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TECHNICAL MEMORANDUM

Date: March 15, 2022

To: Bryan Leamons, Senior Operations Manager

From: Shon Simpson, GBMc & Associates

Re: Flow Calculations and Update of Flows for War Eagle and Holman Creeks.
City of Huntsville NPDES Permit No. AR0022004

As a part of an NPDES permit renewal DEQ performed a reasonable potential (RP) analysis for the City of Huntsville (NPDES Permit No. AR0022004) for minerals to determine if the discharge would cause an exceedance of the new site-specific water quality standards (WQS) in Town Branch or Holman Creek, or the existing domestic water supply criteria (DWSC) in War Eagle Creek. The RP analysis was done using the data shown in Table 1, which resulted showing reasonable potential to exceed the WQS for TDS in Holman Creek and the DWSC in War Eagle Creek.

Table 1: Input data used for City of Huntsville Reasonable Potential Analysis

Parameter	Value	Source
WWTP Design Flow	3.09 cfs	City of Huntsville
WWTP TDS Effluent Concentration	741.8 mg/L	95th Percentile of DMR Data
Background TDS for all streams	143 mg/L	CPP Value for Ozark Highlands
Town Branch Harmonic Mean Flow	0.08 cfs	USGS StreamStats
Town Branch TDS WQS	779 mg/L	Rule 2.511(A)
Holman Creek Harmonic Mean Flow	0.529 cfs	USGS StreamStats
Holman Creek TDS WQS	621 mg/L	Rule 2.511(A)
War Eagle Creek at Holman Creek Confluence 7Q10	0.281 cfs	USGS StreamStats
War Eagle Creek TDS DWSC	500 mg/L	Rule 2.511(A)

In reviewing the flow data, with assistance from USGS, we found that the 7Q10 at War Eagle Creek, upstream of the Holman Creek confluence, was estimated from USGS StreamStats using that used data only through 2005. The StreamsStats calculated harmonic mean flow for Holman Creek upstream from Town Branch used data only through 2015. We also learned that the years omitted from the StreamStats estimates were wetter years than the older data that had been used. USGS noted that there were dry periods in the old data (1953 – 1979) and higher flows in the more recent data (2006 – 2021). USGS recommended that the entire dataset be used for the statistical low flow calculations.

StreamStats computes 7Q10 values and harmonic mean flows for streams without measured flow data using regression analyses based on parameters including drainage area, surficial geology, and base flow indices, but the regressions are not updated with recent years of measured flow data. Therefore, GBMc

updated the 7Q10 at War Eagle Creek and the harmonic mean flow at Holman Creek with full flow datasets through 2021 at War Eagle Creek at Hindsville (USGS 0704900).

Based on StreamStats (data through 2005), the 7Q10 at War Eagle Creek at Hindsville was 2.2 cfs, and the 7Q10 upstream of Holman Creek was 0.28 cfs. Using the entire flow dataset available at War Eagle Creek at Hindsville (1953 – 2021), GBMc updated the 7Q10 to 3.6 cfs. These climatic years include a relatively dry period (1953 – 1970) and a relatively wet period (1998 – 2021). A flow to watershed area approach was then used to estimate the updated 7Q10 at War Eagle Creek upstream from Holman Creek. The Hindsville location has a watershed area of 253 mi^2, resulting in a ratio of 0.014 cfs/mi^2. Multiplying this ratio by the watershed area upstream of Holman Creek (172 mi^2), the updated 7Q10 of War Eagle Creek upstream of Holman Creek is 2.40 cfs. Following the 7Q10 update we contacted USGS for a technical review of our process and calculations. USGS concurred with our procedures and recommended using the entire data set available from the Hindsville Gauge they noted it produced the more reasonable 7Q10 estimate. The analysis done by the USGS in response to our questions regarding the 7Q10 flow for War Eagle Creek is shown in Attachment A.

Based on StreamStats the harmonic mean flow for Holman Creek just upstream of Town Branch is 0.528 cfs and the harmonic mean flow for War Eagle Creek at Hindsville is 25 cfs (data to 2015). The prediction interval for Holman Creek based on StreamStats (data to 2015) is 0.316 – 0.881 cfs. GBMc updated the harmonic mean flow for War Eagle Creek (direct calculation) with flow data through 8/29/2021, which resulted in an increase to 27.947 cfs. The change in harmonic mean flow per watershed area for War Eagle Creek can be calculated as (27.947 cfs - 25 cfs)/ 263 mi^2, which equals a ratio of 0.011 cfs/mi^2. This ratio can then be used to calculate a relative increase in harmonic mean flow at Holman Creek. Using 0.011 cfs/mi^2 * 18.1 mi^2 (i.e., the watershed area of Holman Creek), the change in flow at Holman Creek would be 0.199 cfs. Adding in the StreamStats modeled harmonic mean flow of 0.528 cfs, the updated harmonic mean flow would be 0.727 cfs, which falls within the prediction interval for Holman Creek. During each step and following our updated calculations, we again contacted USGS to evaluate our work.

Insertion of the updated flow values in the table of input parameters for the permit calculations results in the values shown in Table 2.

Table 2. Input parameters for permit calculations, showing updated flows for War Eagle and Holman Creeks.

Parameter	Value	Source
WWTP Design Flow	3.09 cfs	City of Huntsville
WWTP TDS Effluent Concentration	741.8 mg/L	95th Percentile of DMR Data
Background TDS for all streams	143 mg/L	CPP Value for Ozark Highlands
Town Branch Harmonic Mean Flow	0.08 cfs	USGS StreamStats
Town Branch TDS WQS	779 mg/L	Rule 2.511(A)
Holman Creek Harmonic Mean Flow	**0.727 cfs**	USGS StreamStats
Holman Creek TDS WQS	621 mg/L	Rule 2.511(A)
War Eagle Creek at Holman Creek Confluence 7Q10	**2.40 cfs**	USGS StreamStats
War Eagle Creek TDS DWSC	500 mg/L	Rule 2.511(A)

In response to our request the USGS hydrologist noted that he was confident that our approach was good. The email string for the communication with USGS regarding the current harmonic mean flow for Holman Creek upstream from Town Branch is shown in Attachment B.

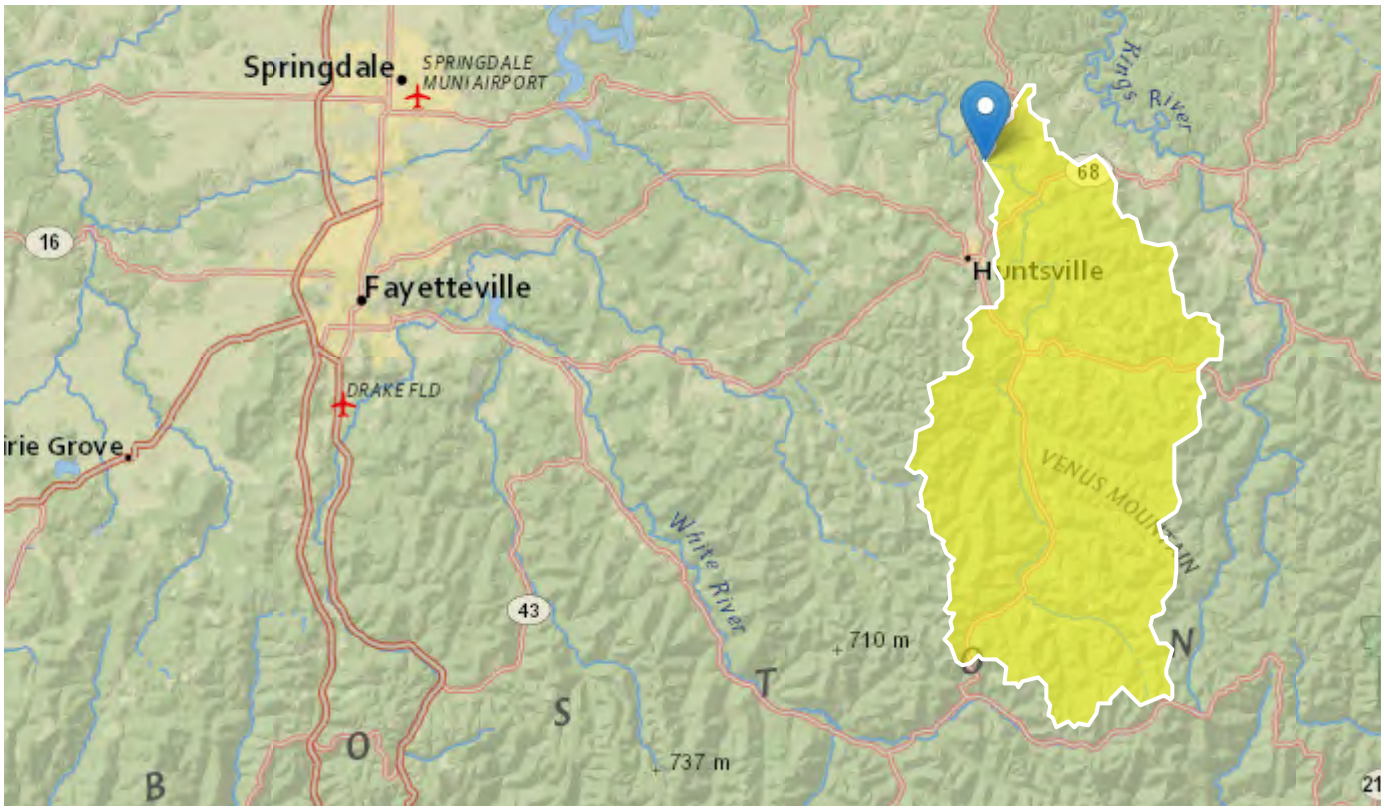
With the updated 7Q10 at War Eagle Creek upstream of Holman Creek and updated harmonic mean flow of Holman Creek upstream of Town Branch, our calculations indicate that the City of Huntsville does not exceed the site-specific WQS in Town Branch or Holman Creek, or DWSC in War Eagle Creek.

Attachment A

USGS 7Q10 War Eagle Creek

War Eagle Creek immediately upstream of confluence with Holman Creek near Huntsville, AR

Region ID: AR
Workspace ID: AR20220202153134763000
Clicked Point (Latitude, Longitude): 36.14060, -93.72975
Time: 2022-02-02 09:31:58 -0600



Prepared for Nicki Johnson, GBM Associates, for comparison with her LP3 analysis of 7Q10 for War Eagle Creek upstream of the confluence with Holman Creek (172 sq mi). Using the 1998-2021 climate years, Nicki estimates 7Q10 = 8 cfs at streamgage 07049000 (253 sq mi). Using 0.0343 cfs / sq mi, 7Q10 = 5.9 cfs at the location of interest (alternatively, applying a drainage area ratio 172/253 = 0.68 yields a similar result of 5.4 cfs). At the location of interest, StreamStats estimates 7Q10 = 0.281 cfs using 1953-2005 climate years. As a check on Nicki's estimate, a provisional LP3 analysis of the 1953-2021 climate years (the entire dataset available at 07049000) estimates 7Q10 = 3.6 cfs (90 % CI 1.9-6.6 cfs). Using 3.6/172 = 0.014 cfs/sq mi yields an estimate of 7Q10 = 2.4 cfs at the location of interest (drainage area ratio 0.68 yields same). Consider 2.4 cfs a more reasonable estimate than 5.9 or 0.281 cfs because it leverages the entire period of record available at a gaged location on the same stream and incorporates data from a relatively dry period (1953-1970) and a relatively wet period (1998-2021). Per the literature, LP3 distribution is acceptable for low-flow analysis. Support Nicki's use of a unique LP3 model to allow for incorporation of additional data April 2005-March 2021, but recommend that the model be updated using the entire period of record available at streamgage 07049000 to achieve the best estimate of 7Q10 possible, given the available data.

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	172	square miles
ORDOMISS	Percent Surficial Geology as Ordovician and Mississippian Rocks	15.2	percent
SOILINDEX	Mean STATSGO Hydrologic Soils Index (from PL. 2 WRIR 03-4107 for WY)	2.59	dimensionless

Parameter Code	Parameter Description	Value	Unit
LOWREG	Low Flow Region Number	1438	dimensionless
TAU_ANN_G	Tau, Average annual base-flow recession time constant as defined in SIR 2008-5065	15	days
PRECIP	Mean Annual Precipitation	49.6	inches
PREMARAPR	Precipitation March-April basin average, mean monthly as defined in SIR 2008-5065	9.24	inches
TRUN0711	Mean annual dry season total runoff, July through November	4.24	inches
PRNOVAPR00	Precipitation November-April basin average, mean seasonal from PRISM 1971-2000	23.6	inches
MARAVPRE	Mean March Precipitation	4.52	inches
NOVAVPRE	Mean November Precipitation	4.24	inches
TAU_WIN_G	Tau, Average base-flow recession time constant for November through December as defined in SIR 2008-5065, estimated from a grid	15	days
PRNOVAPR90	Precipitation November-April basin average, mean seasonal from PRISM 1961-1990	22	inches
PRENOVDEC	Precipitation November-December basin average, mean monthly as defined in SIR 2008-5065	7.82	inches
TAU_SPR_G	Tau, Average base-flow recession time constant for March through April as defined in SIR 2008-5065, estimated from a grid	12	days
LC11PAST	Percentage of area of pasture area from NLCD 2011 class 81	26	percent
UPZ	Percentage of the basin covered by upper Paleozoic strata from Reed & Bush (2005)	100	percent
BSHAPELFP	Basin Shape Factor computed as the square of the longest flow path divided by drainage area	7.665	dimensionless
BFI	Proportion of mean annual flow that is from ground water (base flow)	0.34	dimensionless
PZNSSREGNO	Zeroflow Region Number	1445	dimensionless
ALVM	Percentage of the basin covered by Quaternary alluvial deposits from Reed & Bush (2005)	0	percent
CSL1085ADJ	Adjusted 10-85 slope in feet per mile	13.657	feet per mi

Parameter Code	Parameter Description	Value	Unit
CSL1085LFP	Change in elevation divided by length between points 10 and 85 percent of distance along the longest flow path to the basin divide, LFP from 2D grid	12.5	feet per mi
CSL1085RAW	Unadjusted 10-85 stream slope method in feet per mile.	12.5	feet per mi
CSLBlue	Change in elevation of the longest blue-line stream (not extended to the boundary) divided by stream length	31.6	feet per mi
ELEV	Mean Basin Elevation	1690	feet
HIGHREG	HIGHREG	1718	dimensionless
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	3.81	percent
LC11DVOPN	Percentage of developed open area from NLCD 2011 class 21	3.42	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.33	percent
LFPLENGTH	Length of longest flow path	36.336	miles

Low-Flow Statistics Parameters [Low Flow Region 1 2008 5065]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	12.1	828.5
ORDOMISS	Percent SurficialGeology Ordo and Miss	15.2	percent	0	100
SOILINDEX	Mean Basin Hydrologic Soils Index	2.59	dimensionless	2.5	2.7
LOWREG	Low Flow Region Number	1438	dimensionless		

Low-Flow Statistics Flow Report [Low Flow Region 1 2008 5065]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
7 Day 2 Year Low Flow	1.93	ft^3/s	107

Statistic	Value	Unit	ASEp
7 Day 10 Year Low Flow	0.281	ft^3/s	237

Low-Flow Statistics Citations

Funkhouser, J.E., Eng, Ken, and Moix, M.W.,2008, Low-Flow Characteristics and Regionalization of Low Flow Characteristics for Selected Streams in Arkansas: U. S. Geological Survey Scientific Investigations Report 2008-5065, 161 p. (http://pubs.usgs.gov/sir/2008/5065/pdf/SIR2008-5065.pdf)

Monthly Flow Statistics Parameters [Dry Season Mean Monthly Flow 2015 5031]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	4.1	7350
TRUN0711	Dry Season Total Runoff	4.24	inches	3.6	5.6

Monthly Flow Statistics Parameters [Low Flow Region 1 2008 5065]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	12.1	828.5
ORDOMISS	Percent SurficialGeology Ordo and Miss	15.2	percent	0	100
PRNOVAPR00	Basin Ave Rainfall Nov Apr PRISM 2000	23.6	inches	21.3	26.2
MARAVPRE	Mean March Precipitation	4.52	inches	4.1	5.3
LOWREG	Low Flow Region Number	1438	dimensionless		

Monthly Flow Statistics Flow Report [Dry Season Mean Monthly Flow 2015 5031]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp
July Mean Flow	65.3	ft^3/s	26.3	162	48.1
August Mean Flow	38	ft^3/s	14.2	102	66.3
September Mean Flow	61	ft^3/s	25.1	148	47.8
October Mean Flow	81.8	ft^3/s	31.3	214	46.7
November Mean Flow	176	ft^3/s	64.3	481	43.3

Monthly Flow Statistics Flow Report [Low Flow Region 1 2008 5065]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
Nov 7 Day 10 Year Low Flow	3.02	ft^3/s	133
Dec 7 Day 10 Year Low Flow	4.14	ft^3/s	97
Jan 7 Day 10 Year Low Flow	6.56	ft^3/s	81.6
Feb 7 Day 10 Year Low Flow	14.6	ft^3/s	55.2
Mar 7 Day 10 Year Low Flow	30.4	ft^3/s	58.1
Apr 7 Day 10 Year Low Flow	26.6	ft^3/s	55

Monthly Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp
July Mean Flow	65.3	ft^3/s	26.3	162	48.1
August Mean Flow	38	ft^3/s	14.2	102	66.3
September Mean Flow	61	ft^3/s	25.1	148	47.8
October Mean Flow	81.8	ft^3/s	31.3	214	46.7
November Mean Flow	176	ft^3/s	64.3	481	43.3
Nov 7 Day 10 Year Low Flow	3.02	ft^3/s	133		
Dec 7 Day 10 Year Low Flow	4.14	ft^3/s	97		
Jan 7 Day 10 Year Low Flow	6.56	ft^3/s	81.6		
Feb 7 Day 10 Year Low Flow	14.6	ft^3/s	55.2		
Mar 7 Day 10 Year Low Flow	30.4	ft^3/s	58.1		
Apr 7 Day 10 Year Low Flow	26.6	ft^3/s	55		

Monthly Flow Statistics Citations

Funkhouser, J.E., Eng, Ken, and Moix, M.W.,2008, Low-Flow Characteristics and Regionalization of Low Flow Characteristics for Selected Streams in Arkansas: U. S. Geological Survey Scientific Investigations Report 2008-5065, 161 p. (http://pubs.usgs.gov/sir/2008/5065/pdf/SIR2008-5065.pdf)

Breaker, B.K.,2015, Dry season mean monthly flow and harmonic mean flow regression equations for selected ungaged basins in Arkansas: U.S. Geological Survey Scientific Investigations Report 2015–5031, 25 p. (http://pubs.usgs.gov/sir/2015/5031/)

Seasonal Flow Statistics Parameters [Low Flow Region 1 2008 5065]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	12.1	828.5
ORDOMISS	Percent SurficialGeology Ordo and Miss	15.2	percent	0	100
PRNOVAPR00	Basin Ave Rainfall Nov Apr PRISM 2000	23.6	inches	21.3	26.2
LOWREG	Low Flow Region Number	1438	dimensionless		

Seasonal Flow Statistics Flow Report [Low Flow Region 1 2008 5065]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
Nov to Apr 7 Day 10 Year Low Flow	2.4	ft^3/s	130
Nov to Dec 7 day 10 Year Low Flow	1.43	ft^3/s	130
Jan to Feb 7 Day 10 Year Low Flow	4.96	ft^3/s	82.4
Mar to Apr 7 Day 10 Year Low Flow	17.3	ft^3/s	55.5

Seasonal Flow Statistics Citations

Funkhouser, J.E., Eng, Ken, and Moix, M.W.,2008, Low-Flow Characteristics and Regionalization of Low Flow Characteristics for Selected Streams in Arkansas: U. S. Geological Survey Scientific Investigations Report 2008-5065, 161 p. (http://pubs.usgs.gov/sir/2008/5065/pdf/SIR2008-5065.pdf)

Peak-Flow Statistics Parameters [Peak Region C 2016 5081]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	0.09	2050
LC11PAST	Percent_Pasture_from_NLCD2011	26	percent	0	87.6
UPZ	Percent_Upper_Paleozoic	100	percent	0	100
BSHAPELFP	Basin Shape Factor, Longest flow path method	7.665	dimensionless	1.97	15.1

Peak-Flow Statistics Flow Report [Peak Region C 2016 5081]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp
50-percent AEP flood	9390	ft^3/s	4180	21100	42
20-percent AEP flood	18600	ft^3/s	9330	37100	38
10-percent AEP flood	26600	ft^3/s	14100	50300	37
4-percent AEP flood	38500	ft^3/s	20500	72400	36
2-percent AEP flood	48700	ft^3/s	25400	93300	35
1-percent AEP flood	59700	ft^3/s	30300	118000	35
0.2-percent AEP flood	88900	ft^3/s	43100	184000	37

Peak-Flow Statistics Citations

Wagner, D.M., Krieger, J.D., and Veilleux, A.G.,2016, Methods for estimating annual exceedance probability discharges for streams in Arkansas, based on data through water year 2013: U.S. Geological Survey Scientific Investigations Report 2016–5081, 136 p. (http://dx.doi.org/10.3133/sir20165081)

General Flow Statistics Parameters [Harmonic Mean Flow Region 2 2015 5031]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	4.1	2090
BFI	Base Flow Index	0.34	dimensionless	0.1	0.4
ORDOMISS	Percent SurficialGeology Ordo and Miss	15.2	percent	0	100

General Flow Statistics Flow Report [Harmonic Mean Flow Region 2 2015 5031]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp
Harmonic Mean Streamflow	5.77	ft^3/s	3.6	9.26	76.6

General Flow Statistics Citations

Breaker, B.K.,2015, Dry season mean monthly flow and harmonic mean flow regression equations for selected ungaged basins in Arkansas: U.S. Geological Survey Scientific Investigations Report 2015–5031, 25 p. (http://pubs.usgs.gov/sir/2015/5031/)

Bankfull Statistics Parameters [Interior Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	30.1158	959.0724

Bankfull Statistics Parameters [Ozark Plateaus P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	109.99989	958.99518

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Interior Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	159	ft
Bieger_D_channel_depth	4.51	ft
Bieger_D_channel_cross_sectional_area	716	ft^2

Bankfull Statistics Flow Report [Ozark Plateaus P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	143	ft
Bieger_P_channel_depth	3.68	ft
Bieger_P_channel_cross_sectional_area	485	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	75.8	ft
Bieger_USA_channel_depth	3.61	ft
Bieger_USA_channel_cross_sectional_area	275	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	159	ft
Bieger_D_channel_depth	4.51	ft
Bieger_D_channel_cross_sectional_area	716	ft^2
Bieger_P_channel_width	143	ft
Bieger_P_channel_depth	3.68	ft
Bieger_P_channel_cross_sectional_area	485	ft^2
Bieger_USA_channel_width	75.8	ft
Bieger_USA_channel_depth	3.61	ft
Bieger_USA_channel_cross_sectional_area	275	ft^2

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_can

Probability Statistics Parameters [Pzero Flow Region 1 2008 5065]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	172	square miles	12.1	829
TAU_ANN_G	Tau Annual from Grid	15	days	5.5	26.7
ORDOMISS	Percent SurficialGeology Ordo and Miss	15.2	percent	0	100
PZNSSREGNO	Prob zero flow region number	1445	dimensionless		

Probability Statistics Flow Report [Pzero Flow Region 1 2008 5065]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PC
Probability zero flow 7Day	0.00155	dim	91.5

Statistic	Value	Unit	PC
Probability zero flow 7 day Nov to Apr	0.00148	dim	96.4
Probability zero flow 7 day Nov to Dec	0.00113	dim	98.2
Probability zero flow 7 day Nov	0.00116	dim	96.4

Probability Statistics Citations

Funkhouser, J.E., Eng, Ken, and Moix, M.W.,2008, Low-Flow Characteristics and Regionalization of Low Flow Characteristics for Selected Streams in Arkansas: U. S. Geological Survey Scientific Investigations Report 2008-5065, 161 p. (http://pubs.usgs.gov/sir/2008/5065/pdf/SIR2008-5065.pdf)

Application Version: 4.6.2
StreamStats Services Version: 1.2.22
NSS Services Version: 2.1.2

Attachment B

Email Correspondence Holman Creek Harmonic Mean Flow

Nicki Johnson

From: Wagner, Daniel M <dwagner@usgs.gov>
Sent: Friday, February 11, 2022 3:00 PM
To: Nicki Johnson; Abbie Lasater
Cc: Shon Simpson
Subject: Re: [EXTERNAL] FW: Holman Creek Flow
Attachments: sir2015-5031.pdf

Nicki and Abbie,

Great to talk with you both. I'm confident you've got a good approach for your sites of interest. Attached is the .pdf of Breaker's Harmonic Mean Flows report. And the link, in case you need it for a reference.

Don't hesitate to contact me anytime if you need anything USGS-related.

https://pubs.usgs.gov/sir/2015/5031/pdf/sir2015-5031.pdf

Have a great weekend,
Dan

Dan Wagner
Hydrologist
U.S. Geological Survey
Lower Mississippi-Gulf Water Science Center
Fayetteville, AR office
700 W Research Center Blvd
Fayetteville, AR 72701
(501) 553-5410

From: Wagner, Daniel M <dwagner@usgs.gov>
Sent: Friday, February 11, 2022 11:58 AM
To: Nicki Johnson <Njohnson@gbmcassoc.com>; Abbie Lasater <alasater@gbmcassoc.com>
Cc: Shon Simpson <ssimpson@gbmcassoc.com>
Subject: Re: [EXTERNAL] FW: Holman Creek Flow

Nicki,

Happy to have a call at 2:30 (or later) to follow up. Please send me a meeting invite for your preferred time.

Dan Wagner
Hydrologist
U.S. Geological Survey
Lower Mississippi-Gulf Water Science Center
Fayetteville, AR office
700 W Research Center Blvd
Fayetteville, AR 72701

Nicki Johnson

From: Wagner, Daniel M <dwagner@usgs.gov>
Sent: Friday, February 11, 2022 11:07 AM
To: Abbie Lasater
Cc: Shon Simpson; Nicki Johnson
Subject: Re: [EXTERNAL] FW: Holman Creek Flow

Abbie,

Good morning! You're welcome, happy to do so.

It's funny you bring this up; I had called Nicki earlier and left a voicemail. My reason for calling was that I had a similar thought last night after thinking on this a bit more. Applying a relative increase is more defensible than my initial recommendation. Alternatively to your cfs/sq mi approach, you could consider this in the context of a 12% relative increase to the harmonic mean flow computed for War Eagle Creek at the gage [(27.9-25)/25], which when applied to Holman Creek yields an adjusted harmonic mean flow of 0.591 cfs. Applying either adjustment seems reasonable, given that these sites are in the same harmonic mean flow region. Your estimate of harmonic mean flow (0.727 cfs) is about 23% greater than 0.591 cfs. Given their small magnitudes, these flows are essentially within measurement error of each other and measuring such flows pushes the low end of the operational limits of a current meter. Both flows are within the prediction interval of the harmonic mean flow for Holman Creek (0.316-0.881). I think either approach is valid, but your cfs/sq mi approach is consistent with your work at the other location of interest on War Eagle Creek upstream of Holman Creek. It's about the best you can do at this location to incorporate additional period of record at the nearest gaged location on War Eagle Creek.

Hope this helps with your decision. Please let me know if you have more questions.

Best regards to you all,
Dan

Dan Wagner
Hydrologist
U.S. Geological Survey
Lower Mississippi-Gulf Water Science Center
Fayetteville, AR office
700 W Research Center Blvd
Fayetteville, AR 72701
(501) 553-5410

From: Abbie Lasater <alasater@gbmcassoc.com>
Sent: Friday, February 11, 2022 10:24 AM
To: Wagner, Daniel M <dwagner@usgs.gov>
Cc: Shon Simpson <ssimpson@gbmcassoc.com>; Nicki Johnson <Njohnson@gbmcassoc.com>
Subject: RE: [EXTERNAL] FW: Holman Creek Flow

Dan,

Thanks for chatting with us yesterday. Your help is greatly appreciated! We gave the calculation a little more thought, and we wanted to see if the attached would be a valid approach for updating the harmonic mean flow at Holman Creek.

If you'd like to set up another call to discuss, let us know.

Thanks,
Abbie

Abbie Lasater, Ph.D, EIT.
Enivronmental Engineer

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From: Wagner, Daniel M <dwagner@usgs.gov>
Sent: Thursday, February 10, 2022 4:28 PM
To: Nicki Johnson <Njohnson@gbmcassoc.com>
Cc: Shon Simpson <ssimpson@gbmcassoc.com>; Abbie Lasater <alasater@gbmcassoc.com>
Subject: Re: [EXTERNAL] FW: Holman Creek Flow

Nicki and Abbie,

It was good to chat with you both. Hope the approach I described makes sense, and if you have any questions at all, don't hesitate to get in touch. And for the future, Teams is fine, that's our preferred platform. I don't know if you can ping me directly (probably not), but you can send me a meeting invite.

Best of luck with the project,
Dan

Dan Wagner
Hydrologist
U.S. Geological Survey
Lower Mississippi-Gulf Water Science Center
Fayetteville, AR office
700 W Research Center Blvd
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(501) 553-5410

From: Nicki Johnson <Njohnson@gbmcassoc.com>
Sent: Thursday, February 10, 2022 3:53 PM
To: Wagner, Daniel M <dwagner@usgs.gov>
Cc: Shon Simpson <ssimpson@gbmcassoc.com>; Abbie Lasater <alasater@gbmcassoc.com>
Subject: RE: [EXTERNAL] FW: Holman Creek Flow

Attachment to Abbie Lasater's email sent Friday February 11, 2022 10:24 AM

Based on StreamStats (data to 2015), the harmonic mean flow for Holman Creek just upstream of Town Branch is 0.528 cfs and the harmonic mean flow for War Eagle Creek (USGS 07049000) is 25 cfs. The harmonic mean flow for War Eagle Creek is calculated from flow data through 9/30/2015, while the harmonic mean flow for Holman Creek is calculated from USGS regression analyses based on parameters including drainage area, surficial geology, and base flow indices. The prediction interval for Holman Creek based on Streamstats (data to 2015) is 0.316 – 0.881 cfs.

GBMc updated the harmonic mean flow for War Eagle Creek (direct calculation) with flow data through 8/29/2021, which resulted in an increase to 27.947 cfs. The change in harmonic mean flow per watershed area for War Eagle Creek can be calculated as (27.947 cfs - 25 cfs)/ 263 sq mi, which equals a ratio of 0.011 cfs/sq mi. This ratio can then be used to calculate a relative increase in harmonic mean flow at Holman Creek. Using 0.011 cfs/sq mi * 18.1 sq mi (i.e., the watershed area of Holman Creek), the change in flow at Holman Creek would be 0.199 cfs. Adding in the StreamStats modeled harmonic mean flow of 0.528 cfs, the updated harmonic mean flow would be 0.727 cfs, which falls within the prediction interval for Holman Creek.

Yea this afternoon works for us, can we call the number listed in your email or want to set up a teams call?

Nicki Johnson
Environmental Scientist

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From: Wagner, Daniel M <dwagner@usgs.gov>
Sent: Thursday, February 10, 2022 3:34 PM
To: Nicki Johnson <Njohnson@gbmcassoc.com>
Cc: Shon Simpson <ssimpson@gbmcassoc.com>; Abbie Lasater <alasater@gbmcassoc.com>
Subject: Re: [EXTERNAL] FW: Holman Creek Flow

Nicki,

Good afternoon! Happy to have a call with you and Abbie. I've got time this afternoon if that works. Tomorrow I am booked from 10am -2pm, but could talk after that if tomorrow is better for you.

Dan Wagner
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From: Nicki Johnson <Njohnson@gbmcassoc.com>
Sent: Thursday, February 10, 2022 12:01 PM
To: Wagner, Daniel M <dwagner@usgs.gov>
Cc: Shon Simpson <ssimpson@gbmcassoc.com>; Abbie Lasater <alasater@gbmcassoc.com>
Subject: RE: [EXTERNAL] FW: Holman Creek Flow

A couple days answer is quick! Thanks for looking into it for us. We have a question or two we'd like to discuss that we're a little fuzzy on. Do you think we could schedule a call to discuss? It would be me and Abbie Lasater on the call. The only time we can't meet is tomorrow from 8:30-9:30.

Thanks,

Nicki Johnson
Environmental Scientist

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From: Wagner, Daniel M <dwagner@usgs.gov>
Sent: Wednesday, February 9, 2022 1:12 PM
To: Nicki Johnson <Njohnson@gbmcassoc.com>
Cc: Shon Simpson <ssimpson@gbmcassoc.com>
Subject: Re: [EXTERNAL] FW: Holman Creek Flow

Nicki and Shon,

Good morning. Sorry to take a couple days to get back with you. Regarding the harmonic mean flows, that regression model was developed using data through 9/30/2015 (per the StreamStats page for the War Eagle Creek gage, 07049000). It uses 10 more years of data than was used in the low-flow report. So, a more up-to-date model.

Please reference the attached StreamStats report with my thoughts on your proposed cfs/sq mi adjustment. In short, a cfs/sq mi adjustment to a harmonic mean flow at the gage that incorporates additional data through present but is then adjusted using cfs/sq mi computed at your other site of interest on War Eagle Creek just upstream of Holman Creek (5.77/172=0.0335), may be valid if it compares favorably with the predicted harmonic mean flow at the location of interest on Holman Cr (0.528 cfs). The value would need to be within the prediction interval (0.316-0.881 cfs). I would be interested to see what you come up with. Otherwise, I suggest using the harmonic mean flow estimated using StreamStats.

Hope this helps, and don't hesitate to reach out if you have more questions!

Best regards,
Dan

Dan Wagner
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From: Nicki Johnson <Njohnson@gbmcassoc.com>
Sent: Monday, February 7, 2022 12:08 PM
To: Wagner, Daniel M <dwagner@usgs.gov>

Cc: Shon Simpson <ssimpson@gbmcassoc.com>
Subject: [EXTERNAL] FW: Holman Creek Flow

Dan,

Hope you had a good weekend. We have another question pertaining to that same project that Shon poses in the email below. The location that is referred to is Holman Creek at lat: 36.118012° long: -93.736454°. Feel free to call us to discuss.

Thank you,

Nicki Johnson
Environmental Scientist

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From: Shon Simpson <ssimpson@gbmcassoc.com>
Sent: Monday, February 7, 2022 11:29 AM
To: Nicki Johnson <Njohnson@gbmcassoc.com>
Subject: Holman Creek Flow

Nicki,

In going through the flows that DEQ used in calculation of Huntsville TDS limits I see that they cited using Stream Stats to estimate a harmonic mean flow for Holman Creek (an ungauged stream) just upstream of the confluence with Town Branch Creek. Given that we now understand Stream Stats to use only data up to 2005 could you reach back out to Dan to find out if using the same approach on Holman Creek upstream from Town Branch that was used on War Eagle Creek be appropriate. The differences between to two stations would be that Holman is ungauged and a tributary of War Eagle Creek instead of on War Eagle Creek.

Would it be as simple as calculating the harmonic mean flow using the entire dataset for WEC at Hindsville, developing a harmonic mean flow per square mile multiplying that value by the watershed size of Holman Creek just upstream of Town Branch Creek?

Thanks.

Shon

Shon Simpson
Principal

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