



Map Mod Alchemy

Turning Paper into Digital Gold

Molly Cox, CFM
Martha Ziemer
Parker Edmonds, CFM

June 21, 2018

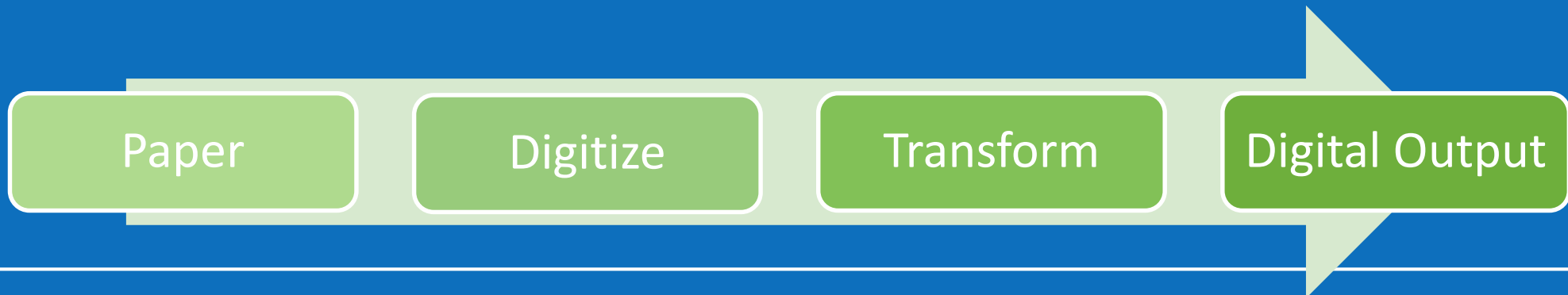


**CDM
Smith**

WATER + ENVIRONMENT + TRANSPORTATION + ENERGY + FACILITIES

Outline

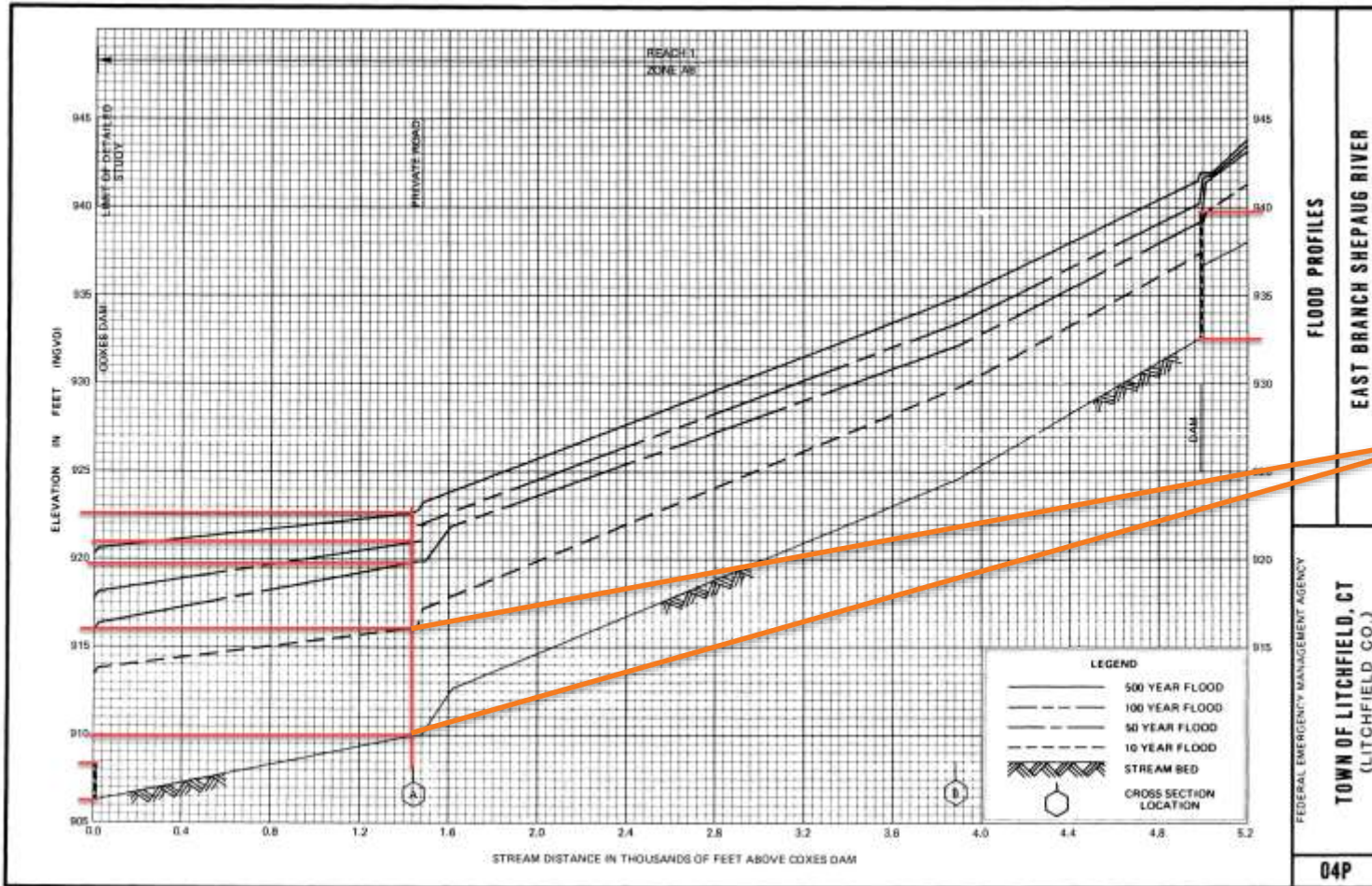
- Map Modernization: paper to digital
- Manual data extraction vs. digitization
- Can it be done in GIS?
- Quality control measures
- Importing data to RASPLOT



Map Modernization: Profiles

- Stream profiles from the 1970s-1990s only exist in paper format
- Must be recreated in digital form using RASPLOT with specific table formatting to allow for datum conversions, modification of labels, etc
- Required information includes:
 - Streambed elevations
 - 100 year profile elevations
 - Elevations for other available flooding events
 - Cross section locations and elevations
 - Hydraulic structure locations and elevations
 - Confluence and backwater locations and labels
- Options for extracting information:
 - Manually extract location and elevation values
 - Digitize profiles and extract information

Manual Extraction of values



Station	XS Letter	Stream Bed	10 Year	50 Year	100 Year	500 Year
0		906.4	913.5	916	917.5	920.2
1,420	A	910	916	919.6	921	922.5
1,600		912.6	917.7	921.6	922.5	923.7
2,400		916.8	922	925.4	926	927.1
3,860	B	924.5	929.6	932.2	933.3	934.9
5,050		932.5	937.5	939.1	940.1	941.5
5,100		936.7	939	941.1	941.6	942

Disadvantages of Manual data extraction

Time consuming



Low precision



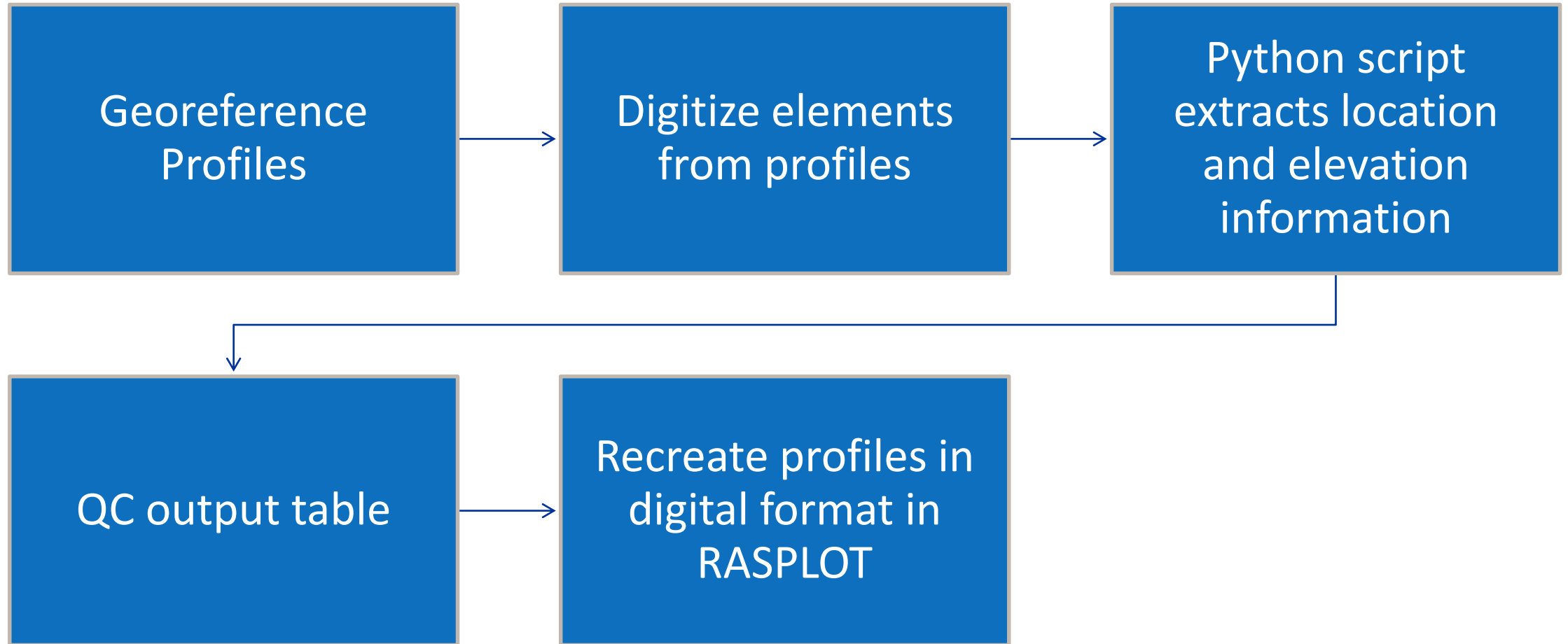
Opportunity for human error at each measurement



Extremely tedious



Our Process for Digitizing Stream Profiles



Georeference Profiles in ArcMap

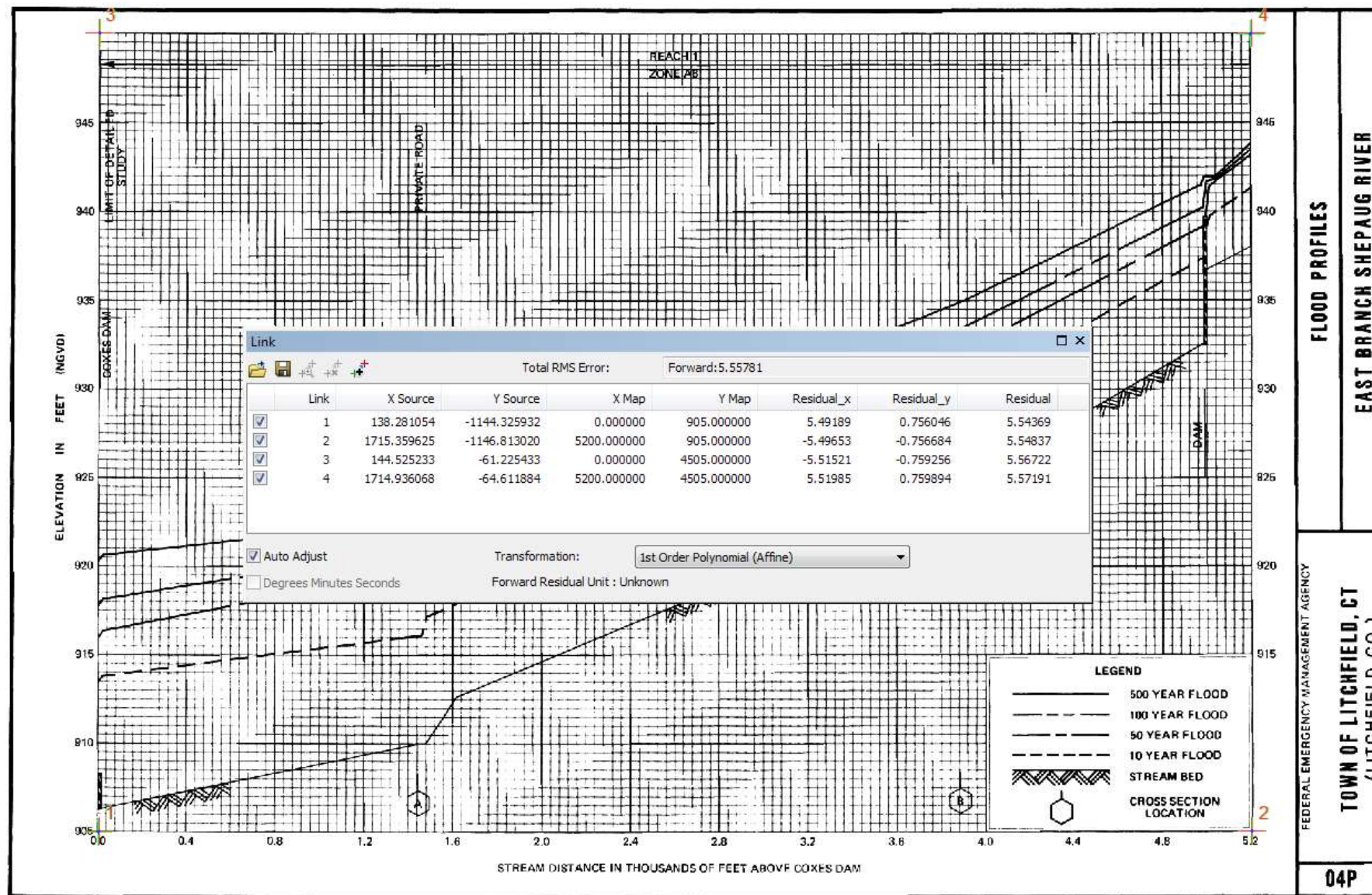
- Add Control Points with exact X and Y values
- Apply scaling factor to stretch Y axis ($y = mx + b$)
- Spreadsheet calculates scale factor to maintain rectangular profile panel

Enter X scale from profile	Enter Y scale from profile	Enter into Y_CONVERSION		Enter into Y_ADD_ZERO
400	5	0.0125	80	893.6875
Enter Y start	Enter Y start from profile			
905	905			
1305	910			
1705	915			
2105	920			
2505	925			
2905	930			
3305	935			
3705	940			
4105	945			
4505	950			

Control Points

- X coordinates from profile
- Y coordinates from conversion spreadsheet

Enter X scale from profile	Enter Y scale from profile
400	5
Enter Y start	Enter Y start from profile
905	905
1305	910
1705	915
2105	920
2505	925
2905	930
3305	935
3705	940
4105	945
4505	950



FEDERAL EMERGENCY MANAGEMENT AGENCY

FLOOD PROFILES

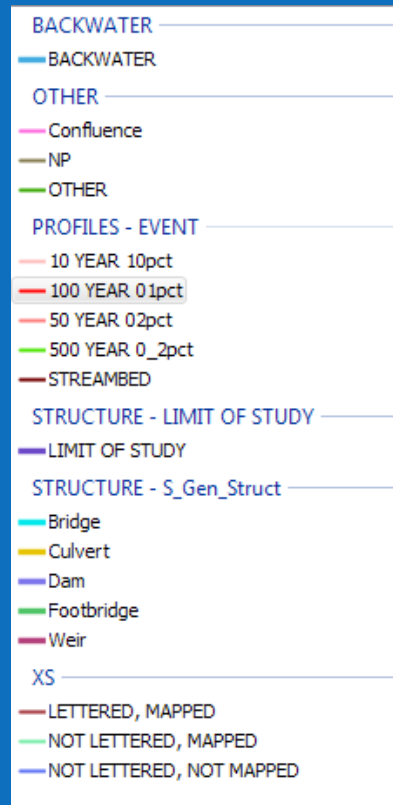
TOWN OF LITCHFIELD, CT
(LITCHFIELD CO.)

EAST BRANCH SHEPAUG RIVER

04P

Leveraging ArcMap Templates

- Use Templates to capture common attributes and streamline process
 - Flooding event profiles
 - Cross sections
 - Structures
 - Confluences
 - Backwater
 - Labels
- Single feature class captures multiple elements from profile



Template Properties

General

Name:

Description:

Tags:

Default Tool: Drawing Symbol

Target Layer: PROFILES - EVENT

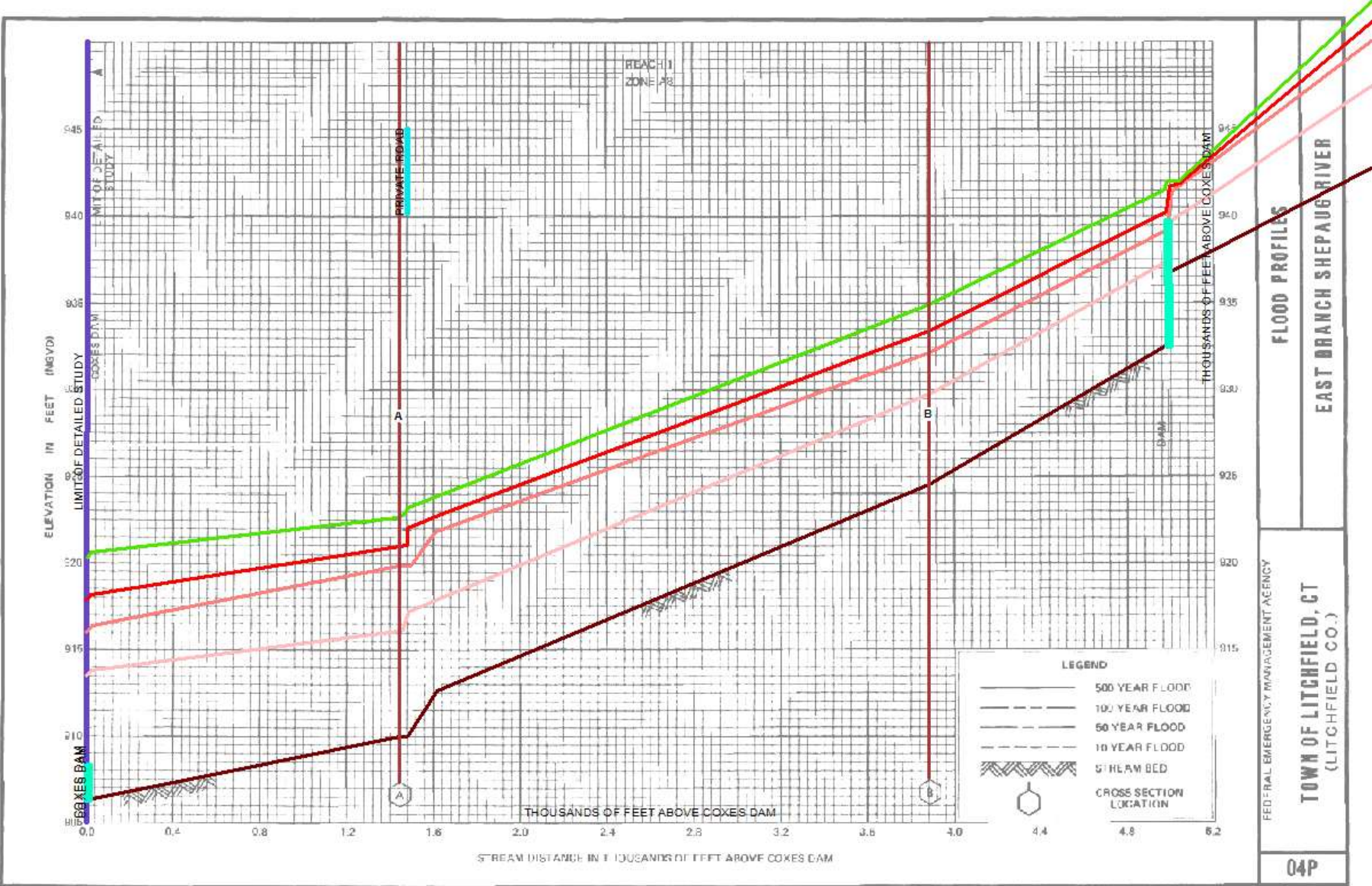
View

XS_LN_TYP	<Null>
WTR_NM	EAST BRANCH SHEPAUG RIVER
STRUCT_TYP	<Null>
XS_LTR	<Null>
Y_CONVERSION	80
Y_ADD_ZERO	893.6875
FEATURE_TYP	S_Profil_BasIn
Y_STA_ZERO	<Null>
LABEL	<Null>
POL_NM_1	LITCHFIELD
COUNTY	LITCHFIELD
STATE	CT
PANEL NUM	

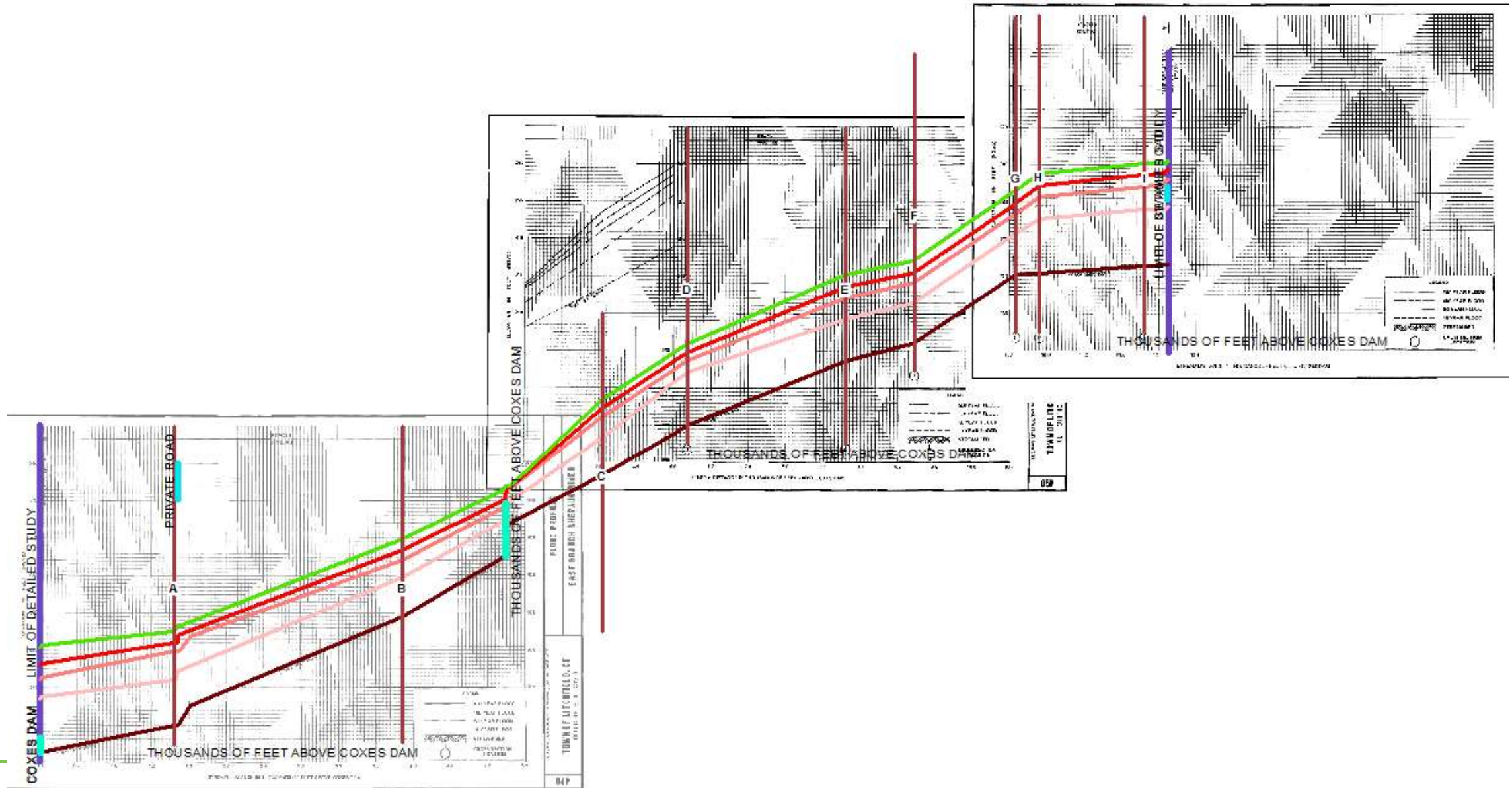
PANEL NUM
Text (Length = 20)
Null values allowed

OK Cancel Apply

Profile Panel with elements digitized



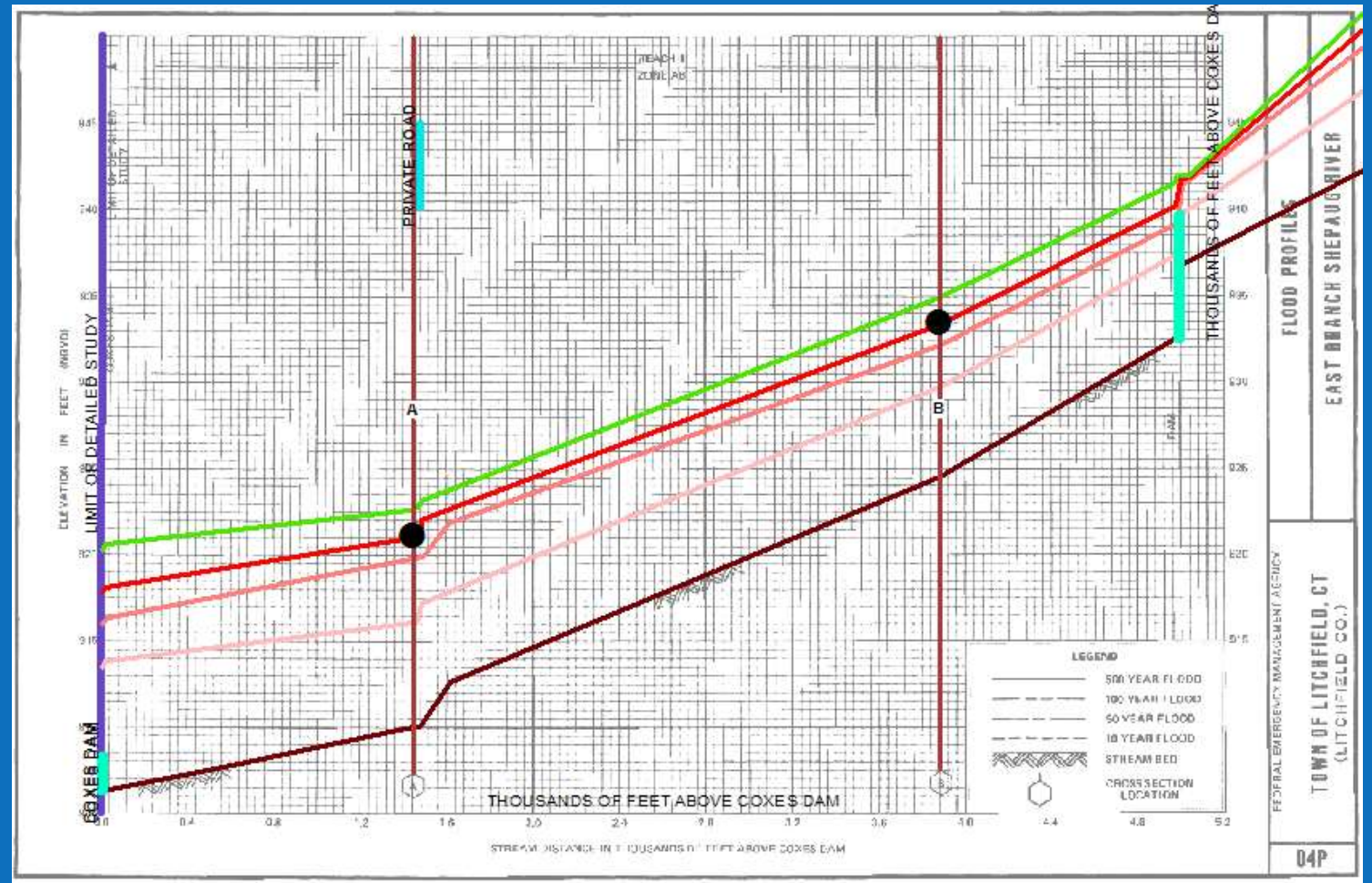
11



Increase accuracy by incorporating Floodway Data Table (FDT)

- Cross section points extracted from FDT and plotted
- Ensures lettered cross sections are in correct position with accurate elevation and station through the use of “snapping”

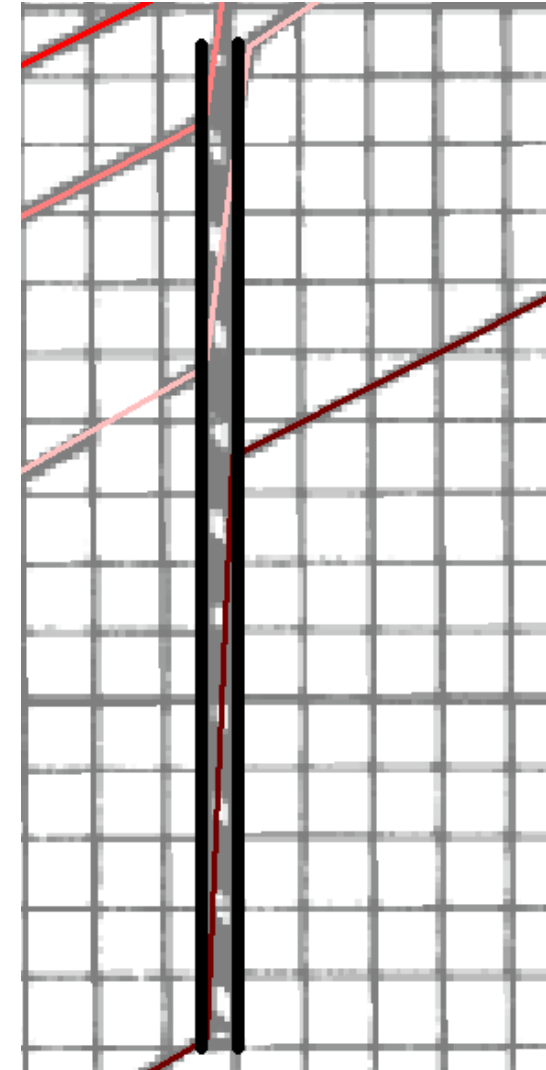
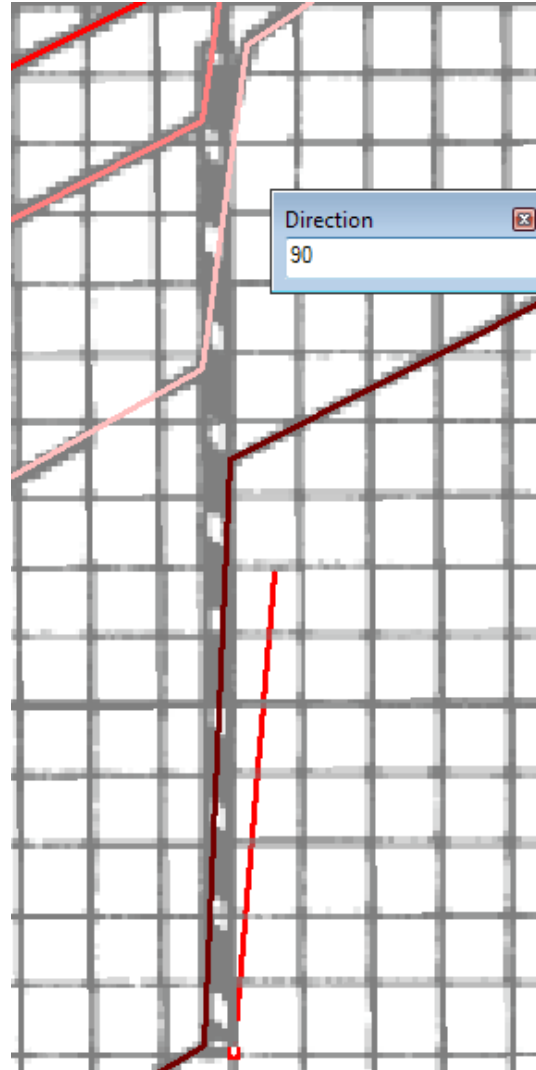
FLOODING SOURCE		FLOODWAY				
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	
East Branch Shepaug River						
A	1,443 ²	156	656	6.6	921.0	
B	3,884 ²	58	370	11.7	933.4	



Use editing tools to accurately draw structures

- Direction tool to draw structures perpendicular to x axis
- Capture upstream and downstream extents of structures
- Edit vertices with exact coordinates for Limit of Study

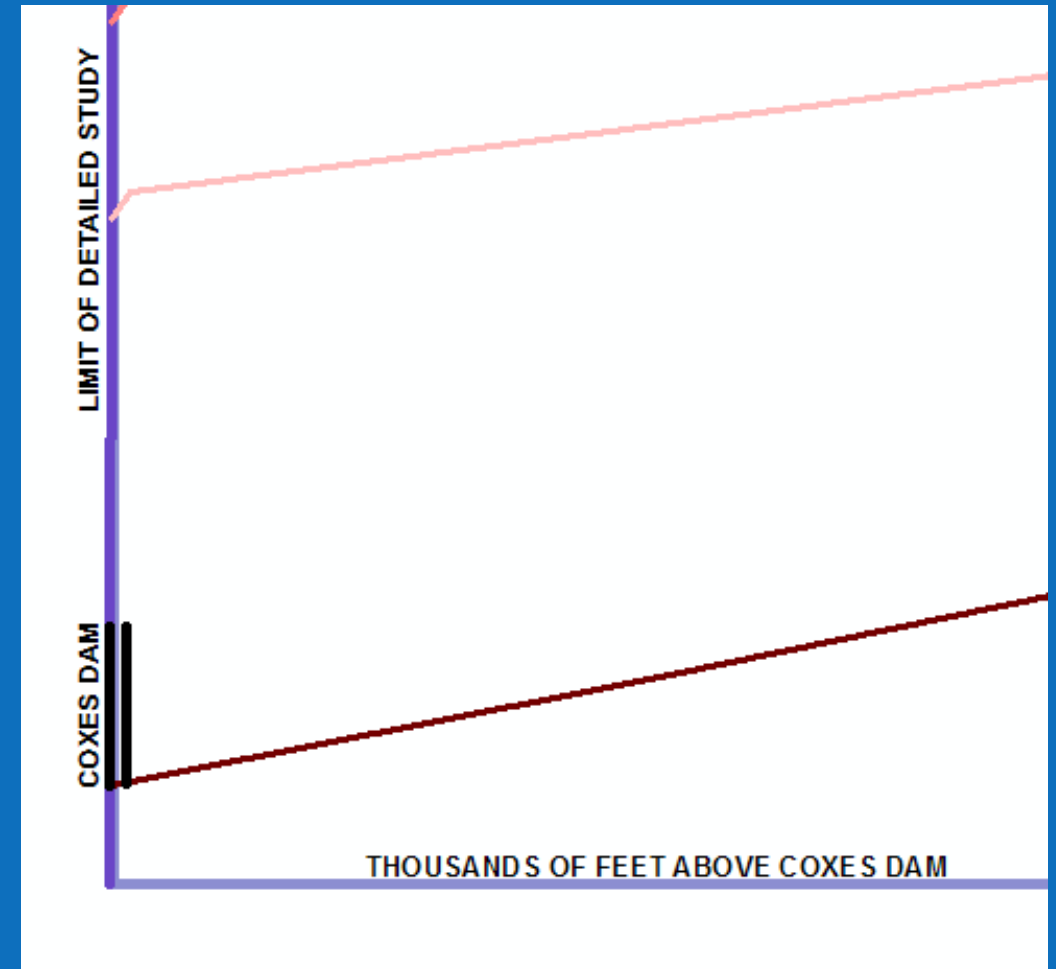
Edit Sketch Properties			
⏮ ⏭ ⏮ Z M ⏮ Finish Sketch			
	#	X	Y
<input type="checkbox"/>	0	0.000	905.000
<input type="checkbox"/>	1	0.000	4505.000



Capture labels

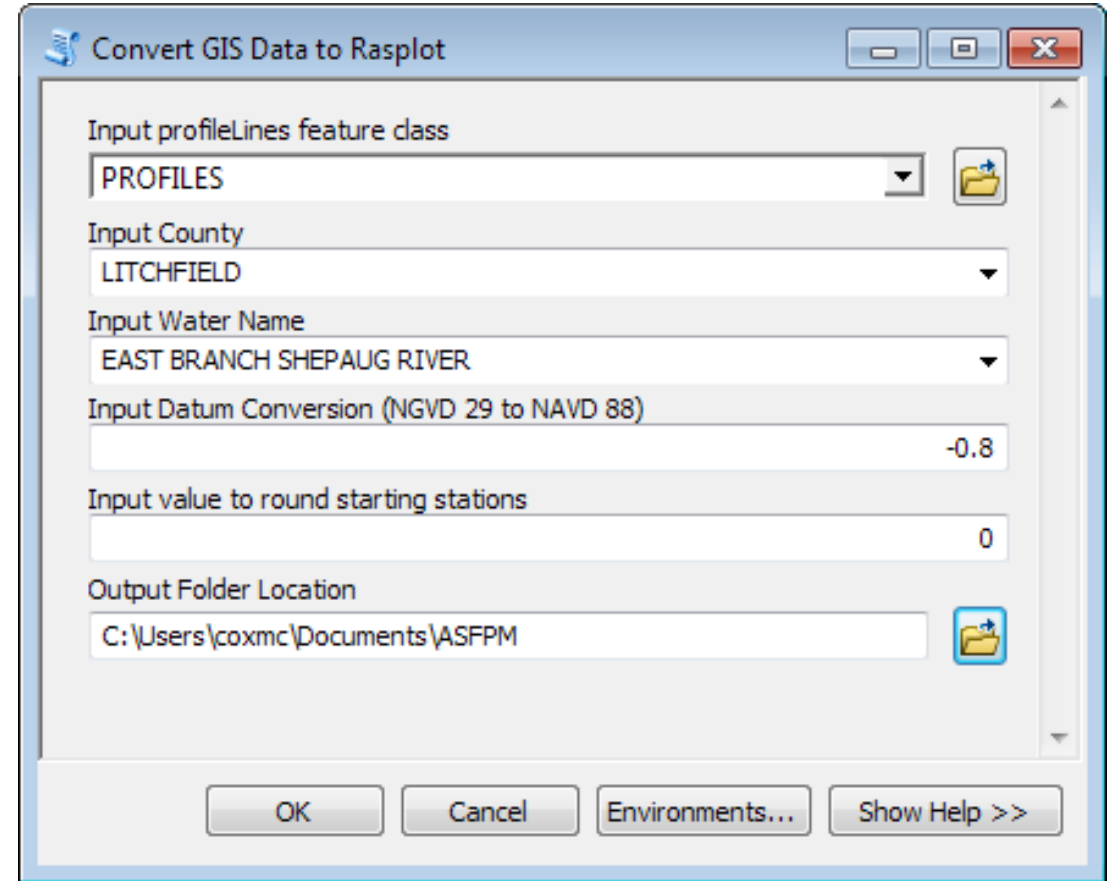
- Use attributes to record labels while digitizing spatial features
 - Structure names
 - Axis labels
 - Limit of study labels

FEATURE_TYP	LABEL
S_Gen_Struct	COXES DAM
LIMIT OF STUDY	LIMIT OF DETAILED STUDY
LIMIT OF STUDY	LIMIT OF DETAILED STUDY
S_Gen_Struct	PRIVATE ROAD
PROFILE PANEL	THOUSANDS OF FEET ABOVE COXES DAM



Extract Data using Python Script

- Easy to use tool
- Input feature class with digitized profile elements
- Runs on one stream at a time
- Optional datum conversion from NGVD29 to NAVD88
- Formats output in RASPLLOT database structure
- Exports to excel to allow for QC and tie-ins



Data extracted from digitized Profiles

RS	RIVER	REACH	STRUC	lengthchnl	cumdist	lowchord	highchord	labelletter	labeltext	ID	Prof4	minchel	Prof1	Prof3	Prof2
0	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		0	0				LIMIT OF DETAILED STUDY	0	919.39	905.44	912.59	916.93	915.09
0	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	Dam-DN	0	0	905.4375	907.4375		COXES DAM	1	919.39	905.44	912.59	916.93	915.09
0	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	Dam-UP	0	0	905.4375	907.4375			2	919.39	905.44	912.59	916.93	915.09
10	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		10	10					3	919.75	905.464812	912.93	917.28	915.47
532	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		522	532					4	920.4646648	906.76	913.7544025	918.3013836	916.739434
1427	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		895	1427					5	921.69	909.0639604	915.1678896	920.0526066	918.9159539
1441	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		14	1441			A		6	921.75	909.1	915.19	920.08	918.95
1455	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		14	1455					7	921.8518182	909.1	915.2	920.096	918.9528
1463	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		8	1463					8	921.91	909.1	915.5323077	920.1051429	918.9544
1476	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	Bridge-DN	13	1476	939.275	944.15		PRIVATE ROAD	9	922.2082353	909.1	916.0723077	920.12	918.957
1476	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	Bridge-UP	0	1476	939.275	944.15			10	922.2082353	909.1	916.0723077	920.12	918.957
1478	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		2	1478					11	922.2541176	909.1379856	916.1553846	921.1	918.9574
1480	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		2	1480					12	922.3	909.1759712	916.2384615	921.1101176	918.9578
1481	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		1	1481					13	922.3048795	909.194964	916.28	921.1151765	918.958
1491	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		10	1491					14	922.3536741	909.3848921	916.3323077	921.1657647	918.96
1608	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		117	1608					15	922.9245719	911.6070504	916.9443077	921.7576471	920.95
1615	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		7	1615					16	922.9587282	911.74	916.9809231	921.7930588	920.9816506
1648	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		33	1648					17	923.1197506	911.9130647	917.1535385	921.96	921.1308604
3886	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		2238	3886			B		18	934.04	923.65	928.86	932.53	931.25
3914	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		28	3914					19	934.2108957	923.8557247	929.03	932.7053846	931.4308759
4969	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		1055	4969					20	940.65	931.6071376	936.4584644	939.3136264	938.2460219
4978	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		9	4978					21	940.9	931.6732634	936.5218352	939.37	938.3041606
4982	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	Dam-DN	4	4982	931.6625	938.8375			22	941.0111111	931.7026527	936.55	939.7158824	938.33
4982	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	Dam-UP	0	4982	931.6625	938.8375			23	941.0111111	931.7026527	936.55	939.7158824	938.33
4983	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		1	4983					24	941.0388889	931.71	936.6392308	939.8023529	938.4204
4987	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		4	4987					25	941.15	932.76	936.9961538	940.1482353	938.782
4995	EAST BRANCH SHEPAUG RIVER	LITCHFIELD		8	4995					26	941.15	934.86	937.71	940.84	939.5052
4997	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	Dam-DN	2	4997	931.6625	938.8625			27	941.15	935.385	937.8884615	940.8482609	939.686
4997	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	Dam-UP	0	4997	931.6625	938.8625			28	941.15	935.385	937.8884615	940.8482609	939.686

Quality Check of Extracted Data

- Compare each lettered cross section to FDT elevation and stationing values where available
- Ensure all profiles are continuously increasing in elevation
- Event types of higher magnitude are always greater in elevation than those of lower magnitude
- One upstream and one downstream value for each applicable structure (dams, culverts)

CROSS	DISTANCE	WIDTH (FT.)	SECTION AREA (SQ. FT)	Regulatory NAVD88
A	1443	156	656	920.2
B	3884	58	370	932.6
C	6044	79	419	951.6
D	6954	73	433	959
E	8644	59	469	967.8
F	9374	60	433	969.7
G	10469	55	358	978.9
H	10729	96	847	981.4
I	11839	98	949	983

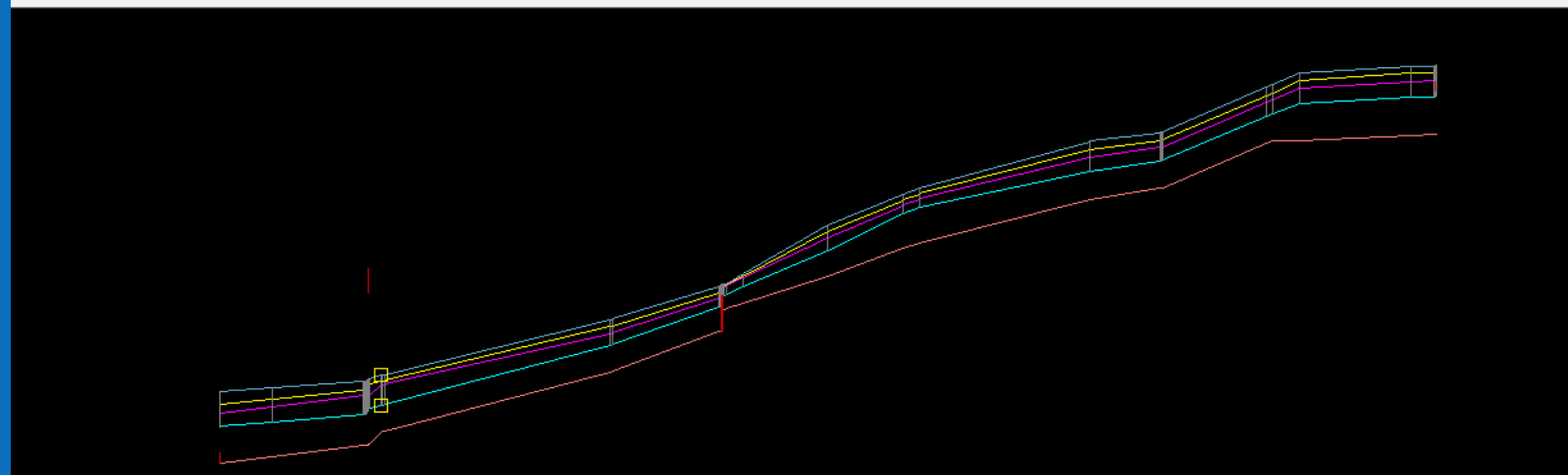
500-100	100-50	50-10	10-chnl
2.46	1.84	2.5	7.15
2.46	1.84	2.5	7.15
2.47	1.81	2.54	7.465188
2.163281	1.56195	2.985031	6.994403
1.637393	1.136653	3.748064	6.103929
1.55	1.25	3.76	6.09
1.755818	1.1432	3.7528	6.1
1.804857	1.150743	3.422092	6.432308

Import to RASPLOT

- Excel spreadsheet formatted by tool
- Easily import into Access database created by RASPLOT

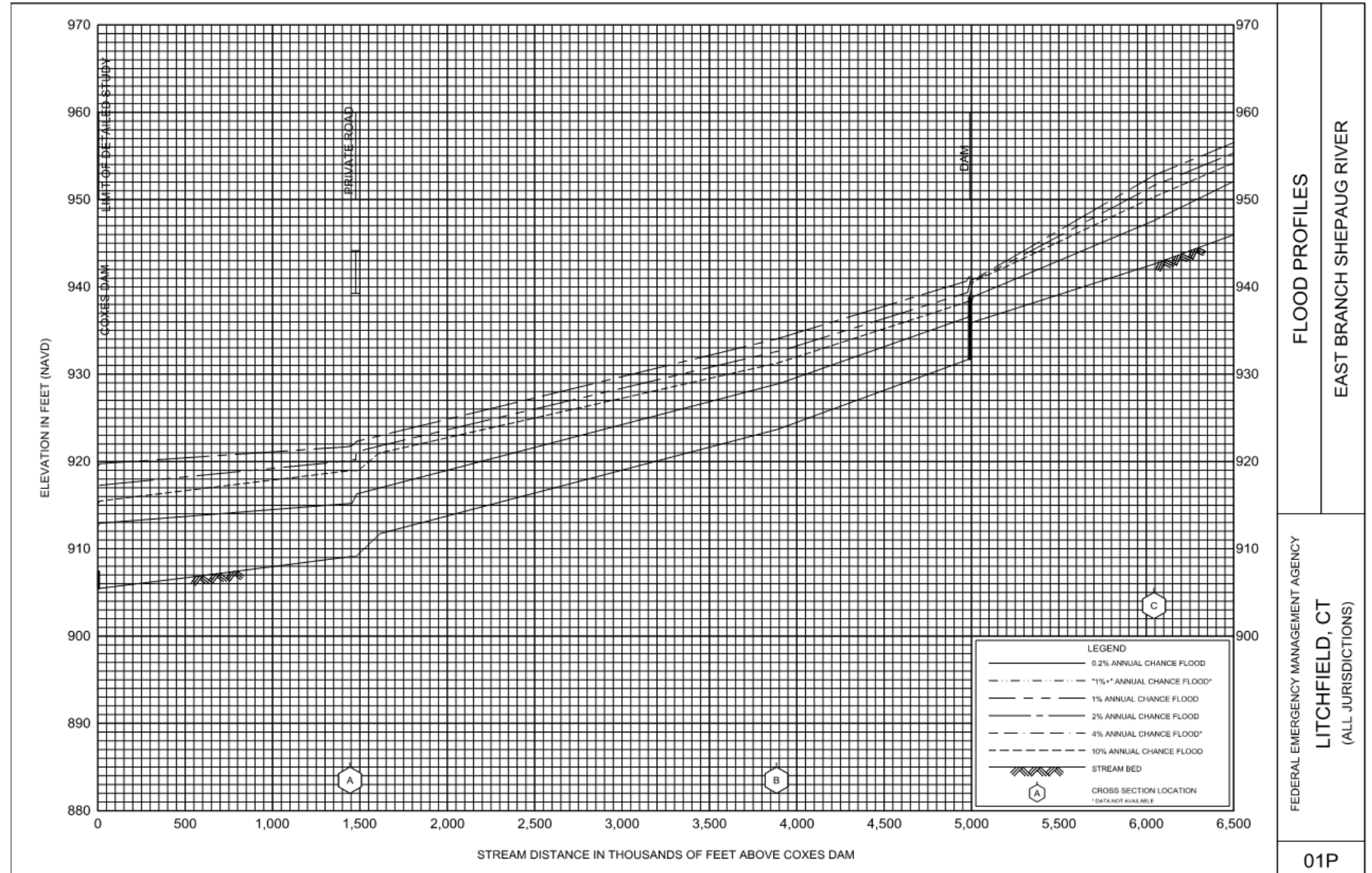
Profile	Frequency	Backwater Elevation	Backwater Text
Prof4	0.2%-annual-chance		
Prof1	10%-annual-chance		
Prof3	1%-annual-chance		
Prof2	2%-annual-chance		

Recalculate Cumulative Distance															
Fix Drawdowns															
Re-letter Cross Sections															
	RIVER	REACH	RS	STRUC	LENGTHCHN	CUMDIST	MINCHEL	LOWCHORD	HIGHCHORD	LABELLETTE	LABELTEXT	PROF1	PROF2	PROF3	PROF4
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	0		0.00	0.00	905.44				LIMIT OF DETAILED STUDY	912.59	915.09	916.93	919.39
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	0	Dam-DN	0.00	0.00	905.44	905.44	907.44		COXES DAM	912.59	915.09	916.93	919.39
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	10	Dam-UP	10.00	10.00	905.46	905.44	907.44			912.93	915.47	917.28	919.75
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	532		522.00	532.00	906.76					913.75	916.74	918.30	920.46
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	1427		895.00	1427.00	909.06					915.17	918.92	920.05	921.69
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	1443		16.00	1443.00	909.10			A		915.19	918.95	920.20	921.75
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	1455		12.00	1455.00	909.10					915.20	918.95	920.20	921.85
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	1463		8.00	1463.00	909.10					915.53	918.95	920.20	921.91
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	1476	Bridge-DN	13.00	1476.00	909.10	939.28	944.15		PRIVATE ROAD	916.07	918.96	920.20	922.21
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	1476	Bridge-UP	0.00	1476.00	909.10	939.28	944.15			916.07	918.96	920.20	922.21
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	1478		2.00	1478.00	909.14					916.16	918.96	921.10	922.25
	EAST BRANCH SHEPAUG RIVER	LITCHFIELD	1480		2.00	1480.00	909.18					916.24	918.96	921.11	922.30



Recreate Profile in RASPLOT

- Profiles recreated in digital format
- Incorporates datum conversion
- Each element can be edited



Summary

- Digitizing profiles in GIS greatly reduces opportunity for human error
- Staff familiarity with GIS software
- Digitizing is streamlined using templates and editing tools
- Python tool efficiently extracts data from digitized profiles
- Output from tool is formatted for seamless integration with RASPLOT
- Resulting RASPLOT databases enable recreation of profiles in digital form



Questions?