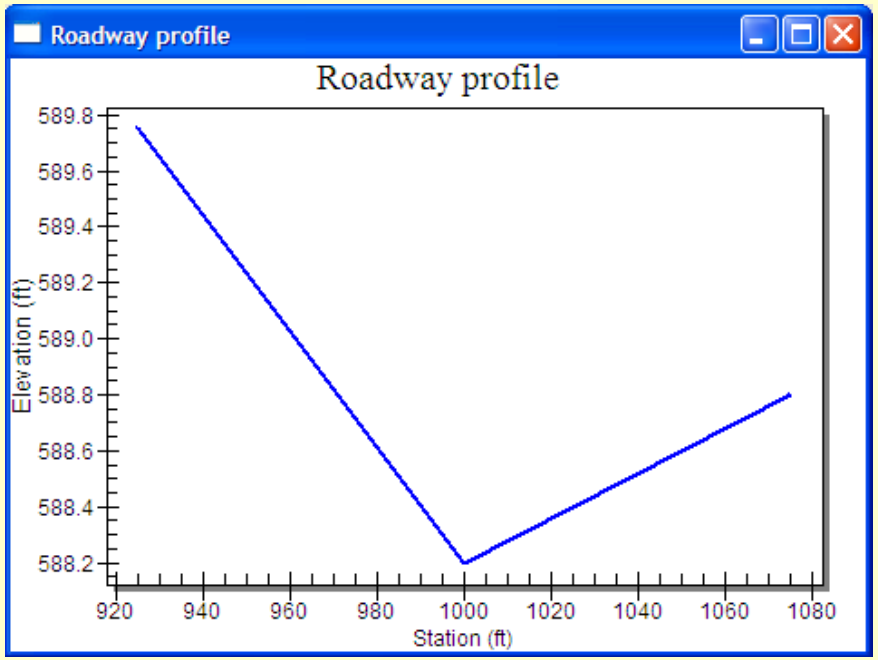
Roadway Options

- Constant or User Defined Profile
- Roadway width
- Paved or gravel?
- Program calculates coefficient of discharge

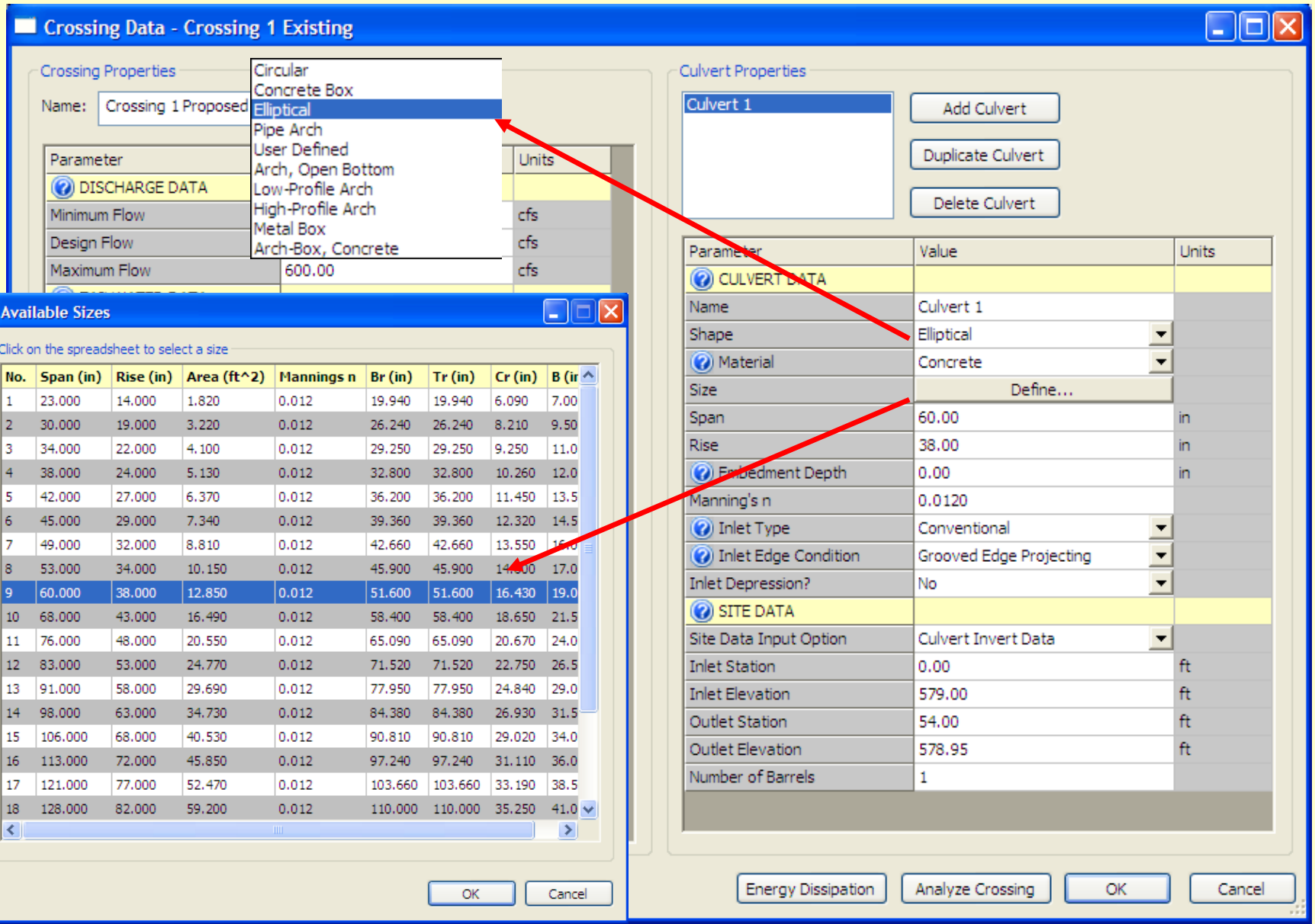
User-defined Roadway



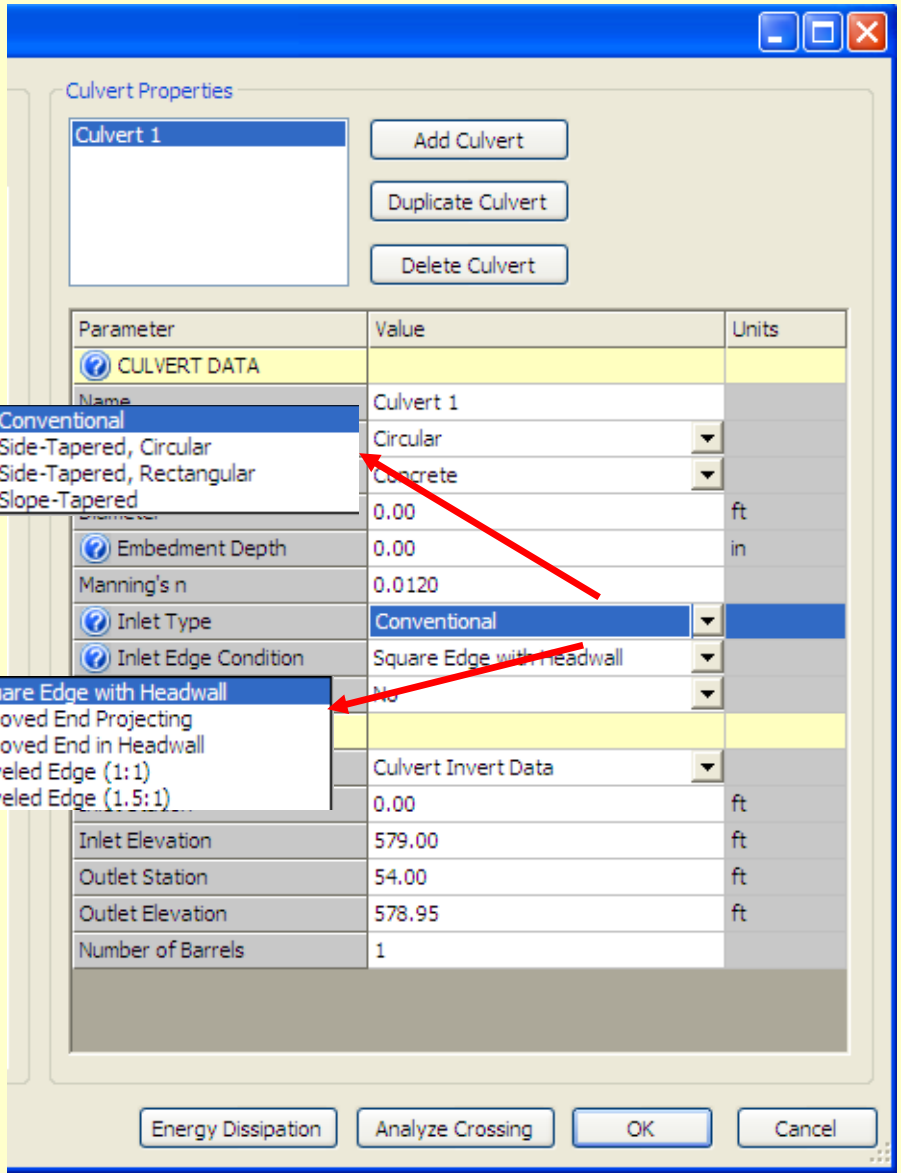
- Enter 3-15 points
- Station and elevation
- Cannot restrict flow areas

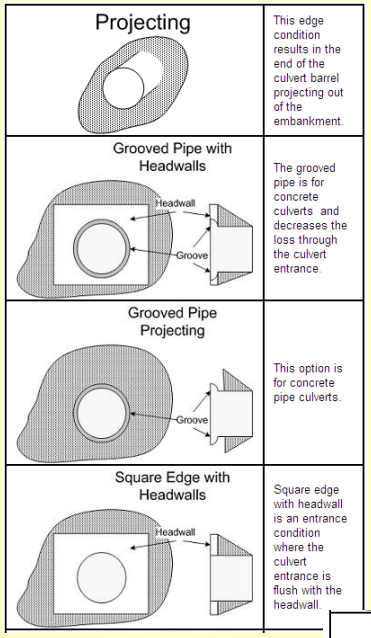


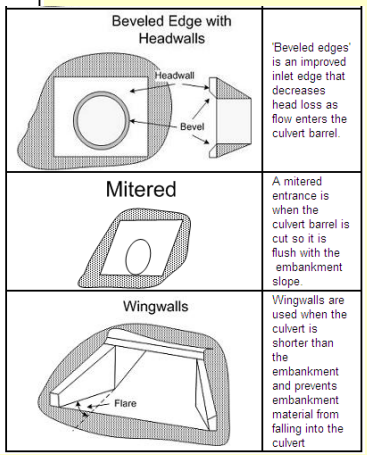
Culvert Options



More Culvert Options

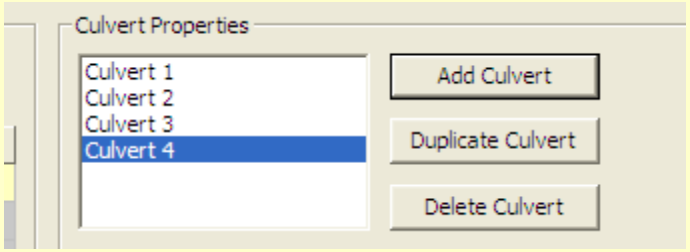






Multiple Culverts

- 99 Barrels
- Different sizes
- Individual inverts and inlet conditions



Embedded Culverts

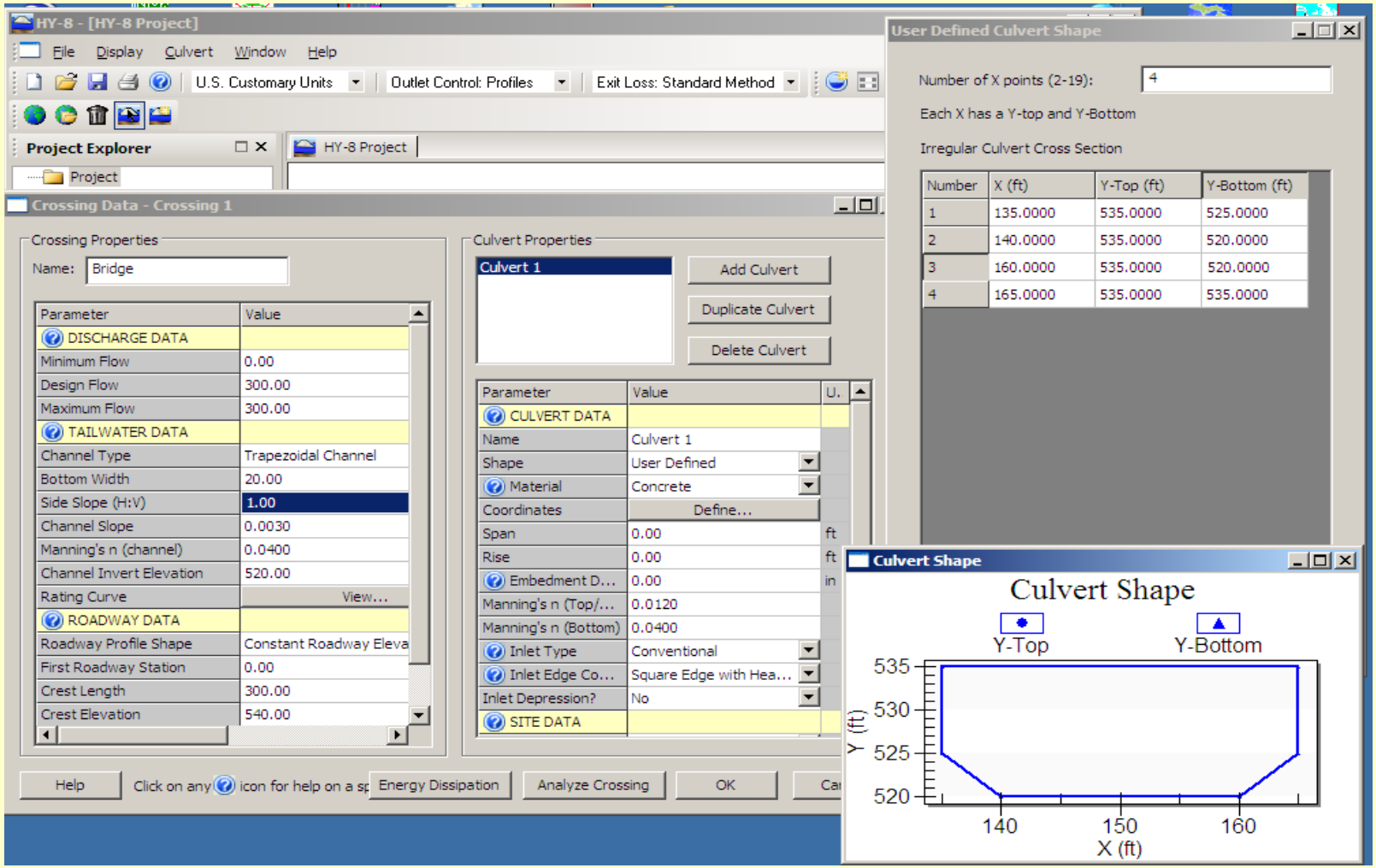
- Typically recessed 6-12 inches
- Reduce total area by recessed area
- Do not change channel inverts

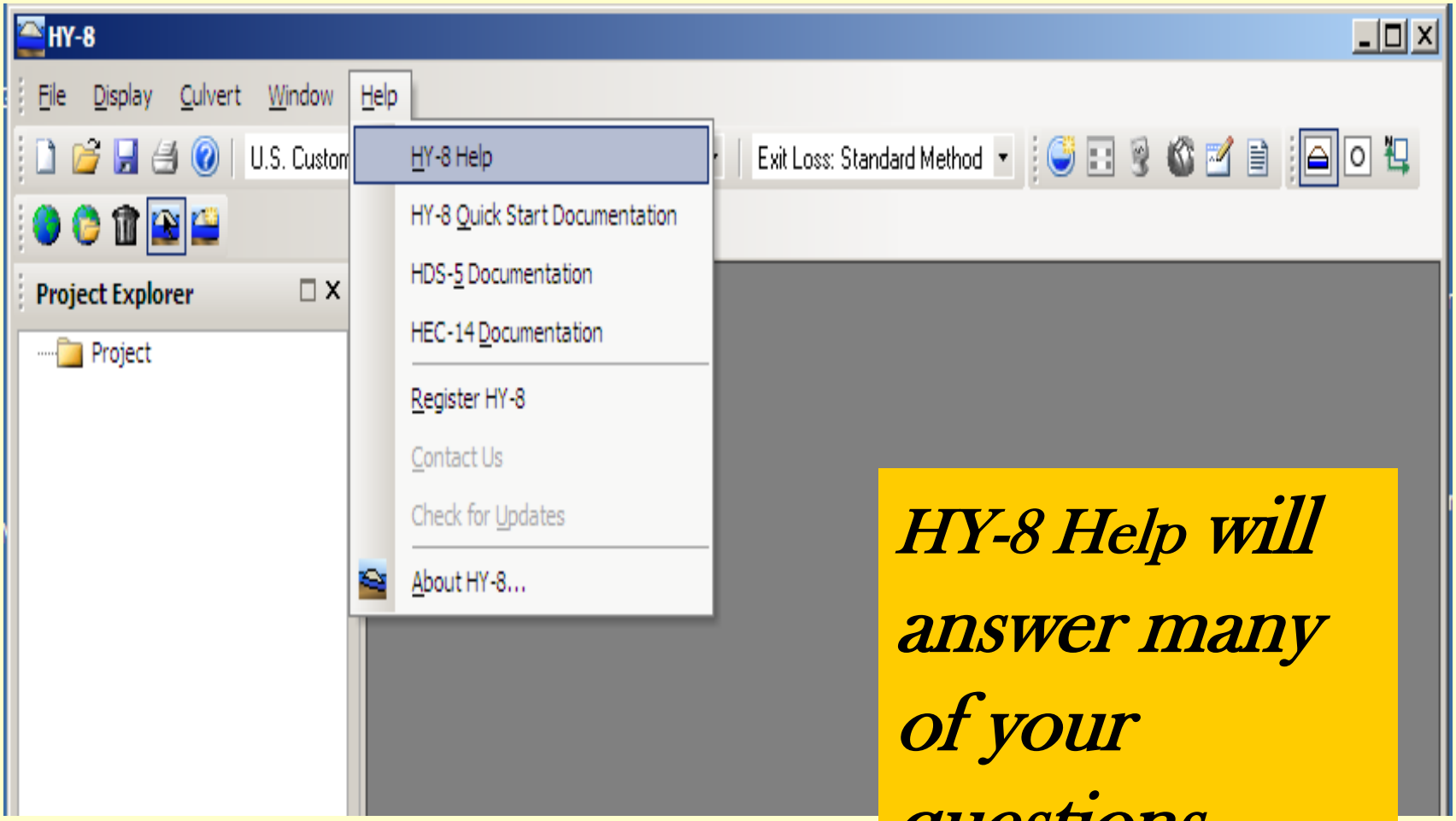
Diameter	3.50	ft
Embedment Depth	12.00	in
Manning's n (Top/Sides)	0.0240	

Simple Bridges

- Simple shapes
- Does not handle piers
- Can specify top and bottom of opening

Using *User Defined Culvert Shape* to Define a Bridge Opening





HY-8 Help will answer many of your questions


Questions?

Transportation and the Environment Conference

Contact
Sheila Meier 906-346-8558
Jim Watling 517-284-5508
Minmin Shu 517-284-5506

Transportation and Flood Hazard Unit
Water Resources Division
Department of Environment Quality

2014