Implementing a Stream Flow Monitoring Program to Inform Management and Conservation Decisions in the Monongahela River Watershed

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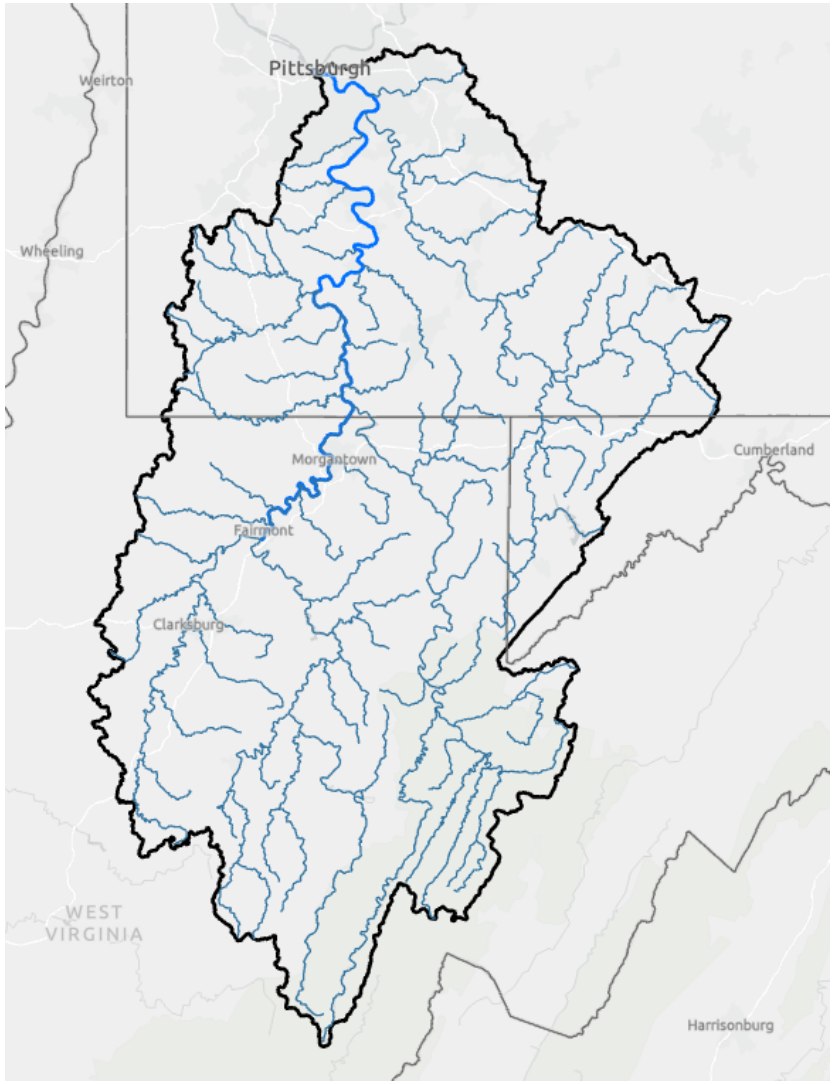
Overview

- Background Information
- Field Work
- Data Processing
- Final Result

Background

- The Monongahela was a severely impacted river.
- Rebounded through effective collaborations and voluntary reductions of Total Dissolved Solids
  - Delisted in 2014
- More restoration is needed
- Insufficient monitoring to support and prioritize restoration and conservation efforts
- Flow data is particularly needed throughout the watershed



To fill the stream flow data gap:

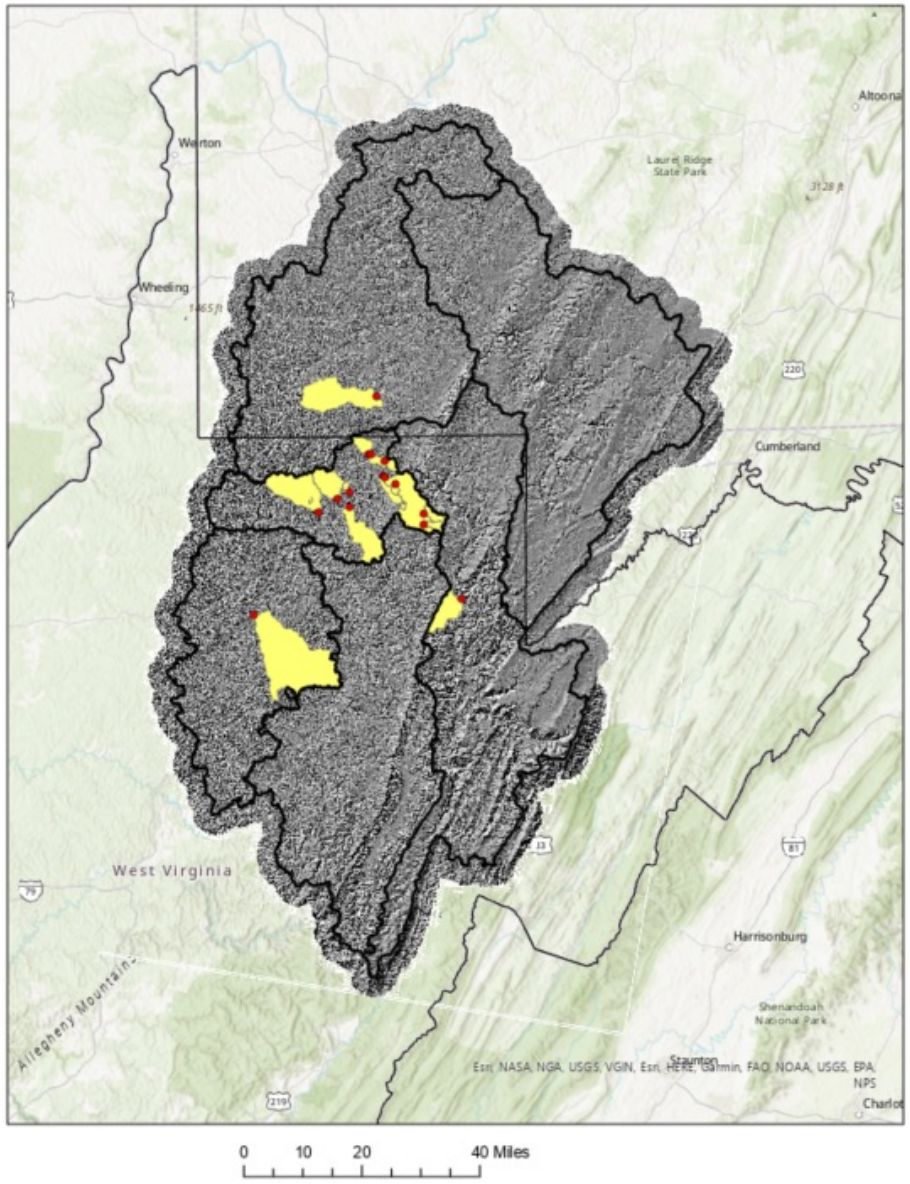
- In collaboration with partners, we installed a network of stream gauges
- Stream flow data will support three mapping applications
  - 7Q10, Flow Distance Above Public Water Supplies, Water Withdrawal Tool
  - Updating the rainfall/runoff relationship with more flow data from ungauged tributaries to the Mon.
- Support Studies ongoing at the University
- 3RQ Water Quality Monitoring Program

Specific Objectives

1. Install HOBO water level loggers in 15 presently un-gauged or under-gauged Monongahela River tributary stream reaches
2. Translate water level data into flow data and use to update and refine stream flow models
3. Make data publicly available and facilitate the transfer of flow information to government and industry partners.

Site Selection

- Working with our partners, 15 sites were selected for gauge installation.
  - WVDEP, WV DNR, FODC, & FOC
- Map shows the Study area, Fifteen sites, associated drainage area boundaries, and large 8-digit HUC boundaries in the hill shaded Monongahela River Basin



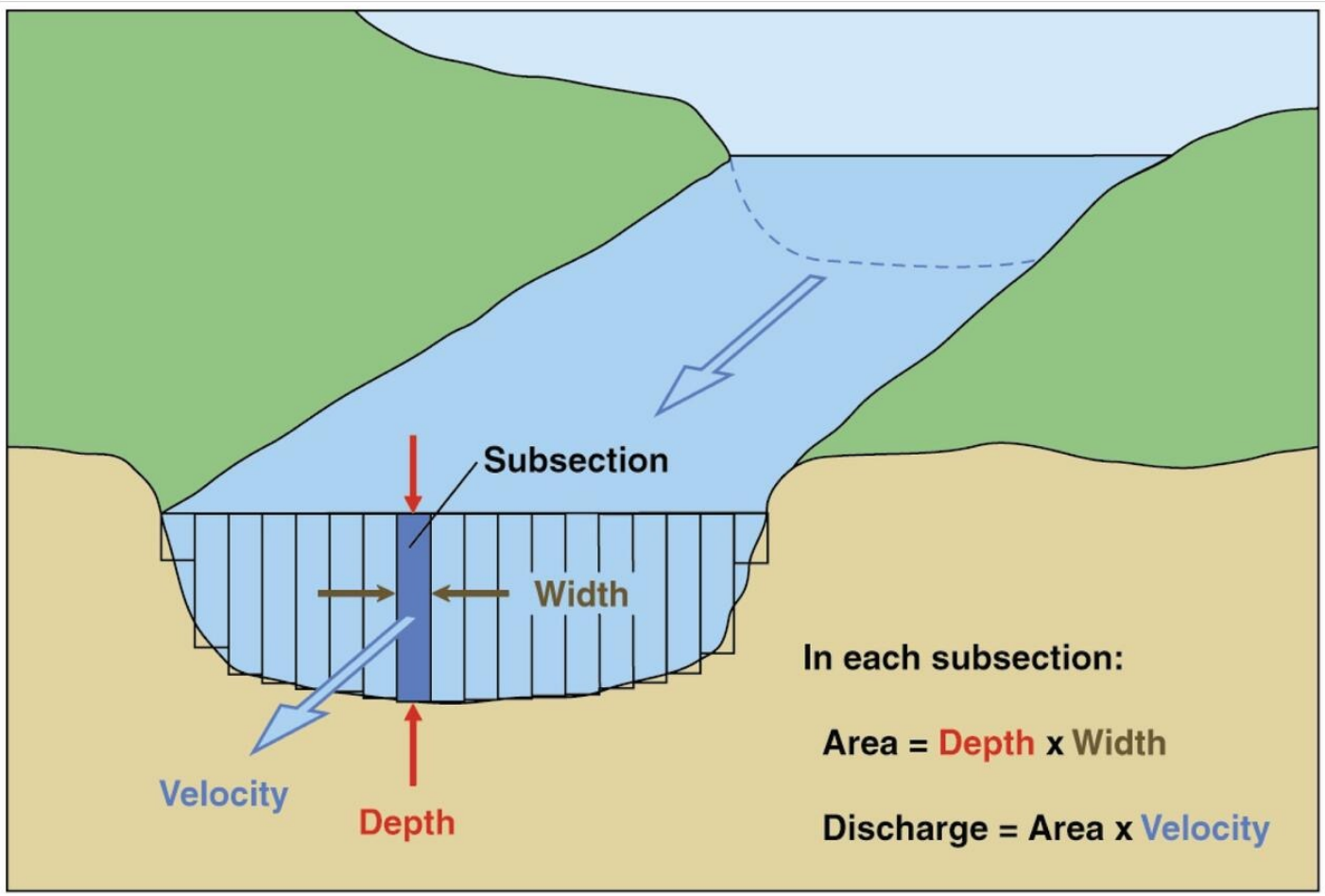
Gauge Information

- 30 OnSet HOBO U20L Water Level Loggers were acquired.
  - 2 Loggers needed for each stream
  - Logger in stream records absolute pressure
  - Logger in a tree records barometric pressure
    - Using HOBO Software, absolute pressure minus barometric pressure can be converted into water level in feet.
  - Monitor water levels in streams at 1-hour increments
  - Operates to depths of 30ft
  - Accuracy to within 0.03 ft
  - Functions in temperatures of 32F to 104F

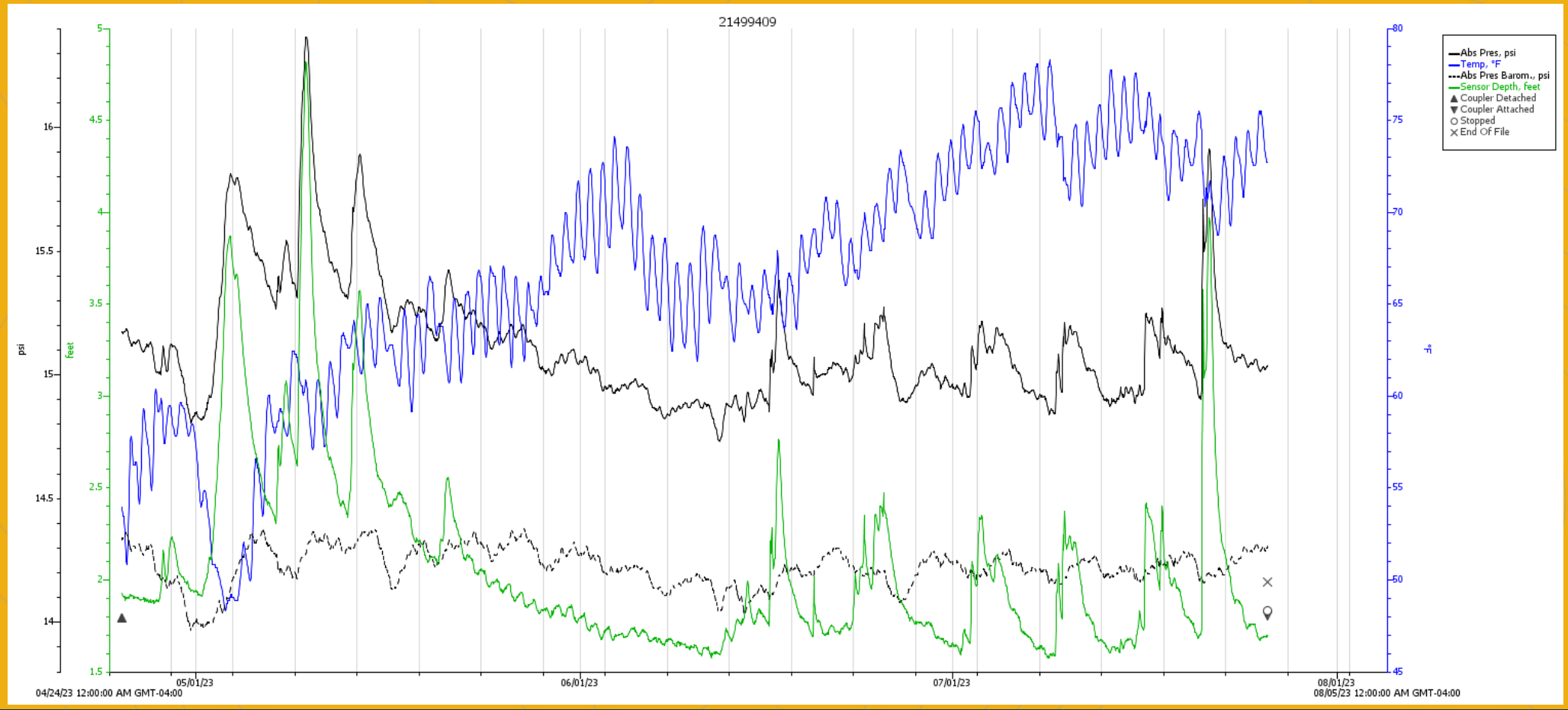
Gauge Installation

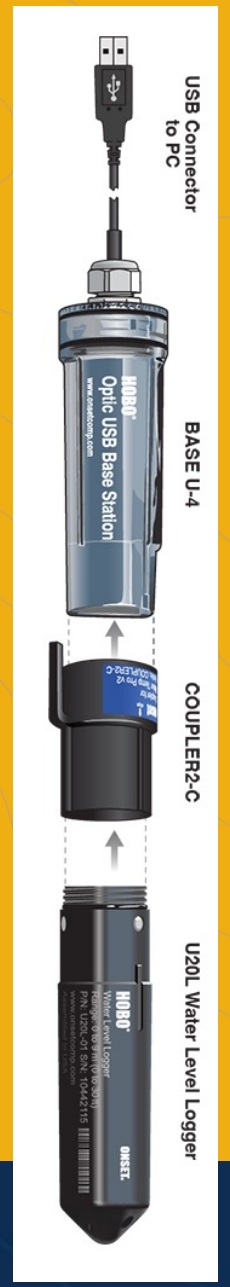
Discharge Measurements

- Taken 3 times at every stream



Pulling Data from the gauges

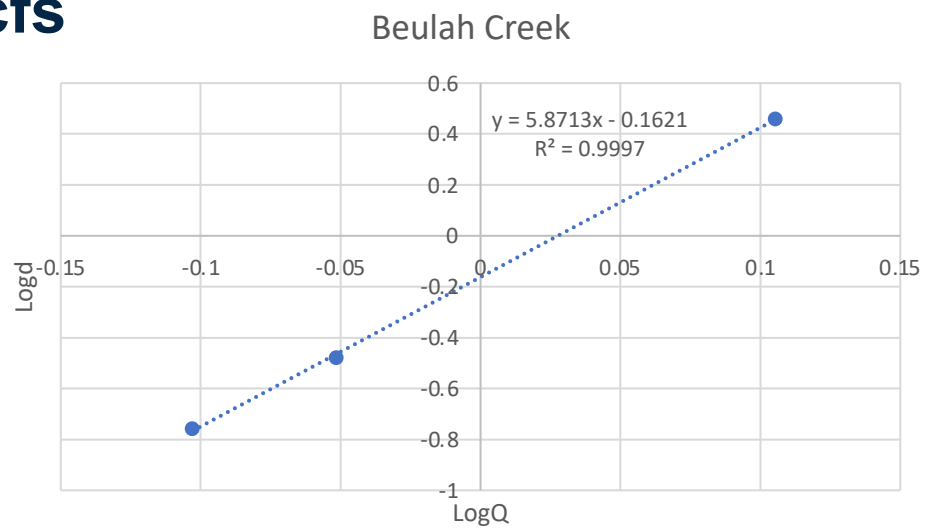




Stage-Discharge Rating Curve

- A stage-discharge rating curve depicts the relation between stage and discharge
  - Is Unique to each stream
- Once the rating curve is developed we can use it to transform the hourly stage data to stream flow in cfs
- Q=Ad^B
  - logQ=B*logd+logA

Date	Time	Flow, cfs (Q)	Stage, ft (d)	logd	logQ
11-May-23	14:06	2.887	1.275	0.10551	0.460447
2-Jun-23	13:36	0.175	0.789	-0.10292	-0.75696
20-Jun-23	13:00	0.333	0.888	-0.05159	-0.47756



Date	Time	Sensor Depth, feet	Q, cfs
3/6/2023	22:00	1.346	4.96092
3/6/2023	23:00	1.341	4.853696
3/7/2023	0:00	1.333	4.68614
3/7/2023	1:00	1.333	4.68614
3/7/2023	2:00	1.316	4.345974
3/7/2023	3:00	1.322	4.46361
3/7/2023	4:00	1.329	4.604179
3/7/2023	5:00	1.324	4.503404
3/7/2023	6:00	1.31	4.230921
3/7/2023	7:00	1.313	4.288127
3/7/2023	8:00	1.296	3.972261
3/7/2023	9:00	1.303	4.099899
3/7/2023	10:00	1.329	4.604179
3/7/2023	11:00	1.319	4.404466
3/7/2023	12:00	1.329	4.604179
3/7/2023	13:00	1.305	4.136985
3/7/2023	14:00	1.306	4.155633
3/7/2023	15:00	1.302	4.081459
3/7/2023	16:00	1.288	3.830443
3/7/2023	17:00	1.279	3.675945
3/7/2023	18:00	1.28	3.692852
3/7/2023	19:00	1.283	3.74396
3/7/2023	20:00	1.272	3.559387
3/7/2023	21:00	1.258	3.335454
3/7/2023	22:00	1.265	3.445911
3/7/2023	23:00	1.27	3.526653
3/8/2023	0:00	1.242	3.09397
3/8/2023	1:00	1.255	3.289023
3/8/2023	2:00	1.251	3.22795
3/8/2023	3:00	1.246	3.152935
3/8/2023	4:00	1.242	3.09397
3/8/2023	5:00	1.236	3.00724
3/8/2023	6:00	1.239	3.050349
3/8/2023	7:00	1.243	3.108625
3/8/2023	8:00	1.236	3.00724

Summarized drainage area, stream flow, elevation, precipitation, and land cover data for each sampling location.

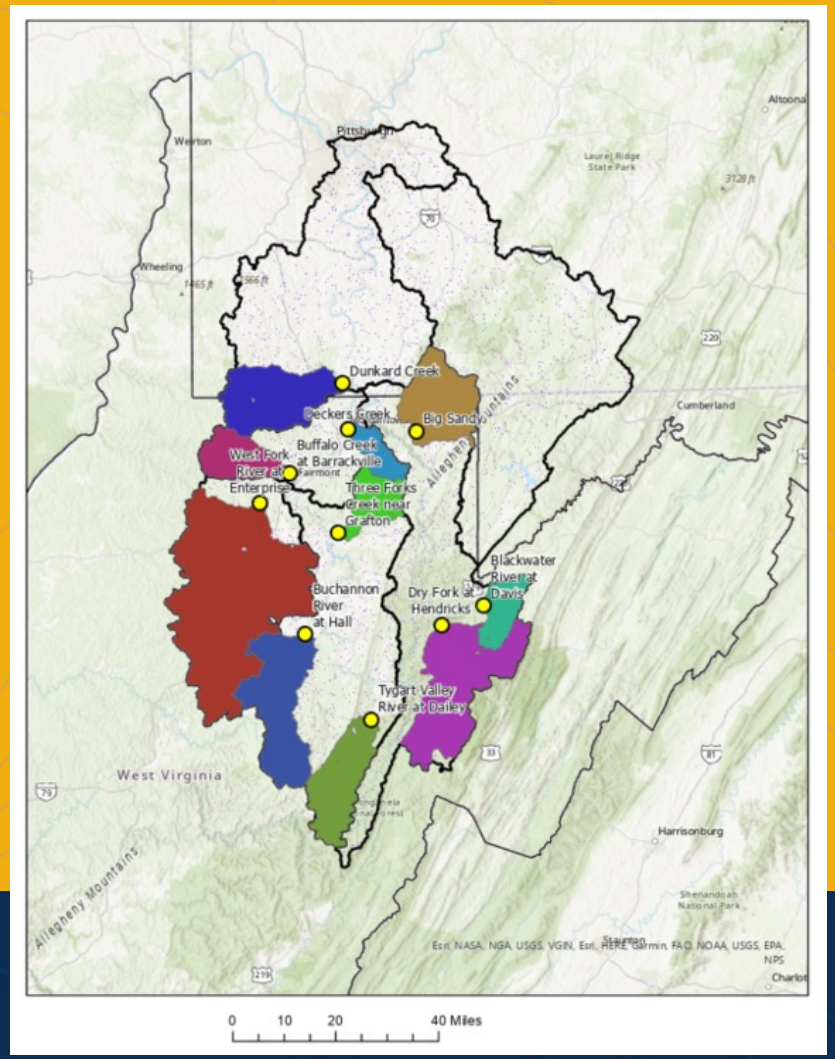
site	xlong	ylat	name	FAC values	m2	Q average	acres	ratio	MINelev	MAXele	RANGE	MEANe	MINprecip	MAXprecip	RANGEprecip	MEANprecip
1	-79.931772	39.625628	Aaron's Creek	180,318	18,031,800	7.89	4,457	564.90	25295	71341	46046	46167	1132	1362	230	1237
2	-79.895646	39.606032	Beulah Hollow	47,433	4,743,300	2.69	1,172	435.85	29145	61602	32457	47328	1203	1271	68	1238
3	-79.688021	39.319577	Buffalo Creek	562,952	56,295,200	9.83	13,915	1,415.57	42763	89058	46295	65972	1407	1479	73	1442
4	-79.925994	39.62025	Deckers Creek	1,334,836	133,483,600	107.81	32,994	306.04	25808	71282	45474	54147	1140	1364	224	1294
5	-79.80558	39.529238	Dillan Creek	159,809	15,980,900	1.93	3,950	2,046.71	51273	67942	16669	57831	1299	1343	44	1320
6	-80.344866	39.286199	Elk Creek	3,122,783	312,278,300	34.11	77,189	2,262.94	28094	60034	31940	38497	1206	1326	120	1256
7	-80.038847	39.584373	Flaggy Meadows	41,262	4,126,200	8.95	1,020	113.96	29311	42524	13213	35573	1175	1184	9	1179
8	-80.079347	39.568538	Indian Creek	509,578	50,957,800	21.94	12,596	574.10	27935	49415	21480	36666	1184	1212	29	1200
9	-79.8051	39.503943	Kanes Creek	108,473	10,847,300	1.99	2,681	1,347.35	51665	73391	21726	60424	1311	1363	52	1338
10	-80.139487	39.537412	Paw Paw Creek	1,052,916	105,291,600	12.91	26,026	2,015.95	26649	52336	25687	37213	1201	1229	28	1215
11	-79.979258	39.679745	Robinson Run	197,547	19,754,700	3.43	4,883	1,423.61	24370	46311	21941	34300	1125	1148	23	1135
12	-79.9264424	39.66207802	West Run, Farm	29,126	2,912,600	2.1	720	342.83	30314	44852	14538	36421	1137	1140	3	1139
13	-79.9697798	39.6774858	West Run, Mouth	229,647	22,964,700	10.58	5,676	536.52	24302	42568	18266	34151	1123	1163	39	1138
14	-80.041644	39.549338	White Day	826,277	82,627,700	13.07	20,424	1,562.66	26708	65132	38424	44820	1191	1316	124	1265
15	-79.9523398	39.8213315	Whiteley Creek	1,356,736	135,673,600	59.41	33,536	564.48	25439	48746	23307	35908	1087	1135	49	1115

OPEN_WATEF	DEV_OPEN_SPAC	DEV_LOW_INT	DEV_MED_INT	DEV_HIGH_INT	BARREN	DECIDUOUS	EVERGREEN	MIXED_FOF	SHRUB_SCRI	HERBACEOU	HAY_PASTUF	CULTIVATED	WOODY_WETL	EMERG_
9900	1358100	1287000	524700	74700	36000	8096400	4500	4046400	183600	214200	1874700	315000	0	0
0	371700	355500	30600	900	49500	1334700	900	2114100	15300	44100	416700	15300	0	0
0	2275200	152100	48600	5400	21600	49395600	8100	1410300	473400	243900	2078100	0	0	9900
414900	6985800	4236300	1810800	376200	413100	47601900	350100	20146500	893700	1060200	16992000	267300	162000	195300
35100	1106100	636300	231300	14400	15300	7883100	50400	789300	111600	84600	4915800	33300	18900	44100
190800	13280400	9393300	6031800	2065500	1081800	198949500	127800	10870200	3233700	3238200	63580500	0	202500	371700
93600	431100	64800	12600	900	0	2722500	0	151200	18000	154800	475200	0	0	0
231300	2583000	568800	66600	5400	1800	32715900	102600	3334500	846900	768600	8427600	1268100	23400	27900
33300	857700	517500	180000	51300	50400	6968700	5400	492300	86400	158400	1329300	0	76500	43200
358200	4998600	1377900	420300	89100	543600	76794300	113400	4368600	1406700	2177100	13944600	36000	37800	20700
154800	1083600	356400	135900	50400	200700	10860300	11700	1806300	615600	974700	2916900	593100	0	0
900	352800	235800	167400	76500	0	1326600	0	212400	24300	23400	360900	132300	0	0
0	2661300	3662100	3555000	1422900	121500	4191300	6300	1611000	297000	258300	1593900	664200	0	1800
8100	4014000	625500	203400	17100	34200	63150300	18900	2129400	850500	726300	10830600	0	22500	8100
152100	6901200	1925100	666000	212400	581400	77277600	87300	13908600	1163700	1862100	21699000	9113400	65700	96300

USGS gauge stations used to develop a relationship between thirty-year annual precipitation and stream flow.

PRISM CLIMATE GROUP

site	name	lat deg	lat min	lat sec	long deg	long min	long sec	longdds	latdds	DAsqmiles
1	Big Sandy	39	37	18.3	79	42	16.4	-79.7046	39.62175	200
2	Buchannon River at Hall	39	3	4	80	6	53	-80.1147	39.05111	277
3	Buffalo Creek at Barrackville	39	30	20.4	80	10	5.4	-80.1682	39.50567	116
4	Blackwater River at Davis	39	7	37	79	28	7	-79.4686	39.12694	86
5	Deckers Creek	39	37	45	79	57	10	-79.9528	39.62917	63
6	Dry Fork at Hendricks	39	4	20	79	37	23	-79.6231	39.07222	347
7	Dunkard Creek	39	45	33	79	58	15	-79.9708	39.75917	229
8	Three Forks Creek near Grafton	39	20	11	79	59	37	-79.9936	39.33639	97
9	Tygart Valley River at Dailey	38	48	33	79	52	55	-79.8819	38.80917	188
10	West Fork River at Enterprise	39	25	20	80	16	34	-80.2761	39.42222	759



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Runoff ratio average across the Monongahela River Basin

Just a conversion of units

Volume = Depth(mm) * Area(# of cells) * 100m^2 * 0.001 m/mm

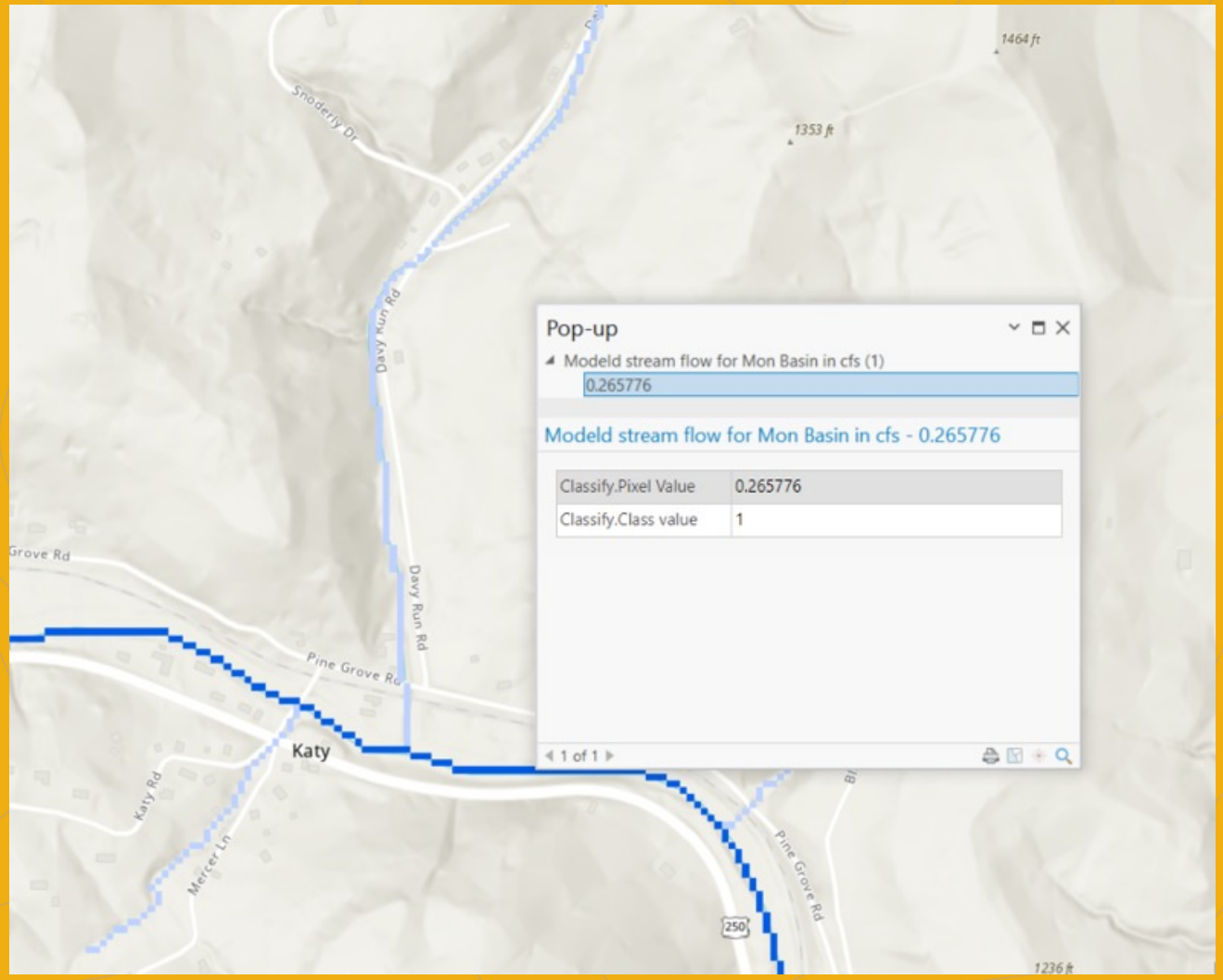
Since our grid cell size is 10m*10m

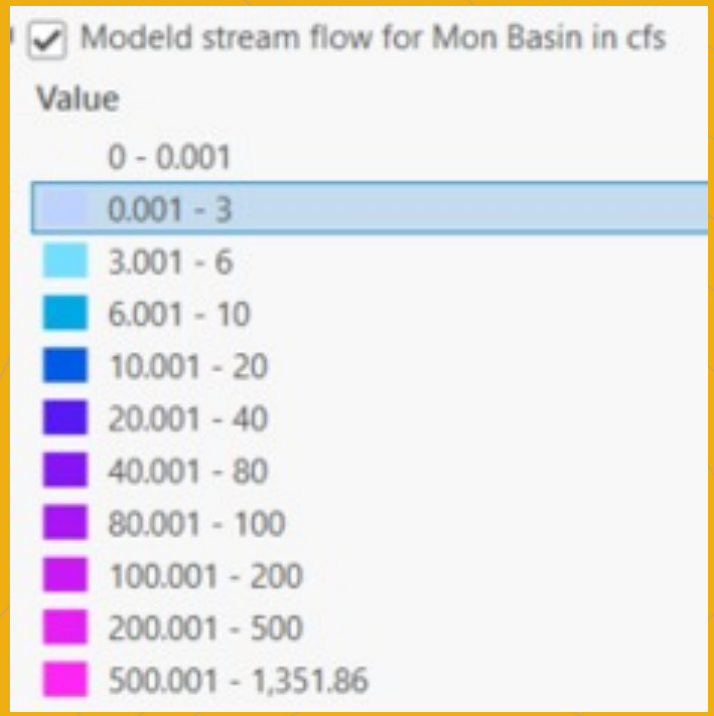
Volume = Depth(mm) * Area(# of cells) * 0.1 m^3/mm

The resulting vol_grid is in m^3/yr

Guage Location Name	Runoff ratio, Q/P	
# USGS 03070500 BIG SANDY CREEK AT ROCKVILLE, WV	0.56	
# USGS 03066000 BLACKWATER RIVER AT DAVIS, WV	0.59	
# USGS 03053500 BUCKHANNON RIVER AT HALL, WV	0.54	
# USGS 03061500 BUFFALO CREEK AT BARRACKVILLE, WV	0.3	
# USGS 03062500 DECKERS CREEK AT MORGANTOWN, WV	0.52	
# USGS 03065000 DRY FORK AT HENDRICKS, WV	0.6	
# USGS 03072000 Dunkard Creek at Shannopin, PA	0.4	
# USGS 03056250 THREE FORK CREEK NR GRAFTON, WV	0.52	
# USGS 03050000 TYGART VALLEY RIVER NEAR DAILEY, WV	0.51	
# USGS 03061000 WEST FORK RIVER AT ENTERPRISE, WV	0.42	
	0.496	average

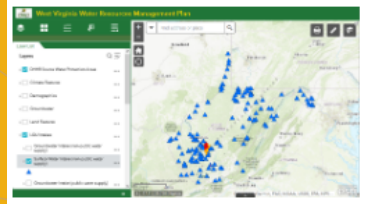
Spatially explicit stream flow modeled output





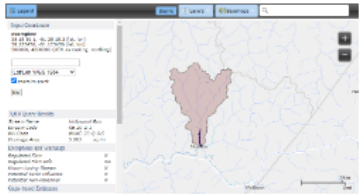
DEP Program Applications

West Virginia Water Resources Management Plan Application



Initially developed by the WVDEP Water Use Section. An application designed in response to the ater Resources Protection and Management Act of 2008 to provide access to information on Large Quantity water users as well as other GIS data layers pertinent to water resource management in the state of West Virginia.

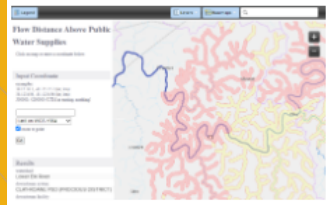
7Q10 Flow Estimates



This application displays calculated flow estimates for streams in the state, based on equations in USGS publications. For more information on the analysis process used to calculate the flow estimates, see here.

Note that this application relies on USGS publications from 2008-2010. The USGS streamstats application is now available and provides a more comprehensive set of estimates.

Flow Distance above public water supplies



Find downstream system name, facility name and flow distance by entering coordinates or clicking on a map. Note that only the nearest facility is reported; other facilities may exist farther downstream. Also note that distance estimates using a grid representation of linear features such as streams can overestimate lengths. Based on this technical note , distances may be overestimated by about 5 percent.

Water Withdraw Tool

This application provides recommendations on whether it is advisable to make water withdraws from streams in the state, depending on real-time flow information from USGS stream gages. Note that this guidance tool is less strict than the water management plans for Oil and Gas Permits. Approved water management plans include safety margins to account for uncertainties related to ungaged streams.

Thank you to our funders:

Colcom Foundation

Any Questions?