Drainage Area & Discharge Determination

Bridges

(February 2017)

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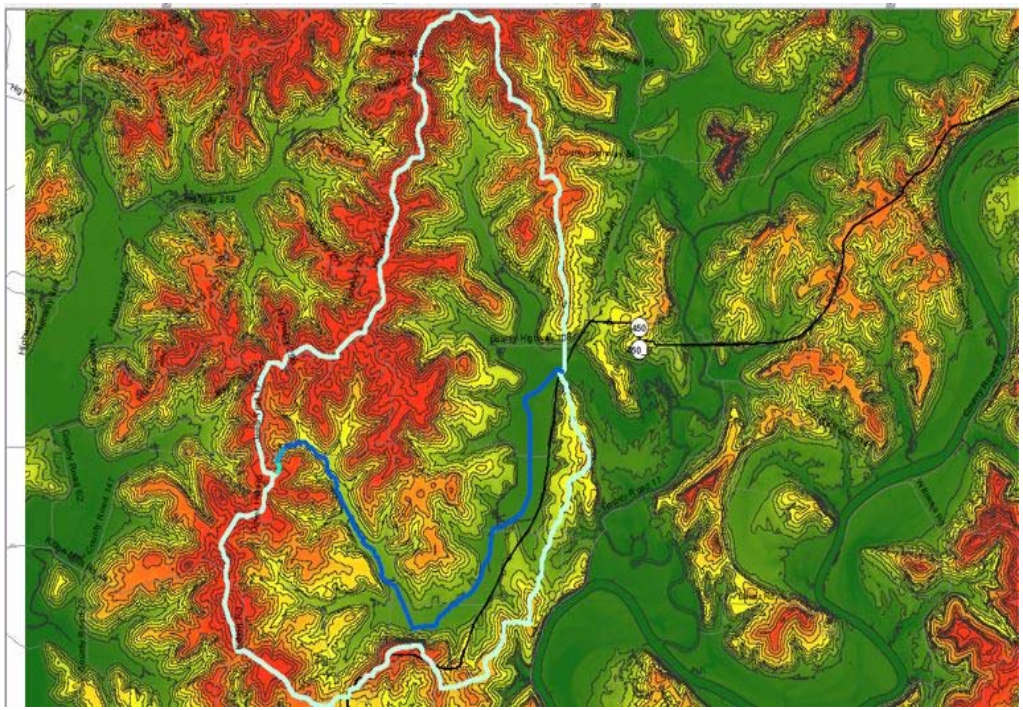
Determining Drainage Area

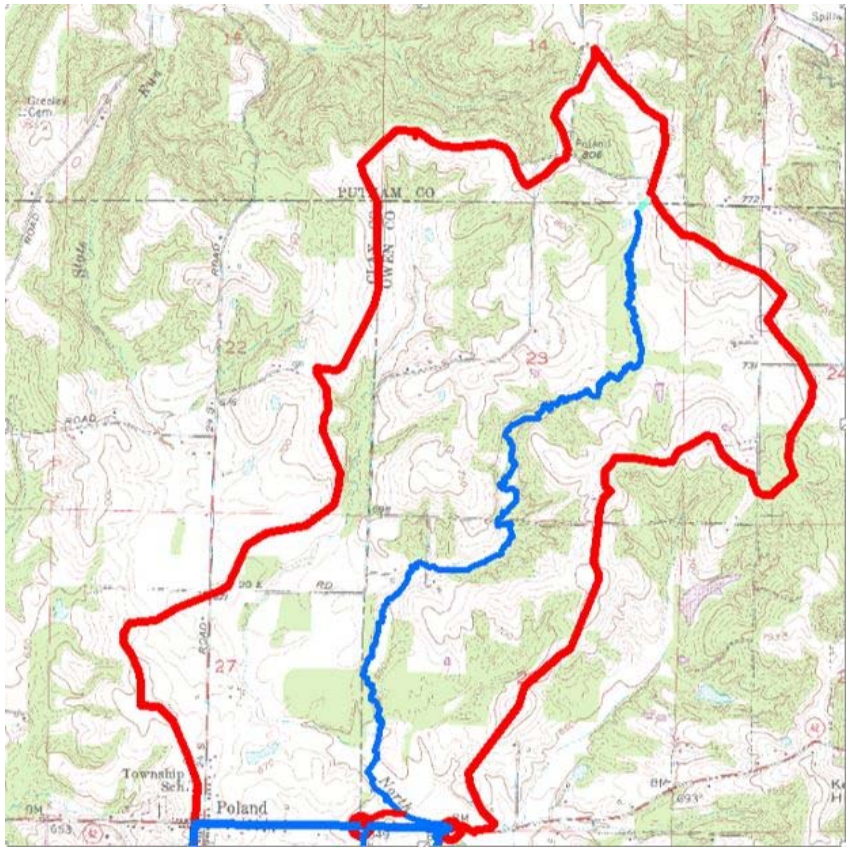
- Digital Elevation Modeling (DEM)
- USGS Quadrangle Topographic Maps
- USGS Streamstats
- L-THIA (Purdue)
- Field Investigation & Plans
- Drainage Areas of Indiana Streams

Digital Elevation Modeling (DEM)



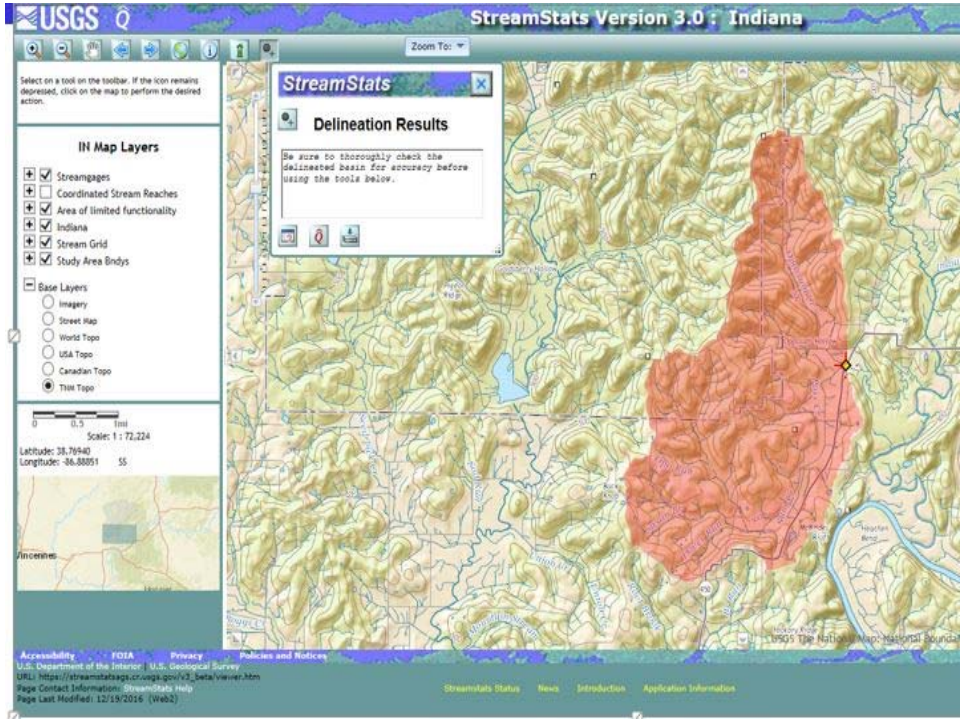
- http://www.indianamap.org/resources.php
- Uses LiDAR information from planes flying the state
- Based on 5 ft pixel size
- Can build customized contours using software such as ARC-GIS
- Currently the most common method used by INDOT for delineation

USGS Quadrangle Maps



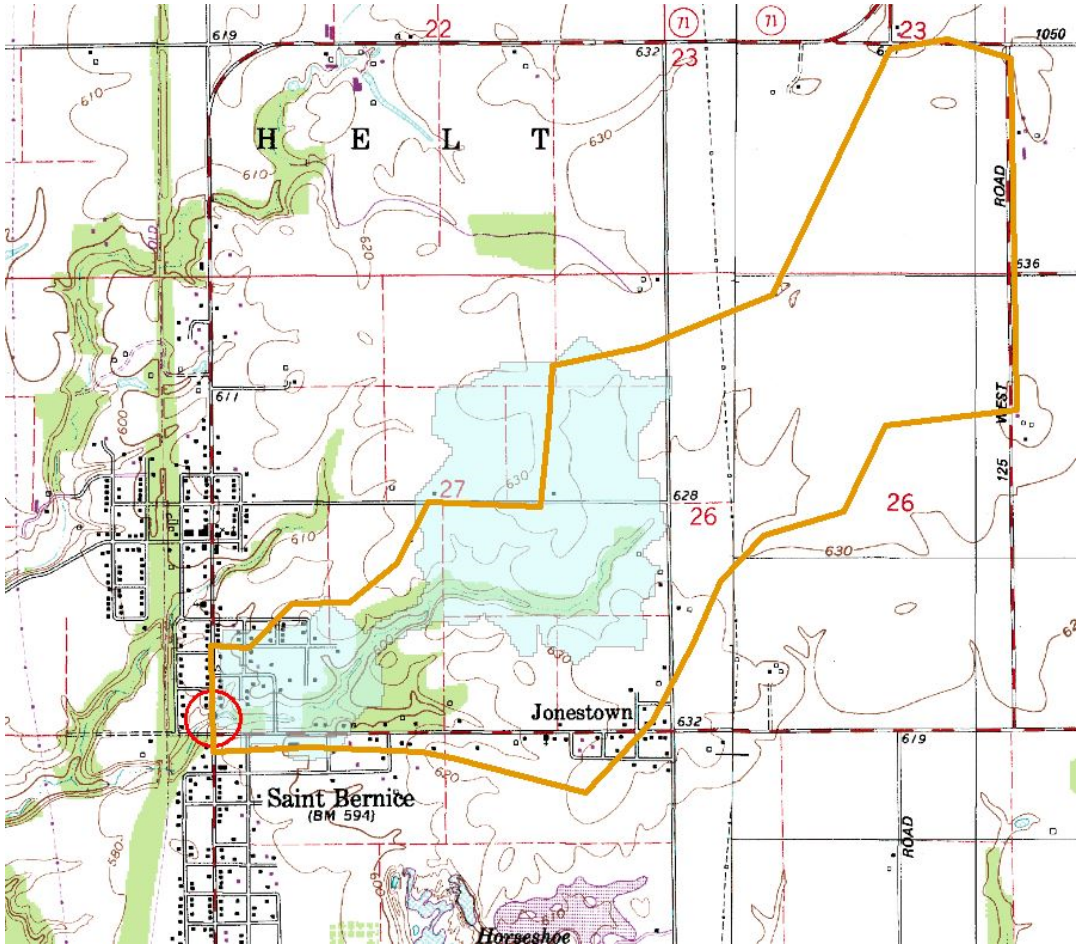
- Topographical maps of the state (originally paper)
- Generally in 5 or 10 ft contour increments
- Works well in hilly areas, but has limitations in flatter areas
- Previously preferred delineation method of INDOT

USGS StreamStats

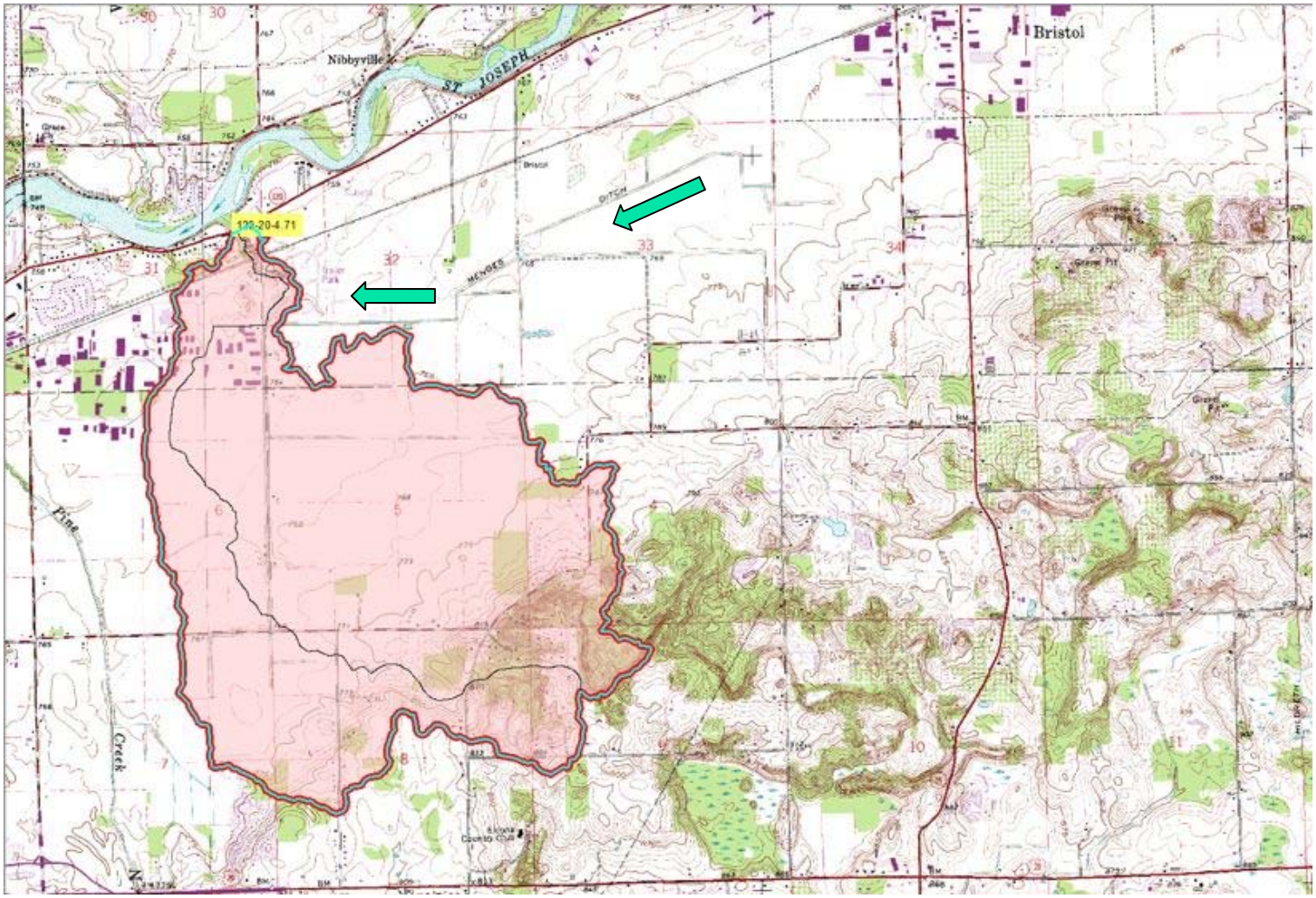


- https://water.usgs.gov/osw/streamstats/indiana.html
- Point and Click determination
- Delineates the watershed for the location selected
- Determines a discharge
- Check for errors

USGS StreamStats - Errors

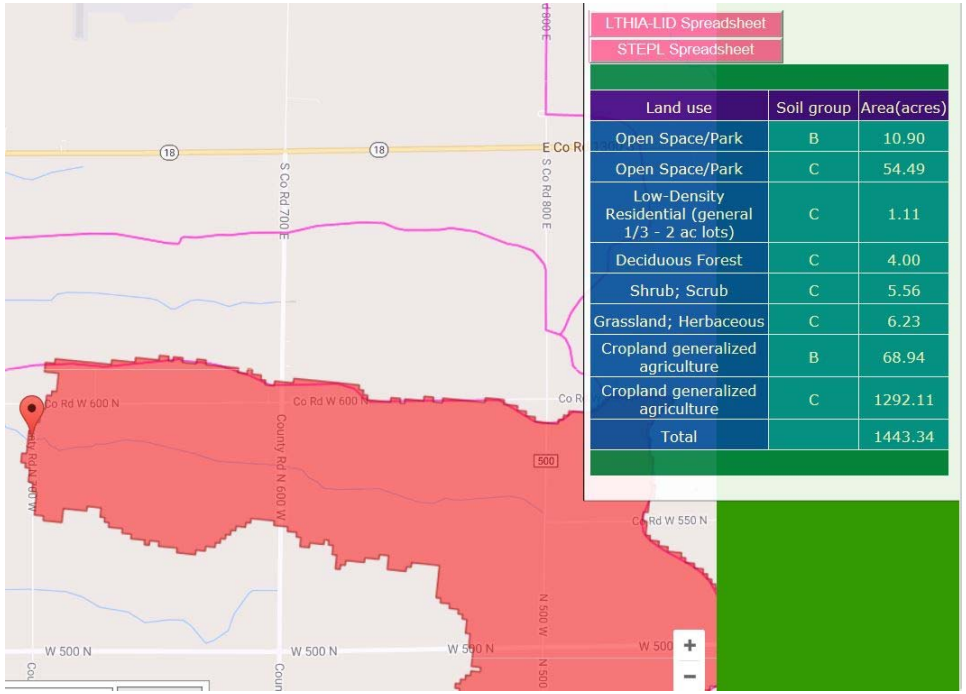


USGS StreamStats - Errors



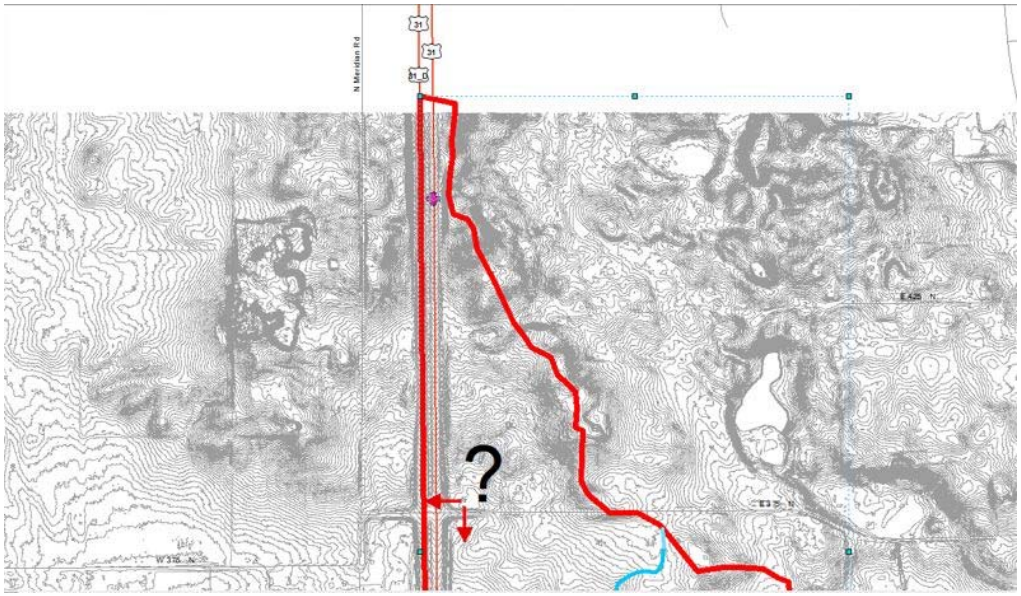
USGS StreamStats - Errors

L-THIA (Purdue)



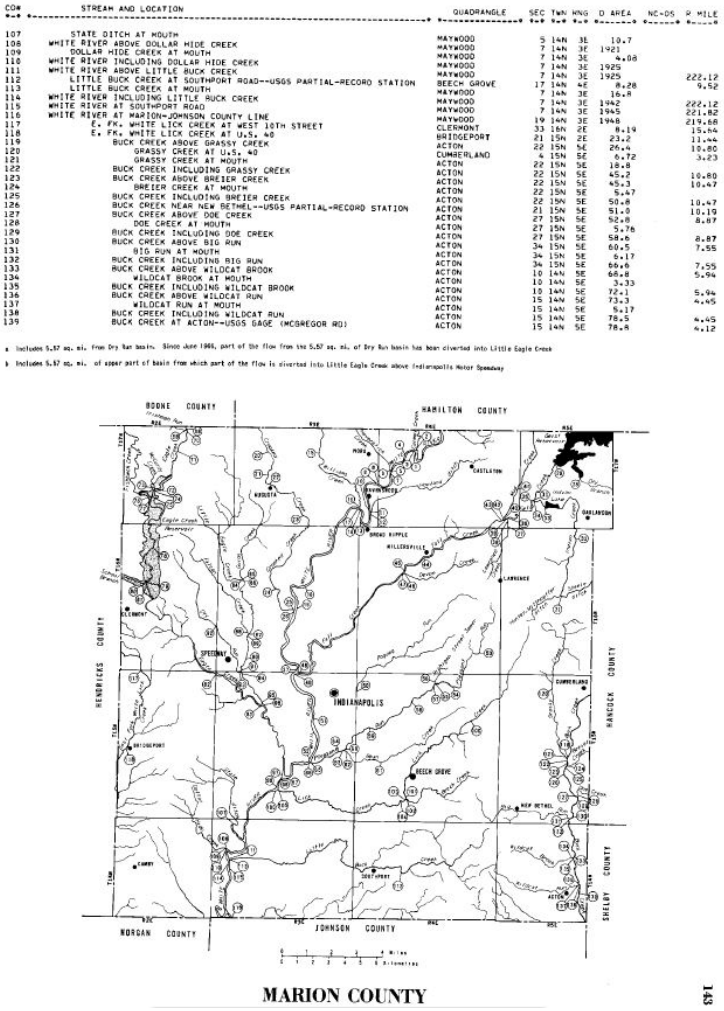
- http://lthia.agriculture.purdue.edu/
- Point and Click determination
- Delineates the watershed for the location selected
- Produces soil type and land use acreage
- Check for errors

Field Investigation and Plans



- Identify road barriers and culvert locations that may change the watershed (sometimes this can be done with aerial photography)
- Can help with determining ditch slope direction and break points
- Pond outlet directions

Drainage Areas of Indiana Streams



CO#	STREAM AND LOCATION	QUADRANGLE	SEC	TWN	RNG	D AREA	NC-DS	P MILE
107	STATE DITCH AT MOUTH	MAYWOOD	5	14N	3E	10.7		
108	WHITE RIVER ABOVE DOLLAR HIDE CREEK	MAYWOOD	7	14N	3E	1921		
109	DOLLAR HIDE CREEK AT MOUTH	MAYWOOD	7	14N	3E	4.08		
110	WHITE RIVER INCLUDING DOLLAR HIDE CREEK	MAYWOOD	7	14N	3E	1925		
111	WHITE RIVER ABOVE LITTLE BUCK CREEK	MAYWOOD	7	14N	3E	1925		222.12
112	LITTLE BUCK CREEK AT SOUTHPORT ROAD--USGS PARTIAL-RECORD STATION	BEECH GROVE	17	14N	4E	8.28		9.52
113	LITTLE BUCK CREEK AT MOUTH	MAYWOOD	7	14N	3E	16.8		
114	WHITE RIVER INCLUDING LITTLE BUCK CREEK	MAYWOOD	7	14N	3E	1942		222.12
115	WHITE RIVER AT SOUTHPORT ROAD	MAYWOOD	7	14N	3E	1945		221.82
116	WHITE RIVER AT MARION-JOHNSON COUNTY LINE	MAYWOOD	19	14N	3E	1948		219.68
117	E. FK. WHITE LICK CREEK AT WEST 10TH STREET	CLERMONT	33	16N	2E	8.19		15.44
118	E. FK. WHITE LICK CREEK AT U.S. 40	BRIDGEPORT	21	15N	2E	23.2		11.44
119	BUCK CREEK ABOVE GRASSY CREEK	ACTON	22	15N	5E	26.4		10.80
120	GRASSY CREEK AT U.S. 40	CUMBERLAND	a	15N	5E	6.72		3.23
121	GRASSY CREEK AT MOUTH	ACTON	22	15N	5E	18.8		
122	BUCK CREEK INCLUDING GRASSY CREEK	ACTON	22	15N	5E	45.2		10.80
123	BUCK CREEK ABOVE BREIER CREEK	ACTON	22	15N	5E	45.3		10.47
124	BREIER CREEK AT MOUTH	ACTON	22	15N	5E	5.47		
125	BUCK CREEK INCLUDING BREIER CREEK	ACTON	22	15N	5E	50.8		10.47
126	BUCK CREEK NEAR NEW BETHEL--USGS PARTIAL-RECORD STATION	ACTON	21	15N	5E	51.0		10.19
127	BUCK CREEK ABOVE DOE CREEK	ACTON	27	15N	5E	52.8		8.87
128	DOE CREEK AT MOUTH	ACTON	27	15N	5E	5.76		
129	BUCK CREEK INCLUDING DOE CREEK	ACTON	27	15N	5E	58.6		8.87
130	BUCK CREEK ABOVE BIG RUN	ACTON	34	15N	5E	60.5		7.55
131	BIG RUN AT MOUTH	ACTON	34	15N	5E	6.17		
132	BUCK CREEK INCLUDING BIG RUN	ACTON	34	15N	5E	66.6		7.55
133	BUCK CREEK ABOVE WILDCAT BROOK	ACTON	10	14N	5E	66.8		5.94
134	WILDCAT BROOK AT MOUTH	ACTON	10	14N	5E	3.33		
135	BUCK CREEK INCLUDING WILDCAT BROOK	ACTON	10	14N	5E	72.1		5.94
136	BUCK CREEK ABOVE WILDCAT RUN	ACTON	15	14N	5E	73.3		4.45
137	WILDCAT RUN AT MOUTH	ACTON	15	14N	5E	5.17		
138	BUCK CREEK INCLUDING WILDCAT RUN	ACTON	15	14N	5E	78.5		4.45
139	BUCK CREEK AT ACTON--USGS GAGE (MCGREGOR RD)	ACTON	15	14N	5E	78.8		4.12

a Includes 5.57 sq. mi. from Dry Run basin. Since June 1966, part of the flow from the 5.57 sq. mi. of Dry Run basin has been diverted into Little Eagle Creek

b Includes 5.57 sq. mi. of upper part of basin from which part of the flow is diverted into Little Eagle Creek above Indianapolis Motor Speedway

MARION COUNTY

163

- http://www.in.gov/dnr/water/4936.htm
- From 1975
- Gives spot locations of drainage areas in all Indiana counties (usually where tributaries come together)
- Works well for large drainage areas
- Good for a drainage area check

Determining Q100

- Selection of Discharge Table (Figure 202-3A)
- IDNR Discharge Letter
- Coordinated Discharges
- Gage Stations
- Similar Streams & Previous Work
- TR-20
- StreamStats & Purdue Regression Equations
- IDNR Discharge Tool (used for evaluation only)

Selection of Discharge Table

Facility Description	Methodology					
	Rational Method*	TR-20 or HEC-HMS	IDNR Coordinated Curves	USGS Gaging Information	Stream Stats	Purdue Regression Equations
Culvert	2	2	1	--	3	--
Bridge or Channel, < 5 sq mi drainage area	--	2	1	3	3	3
Bridge or Channel, ≥ 5 sq mi drainage area	--	3	1	2	3	3
Storm Drain and Inlets	1	4	--	--	--	--
Storage Facility	5	1	--	--	--	--
Pumping Station **	--	1	--	--	--	--

Notes: Must use IDNR Discharge Letter if IDNR Permit is required.

1 is the preferred method

2 is the preferred method if 1 is unavailable

3 is the secondary method

4 may be used if a complex facility exists

5 may be used for retention storage with no outlet

* Rational Method may be used only if drainage area is less than 100 ac in an urban area or less than 200 ac in a rural area.

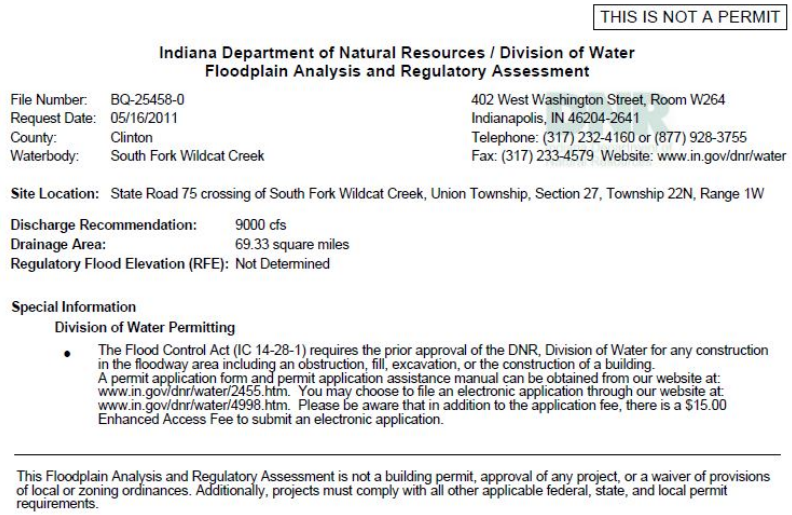
** See HEC-24, Chapters 5.3 – 5.5.

SELECTION OF DISCHARGE-COMPUTATION METHOD

Figure 202-3A

- Figure 202-3A in the Indiana Design Manual (IDM)

IDNR Discharge Letter



THIS IS NOT A PERMIT

Indiana Department of Natural Resources / Division of Water
Floodplain Analysis and Regulatory Assessment

File Number: BQ-25458-0
Request Date: 05/16/2011
County: Clinton
Waterbody: South Fork Wildcat Creek

402 West Washington Street, Room W264
Indianapolis, IN 46204-2641
Telephone: (317) 232-4160 or (877) 928-3755
Fax: (317) 233-4579 Website: www.in.gov/dnr/water

Site Location: State Road 75 crossing of South Fork Wildcat Creek, Union Township, Section 27, Township 22N, Range 1W

Discharge Recommendation: 9000 cfs
Drainage Area: 69.33 square miles
Regulatory Flood Elevation (RFE): Not Determined

Special Information

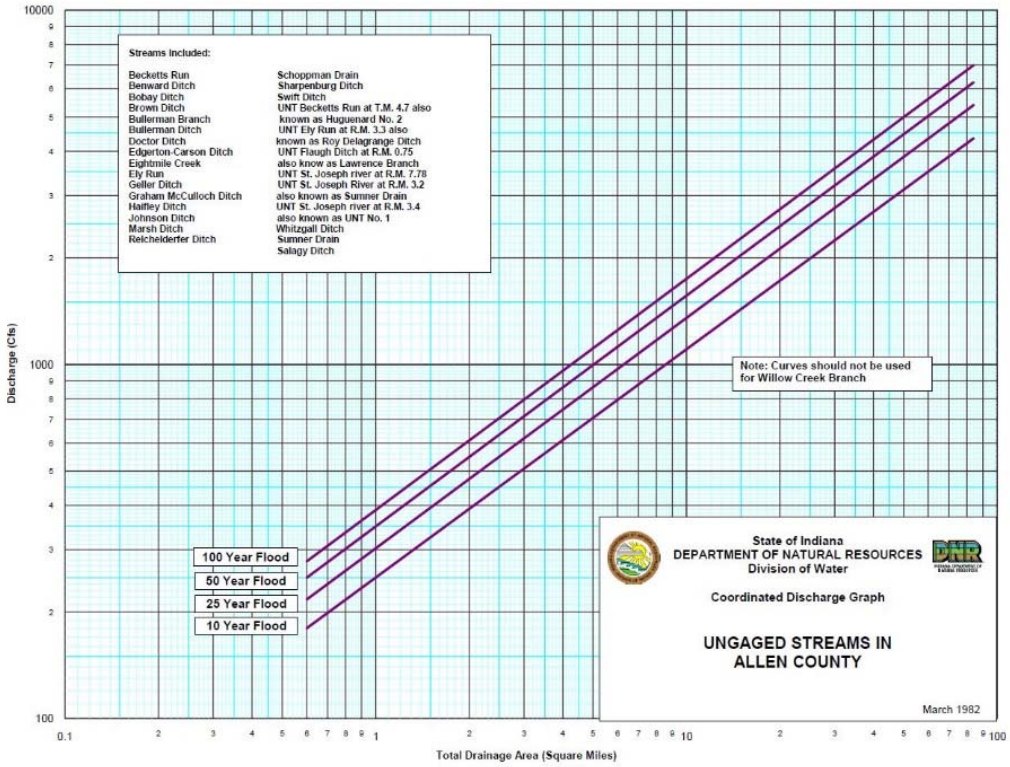
Division of Water Permitting

- The Flood Control Act (IC 14-28-1) requires the prior approval of the DNR, Division of Water for any construction in the floodway area including an obstruction, fill, excavation, or the construction of a building. A permit application form and permit application assistance manual can be obtained from our website at: www.in.gov/dnr/water/2455.htm. You may choose to file an electronic application through our website at: www.in.gov/dnr/water/4998.htm. Please be aware that in addition to the application fee, there is a $15.00 Enhanced Access Fee to submit an electronic application.

This Floodplain Analysis and Regulatory Assessment is not a building permit, approval of any project, or a waiver of provisions of local or zoning ordinances. Additionally, projects must comply with all other applicable federal, state, and local permit requirements.

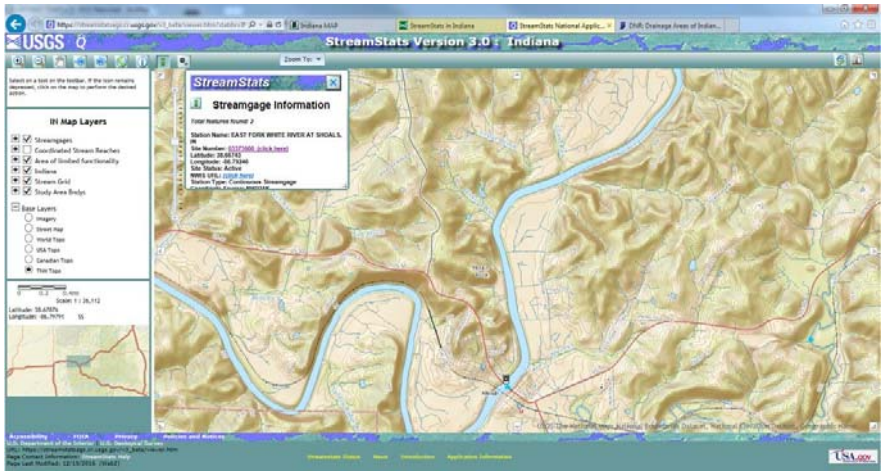
- Must be used if a Construction in Floodway (CIF) permit is needed
- No other methods need to be performed, but make sure the discharge values make sense

IDNR Coordinated Discharges



- http://www.in.gov/dnr/water/4898.htm
- Easy to use, preferred by IDNR
- Recent studies tend to be more realistic than older ones
- Extrapolation within reason is acceptable
- Can use studies from different streams if they are deemed to be similar
- Make sure results seem realistic

Gage Stations



Stream_Slope_10_and_85_Method	2.0000	feet per mi	31
Basin Dimensional Characteristics			
Contributing_Drainage_Area	4927.00	square miles	31
Drainage_Area	4927	square miles	290

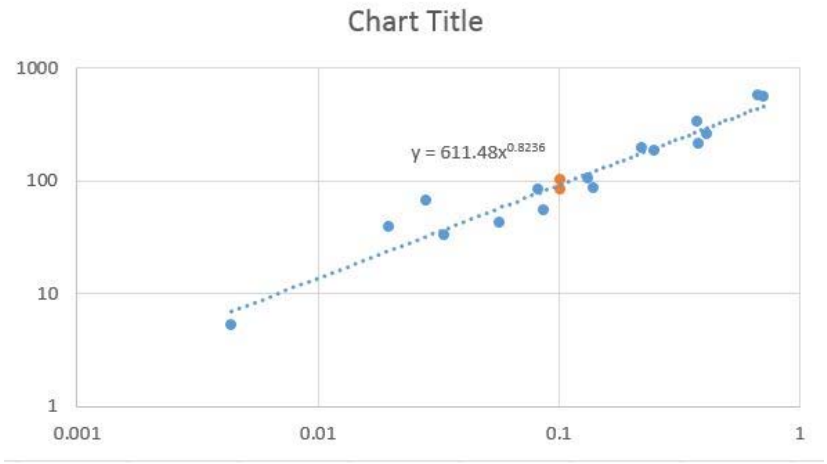
Streamflow Statistics

Statistic Name	Value	Units	Citation Number	Preferred?	Ye
Peak-Flow Statistics					
10_Year_Peak_Flood	70400	cubic feet per second	62	Y	
25_Year_Peak_Flood	87600	cubic feet per second	62	Y	
50_Year_Peak_Flood	101000	cubic feet per second	62	Y	
100_Year_Peak_Flood	114000	cubic feet per second	62	Y	
200_Year_Peak_Flood	128000	cubic feet per second	62	Y	
500_Year_Peak_Flood	146000	cubic feet per second	62	Y	
Systematic_peak_years	101	years	62	Y	
Flood-Volume Statistics					
1_Day_2_Year_Maximum	36500.0	cubic feet per second	31	Y	
1_Day_20_Year_Maximum	82000.0	cubic feet per second	31	Y	
1_Day_5_Year_Maximum	55000.0	cubic feet per second	31	Y	
1_Day_10_Year_Maximum	68000.0	cubic feet per second	31	Y	
1_Day_25_Year_Maximum	86000.0	cubic feet per second	31	Y	
1_Day_50_Year_Maximum	100000	cubic feet per second	31	Y	
3_Day_2_Year_Maximum	36100.0	cubic feet per second	31	Y	
3_Day_5_Year_Maximum	55100.0	cubic feet per second	31	Y	
3_Day_10_Year_Maximum	64000.0	cubic feet per second	31	Y	
3_Day_20_Year_Maximum	76000.0	cubic feet per second	31	Y	
3_Day_25_Year_Maximum	80600.0	cubic feet per second	31	Y	

- http://www.in.gov/dnr/water/4898.htm
- Uses historical real stream data to predict hypothetical storm probabilities
- The more data, the more reliable the results

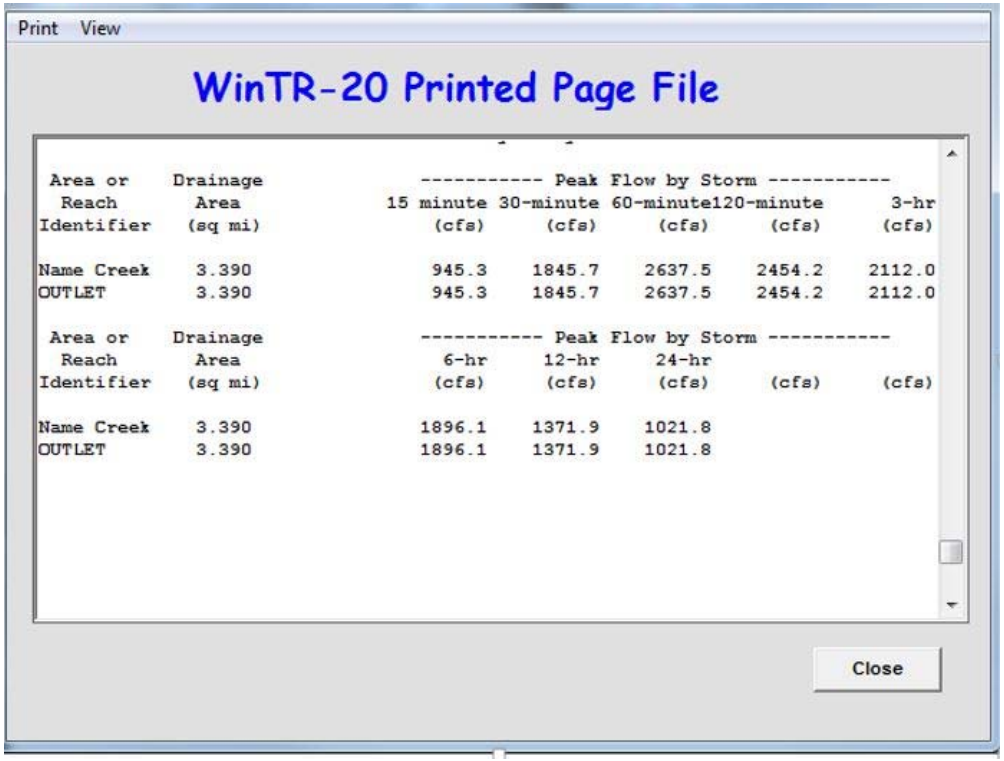
Similar Streams and Previous Work

Past Local Projects					
des#	route	county	rp	area	Q100
	SR 68	Posey	11.54	0.033641	32.83
100957	US 41	Vanderburgh		0.41	256.5
1500595	US 41	Gibson	17.28	0.139531	86.7
501206	I64	Vanderbur	21.9	0.019688	39.1
501206	I64	Vanderbur	22.6	0.028281	67.6
501206	I64	Vanderbur	24.4	0.004375	5.2
1005839	I64	Gibson	24.2	0.25	186
1005839	I64	Gibson	24.25	0.375	331
1296555	I64	Gibson	24.49	0.7125	550
1298246	SR 64	Gibson	18.48	0.22	196
1400206	SR 64	Gibson	7.23	0.380938	211.5
1400206	SR 64	Gibson		0.056563	42.2
1400206	SR 64	Gibson		0.082188	83.8
1400206	SR 64	Gibson	8.95	0.1325	104.4
1400206	SR 64	Gibson		0.086875	54.6
	SR 64	Gibson	19.15	0.674	569.3



- Can look at previously completed work of similar watershed or nearby areas
- Create a regression line to help predict discharge at site of interest

TR-20



Area or Reach Identifier | Drainage Area (sq mi) | Peak Flow by Storm: 15 minute (cfs) | 30-minute (cfs) | 60-minute (cfs) | 120-minute (cfs) | 3-hr (cfs)

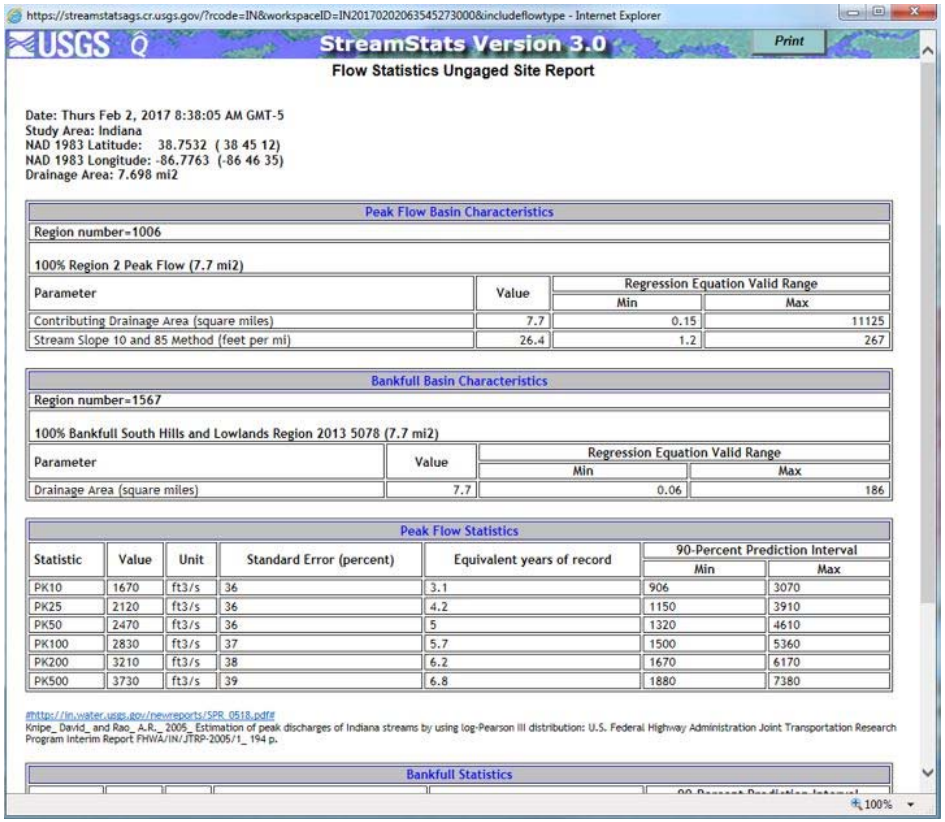
Name Creek	3.390	945.3	1845.7	2637.5	2454.2	2112.0
OUTLET	3.390	945.3	1845.7	2637.5	2454.2	2112.0

Area or Reach Identifier | Drainage Area (sq mi) | Peak Flow by Storm: 6-hr (cfs) | 12-hr (cfs) | 24-hr (cfs)

Name Creek	3.390	1896.1	1371.9	1021.8
OUTLET	3.390	1896.1	1371.9	1021.8

- https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/null/?cid=stelprdb1042793
- Software from USDA - NRCS
- For bridges, use only with smaller watersheds (say < 5 square miles)
- Requires Drainage Area, Curve Number (Soil Information), and Time of Concentration
- Requires multiple hydrographs to determine peak discharge
- Use Huff methodology for rainfall distributions

StreamStats and Purdue Regression Equations



https://streamstatsags.cr.usgs.gov/?rcode=IN&workspaceID=IN20170202063545273000&includeflowtype - Internet Explorer

USGS StreamStats Version 3.0 Print

Flow Statistics Ungaged Site Report

Date: Thurs Feb 2, 2017 8:38:05 AM GMT-5
Study Area: Indiana
NAD 1983 Latitude: 38.7532 (38 45 12)
NAD 1983 Longitude: -86.7763 (-86 46 35)
Drainage Area: 7.698 mi2

Peak Flow Basin Characteristics

Region number=1006

100% Region 2 Peak Flow (7.7 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Contributing Drainage Area (square miles)	7.7	0.15	11125
Stream Slope 10 and 85 Method (feet per mi)	26.4	1.2	267

Bankfull Basin Characteristics

Region number=1567

100% Bankfull South Hills and Lowlands Region 2013 5078 (7.7 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	7.7	0.06	186

Peak Flow Statistics

Statistic	Value	Unit	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
PK10	1670	ft3/s	36	3.1	906	3070
PK25	2120	ft3/s	36	4.2	1150	3910
PK50	2470	ft3/s	36	5	1320	4610
PK100	2830	ft3/s	37	5.7	1500	5360
PK200	3210	ft3/s	38	6.2	1670	6170
PK500	3730	ft3/s	39	6.8	1880	7380

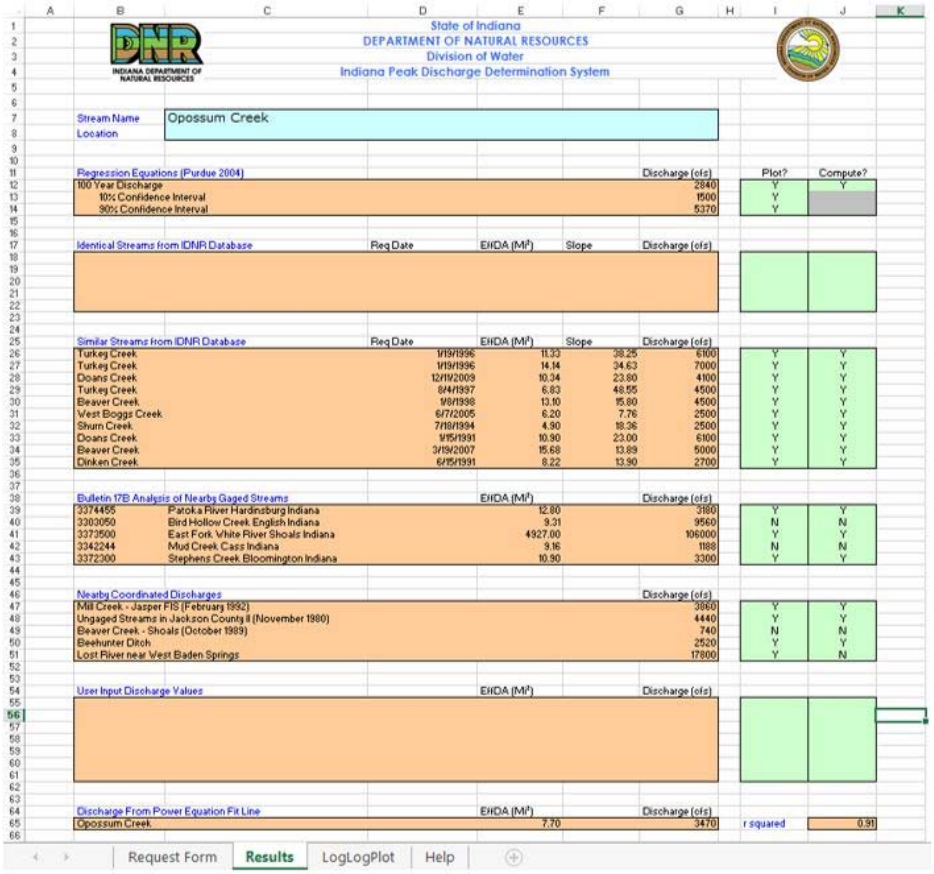
http://in.water.usgs.gov/newreports/SPR_0518.pdf#
Knipe, David, and Rao, A.R., 2005, Estimation of peak discharges of Indiana streams by using log-Pearson III distribution: U.S. Federal Highway Administration Joint Transportation Research Program Interim Report FHWA/IN/JTRP-2005/1, 194 p.

Bankfull Statistics

100%

- Can have a large variable range
- Do not use by itself
- Requires checking with other methods to determine validity

IDNR Discharge Tool



State of Indiana
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Indiana Peak Discharge Determination System

Stream Name: Opossum Creek
Location:

Regression Equations (Purdue 2004)	Discharge (cfs)	Plot?	Compute?
100 Year Discharge	2840	Y	Y
10% Confidence Interval	1500	Y	
90% Confidence Interval	5370	Y	

Identical Streams from IDNR Database	Req Date	EHDA (Mi²)	Slope	Discharge (cfs)		

Similar Streams from IDNR Database	Req Date	EHDA (Mi²)	Slope	Discharge (cfs)		
Turkey Creek	1/19/1996	11.33	38.25	6100	Y	Y
Turkey Creek	1/19/1996	14.14	34.63	7000	Y	Y
Doans Creek	12/19/2009	10.34	23.80	4100	Y	Y
Turkey Creek	8/4/1997	6.83	48.55	4500	Y	Y
Beaver Creek	9/8/1998	13.10	15.80	4500	Y	Y
West Boggs Creek	6/7/2005	6.20	7.76	2500	Y	Y
Shurn Creek	7/16/1994	4.90	18.36	2500	Y	Y
Doans Creek	1/15/1991	10.90	23.00	6100	Y	Y
Beaver Creek	3/19/2007	15.68	13.89	5000	Y	Y
Dinken Creek	6/15/1991	8.22	13.90	2700	Y	Y

Bulletin 17B Analysis of Nearby Gaged Streams		EHDA (Mi²)	Discharge (cfs)		
3374455	Patoka River Hardinsburg Indiana	12.80	3180	Y	Y
3303050	Bird Hollow Creek English Indiana	9.31	9560	N	N
3373500	East Fork White River Shoals Indiana	4927.00	105000	Y	Y
3342244	Mud Creek Cass Indiana	9.16	1188	N	N
3372300	Stephens Creek Bloomington Indiana	10.90	3300	Y	Y

Nearby Coordinated Discharges	Discharge (cfs)		
Mill Creek - Jasper FIS (February 1992)	3860	Y	Y
Ungaged Streams in Jackson County II (November 1980)	4440	Y	Y
Beaver Creek - Shoals (October 1989)	740	N	N
Beehunter Ditch	2520	Y	Y
Lost River near West Baden Springs	17800	Y	N

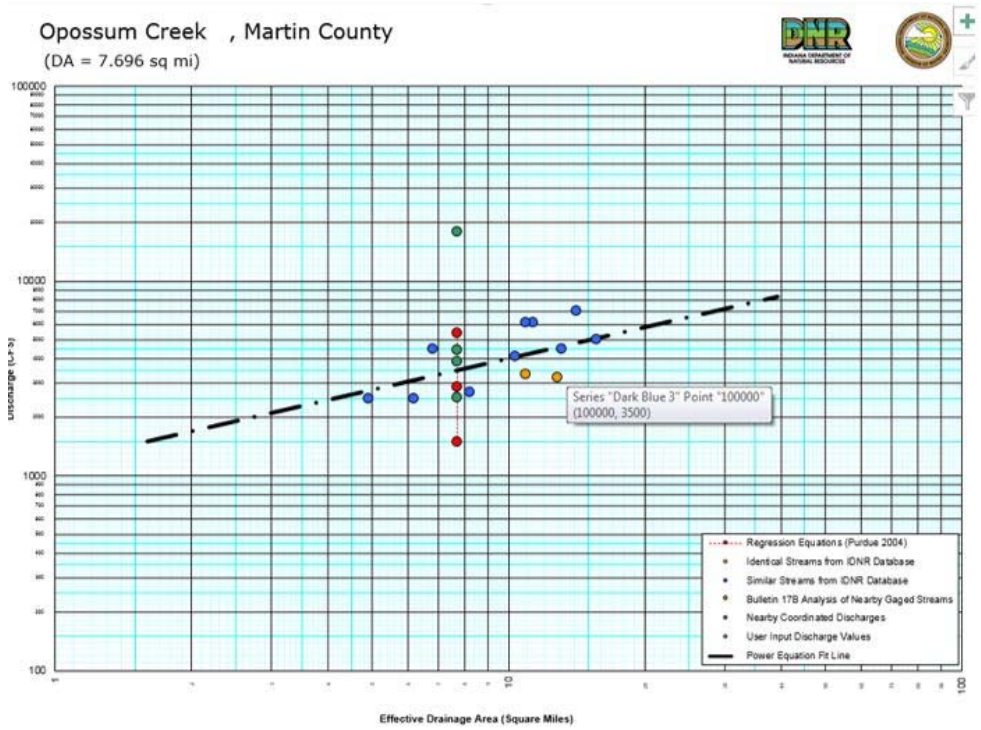
User Input Discharge Values	EHDA (Mi²)	Discharge (cfs)		

Discharge From Power Equation Fit Line	EHDA (Mi²)	Discharge (cfs)		
Opossum Creek	7.70	3470	r squared	0.91

Request Form | Results | LogLogPlot | Help

- Great for Regression Analysis
- Uses most of the methods preferred by INDOT
- Do not accept blindly
- Eliminate inputs that don't relate to the site of interest
- Add additional inputs as needed

IDNR Discharge Tool



- Use plot to see if there are outliers or adjustments to be made
- http://dnrmaps.dnr.in.gov/appsphp/dischargecalc/
- See website for details on how to use
- IDNR will be giving a presentation on the tool at Road School in March

Questions