



4955 Steubenville Pke Ste 305, Pittsburgh PA 15205 • Phone: (412) 446-1728
E-mail: rettew@rettew.com • Web site: rettew.com

FILED

We answer to you.

Engineers
Planners
Surveyors
Landscape Architects
Environmental Consultants

2014 FEB 27 PM 3:01

BETH A. ROGERS
COUNTY CLERK
DODDRIDGE COUNTY, WV

February 26, 2014

Mr. Ralph Sandora
Doddridge County Commissioner / Floodplain Manager
Doddridge County Courthouse
118 East Court Street
West Union, WV 26456
304-873-2631

RE: SMI-31 Well Pad
Floodplain Permit Application Submission
New Milton Tax District, Doddridge County, WV
RETTEW Project No. 092612019

Dear Mr. Sandora:

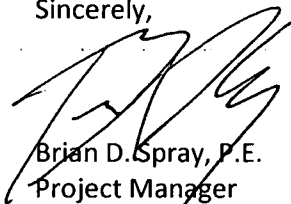
On behalf of EQT Production Company; RETTEW Associates, Inc. is pleased to submit the enclosed permit submission referenced above. Included with this submission are the following:

- Floodplain Development Permit Application
- Location Map showing the site on USGS mapping
- Floodplain Study with site plans included

A gravel well pad and related infrastructure will be constructed within the Douglascamp Run watershed. The proposed development is not located in the floodplain as shown in the floodplain study included with this submission.

If you have any questions or require clarification regarding this submission, please do not hesitate to contact me at 412-446-1728 or via email at bspray@rettew.com.

Sincerely,



Brian D. Spray, P.E.
Project Manager

Enclosures

copy: Megan Landfried, EQT Production Company
File

\\CHOWDER\Share\Projects\09261\092612019\LD\Permits\Doddridge Floodplain\LTR-Submit-Doddridge Floodplain 2014-02-26.docx



FLOODPLAIN STUDY

FOR

SMI31 Well Pad

**DODDRIDGE COUNTY, WEST VIRGINIA
PROJECT NO. 092612019**

Prepared by:

**RETTEW ASSOCIATES, INC.
4955 Steubenville Pike; Suite 305
Pittsburgh, PA 15205**

December 13, 2013

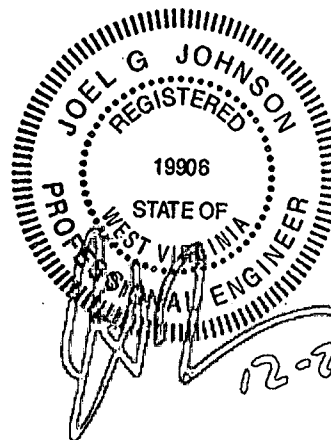


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BACKGROUND

On behalf of EQT Production Company, RETTEW has prepared a Floodplain study of the area of Douglasscamp Run denoted as Zone 'A' on the FEMA mapping (Attachment 3) to demonstrate compliance with the Doddridge County Floodplain Ordinance. The proposed project encompasses the construction of a natural gas well pad, flowback pit, and access road. The center of the proposed well pad is at Latitude 39.264064, Longitude -80.718445. The enclosed mapping indicates the proposed project location (Attachment 2)

There is no proposed encroachment into the floodplain. The purpose of this study is to provide proof that the project is beyond the actual floodplain.

FLOODPLAIN STUDY

HYDROLOGY

Douglasscamp Run flows generally from North of the property in a South Southwest direction to State Route 18 and finally to Meathouse Fork. The flow utilized for this flood study was computed using the equations developed in the USGS report *Estimation of Flood-Frequency Discharges for Rural, Unregulated Streams in West Virginia*. A 100-year flow of 448 cfs was used for the floodplain study. A watershed map showing the drainage area from the USGS mapping is included herein. (Attachment 1)

HYDRAULICS

The Corps of Engineers' HEC-RAS computer program, version 4.1, was utilized to establish water surface elevations for the 100-year flow. The average starting slopes for normal depth calculations were obtained from the topographical survey of the area.

The HEC-RAS cross sections and culvert (labeled as bridge in the HEC-RAS model) for the study were obtained from the 2-foot contour generated by topographical survey.

The HEC-RAS summary table is provided on the next page; however the key elements are listed below.

Cross Section Water Surface Elevation Summary

Cross Section	Flow	WSE	Change in WSE
7	448.00	824.56	
6	448.00	820.28	0
5	448.00	818.10	0
4	448.00	815.88	0
3	448.00	815.77	0
2	448.00	812.95	0
1	448.00	813.00*	0

*Value taken from FEMA study of Meathouse Fork

#14-133
EQT = SM131 Well
Pad

DODDRIDGE COUNTY FLOODPLAIN DEVELOPMENT PERMIT APPLICATION

SECTION 1: GENERAL PROVISIONS (APPLICANT TO READ AND SIGN)

1. No work may start until a permit is issued.
2. The permit may be revoked if any false statements are made herein.
3. If revoked, all work must cease until permit is re-issued.
4. Development shall not be used or occupied until a Certificate of Compliance is issued.
5. The permit will expire if no work is commenced within six months of issuance.
6. Applicant is hereby informed that other permits may be required to fulfill local, state, and federal requirements.
7. Applicant hereby gives consent to the Floodplain Administrator/Manager or his/her representative to make inspections to verify compliance.
8. **I THE APPLICANT CERTIFY THAT ALL STATEMENTS HEREIN AND IN ATTACHMENTS TO THIS APPLICATION ARE, TO THE BEST OF MY KNOWLEDGE, TRUE AND ACCURATE.**

APPLICANT'S SIGNATURE Megan S. Jorgensen
DATE 2/25/14

SECTION 2: PROPOSED DEVELOPMENT (TO BE COMPLETED BY APPLICANT).

IF THE APPLICANT IS NOT A NATURAL PERSON, THE NAME, ADDRESS, AND TELEPHONE NUMBER OF A NATURAL PERSON WHO SHALL BE APPOINTED BY THE APPLICANT TO RECEIVE NOTICE PURSUANT TO ANY PROVISION OF THE CURRENT DODDRIDGE COUNTY FLOODPLAIN ORDINANCE.

APPLICANT'S NAME: Megan Landfried
Timothy Groves, EQT Production Company
ADDRESS: 115 Professional Place, Bridgeport, WV 26330
TELEPHONE NUMBER: 304-848-0087

CONTRACTOR NAME: _____
ADDRESS: _____
TELEPHONE # _____
WV CONTRACTOR LICENCE # _____

ENGINEER'S NAME: Brian Spray, RETTEW Associates Inc
ADDRESS: 4955 Steubenville Pike, Suite 305, Pittsburgh, PA 15205
TELEPHONE NUMBER: 412-446-1728

PROJECT LOCATION:

NAME OF SURFACE OWNER/OWNERS (IF NOT THE APPLICANT) _____
Ronald G. Barnes & Donald Barnes

ADDRESS OF SURFACE OWNER/OWNERS (IF NOT THE APPLICANT) _____
181 Smith Lane, Howard, PA 16841

DISTRICT: New Milton

LAND BOOK DESCRIPTION: _____

DEED BOOK REFERENCE: Book 277 Page 653 & Book 277 Page 657

TAX MAP REFERENCE: 6-1-10

EXISTING BUILDINGS/USES OF PROPERTY: The subject parcel contains no buildings/Agriculture

NAME OF AT LEAST ONE ADULT RESIDING IN EACH RESIDENCE LOCATED UPON THE SUBJECT PROPERTY The subject parcel contains no buildings.

ADDRESS OF AT LEAST ONE ADULT RESIDING IN EACH RESIDENCE LOCATED UPON THE SUBJECT PROPERTY The subject parcel contains no buildings.

To avoid delay in processing the application, please provide enough information to easily identify the project location.

Near Blandville, North of SR18 Intersection with Douglass Run Road (CR 18/5) N 39.264064, W 80.718455

DESCRIPTION OF WORK (CHECK ALL APPLICABLE BOXES)

A. STRUCTURAL DEVELOPMENT

<u>ACTIVITY</u>	<u>STRUCTURAL TYPE</u>
<input type="checkbox"/> New Structure	<input type="checkbox"/> Residential (1 – 4 Family)
<input type="checkbox"/> Addition	<input type="checkbox"/> Residential (more than 4 Family)
<input type="checkbox"/> Alteration	<input type="checkbox"/> Non-residential (floodproofing)
<input type="checkbox"/> Relocation	<input type="checkbox"/> Combined Use (res. & com.)
<input type="checkbox"/> Demolition	<input type="checkbox"/> Replacement
<input type="checkbox"/> Manufactured/Mobil Home	

B. OTHER DEVELOPMENT ACTIVITIES:

- Fill Mining Drilling Pipelining
 Grading
 Excavation (except for STRUCTURAL DEVELOPMENT checked above)
 Watercourse Alteration (including dredging and channel modification)
 Drainage Improvements (including culvert work)
 Road, Street, or Bridge Construction
 Subdivision (including new expansion)
 Individual Water or Sewer System
 Other (please specify)
Horizontal Well Development
-

C. STANDARD SITE PLAN OR SKETCH

1. **SUBMIT ALL STANDARD SITE PLANS, IF ANY HAVE BEEN PREPARED (ENGINEERING PLANS MUST BE SIGNED AND SEALED).**
2. **IF STANDARD SITE PLANS HAVE NOT BEEN PREPARED:**
SKETCH ON A SEPARATE 8 ½ X 11 INCH SHEET OF PAPER THE SHAPE AND LOCATION OF THE LOT. SHOW THE LOCATION OF THE INTENDED CONSTRUCTION OR LAND USE INDICATING BUILDING SETBACKS, SIZE & HEIGHT. IDENTIFY EXISTING BUILDINGS, STRUCTURES OR LAND USES ON THE PROPERTY.
3. **SIGN AND DATE THE SKETCH.**

**ACTUAL TOTAL CONSTRUCTION COSTS OF THE COMPLETE DEVELOPMENT/
PROPOSED CONSTRUCTION PROJECT WITHIN THE FLOODPLAIN**

\$ 0 _____

D. ADJACENT AND/OR AFFECTED LANDOWNERS:

- 1. NAME AND ADDRESS OF ALL OWNERS OF SURFACE TRACTS ADJACENT TO THE AREA OF THE SURFACE TRACT (UP & DOWN STREAM) UPON WHICH THE PROPOSED ACTIVITY WILL OCCUR AND ALL OTHER SURFACE OWNERS UP & DOWN STREAM) WHO OWN PROPERTY THAT MAY BE AFFECTED BY FLOODING AS IS DEMONSTRATED BY A FLOODPLAIN STUDY OR SURVEY (IF ONE HAS BEEN COMPLETED.**

NAME: Homer L. & Delores Weekley (6-3-4.2)

ADDRESS: HC 68 Box 16B
West Union, WV 26456

NAME: Davis G. & Victoria L. Bland (6-3-4)

ADDRESS: 3889 WV RT 18 S
West Union, WV 26456

NAME: Thurman & Virginia Osborne Bailey (6-3-3)

ADDRESS: RT 1 Box 730
Greenwood, WV 26415

NAME: Fern A. Shepard (6-3-2)

ADDRESS: 5188 Long Run Road
Pennsboro, WV 26415

- 1. NAME AND ADDRESS OF AT LEAST ONE ADULT RESIDING IN EACH RESIDENCE LOCATED UPON ANY ADJACENT PROPERTY AT THE TIME THE FLOODPLAIN PERMIT APPLICATION IS FILED AND THE NAME AND ADDRESS OF AT LEAST ONE ADULT RESIDING IN ANY HOME ON ANY PROPERTY THAT MAY BE AFFECTED BY FLOODING AS IS DEMONSTRATED BY A FLOODPLAIN STUDY OR SURVEY.**

NAME: Homer L. & Delores Weekley (6-3-4.2)

ADDRESS: HC 68 Box 16B
West Union, WV 26456

NAME: Davis G. & Victoria L. Bland (6-3-4)

ADDRESS: 3889 WV RT 18S
West Union, WV 26456

E. CONFIRMATION FORM

THE APPLICANT ACKNOWLEDGES, AGREES, AND CONFIRMS THAT HE/IT WILL PAY WITHIN 30 DAYS OF RECEIPT OF INVOICE BY THE COUNTY FOR ALL EXPENSES RELATIVE TO THE PERMIT APPLICATION PROCESS GREATER THAN THE REQUIRED DEPOSIT FOR EXPENSES INCLUDING:

- (A) PERSONAL SERVICE OF PROCESS BY THE DODDRIDGE COUNTY SHERIFF AT THE RATES PERMITTED BY LAW FOR SUCH SERVICE.
- (B) SERVICE BY CERTIFIED MAIL RETURN RECEIPT REQUESTED.
- (C) PUBLICATION.
- (D) COURT REPORTING SERVICES AT ANY HEARINGS REQUESTED BY THE APPLICANT.

(E) CONSULTANTS AND/OR HEARING EXPERTS UTILIZED BY DODDRIDGE COUNTY FLOODPLAIN ADMINISTRATOR/MANAGER OR FLOODPLAIN APPEALS BOARD FOR REVIEW OF MATERIALS AND/OR TESTIMONY REGARDING THE EFFICACY OF GRANTING OR DENYING THE APPLICANT'S FLOODPLAIN PERMIT.

NAME (PRINT): _____

SIGNATURE: Ralph Darden DATE: 2-28-14

After completing SECTION 2, APPLICANT should submit form and fees to Clerk of Doddridge County Court or his/her representative for review.

SECTION 3: FLOODPLAIN DETERMINATION (to be completed by Floodplain Administrator/Manager or his/her representative)

THE PROPOSED DEVELOPMENT:

THE PROPOSED DEVELOPMENT IS LOCATED ON:

FIRM Panel: _____

Dated: _____

Is **NOT** located in a Specific Flood Hazard Area (Notify applicant that the application review is complete and **NO FLOODPLAIN DEVELOPMENT PERMIT IS REQUIRED**).

Is located in Special Flood Hazard Area.

FIRM zone designation _____

100-Year flood elevation is _____ NGVD.

Stream name _____

Profile # _____

Unavailable

The proposed development is located in a floodway.

See section 4 for additional instructions.

SIGNED _____

DATE _____

**SECTION 4: ADDITIONAL INFORMATION REQUIRED FOR DEVELOPMENT IN
SPECIAL FLOOD HAZARD AREA (To be completed by Floodplain
Administrator/Manager or his/her representative)**

The applicant must submit the documents checked below before the application can be processed.

- A plan showing the location of all existing structures, water bodies, adjacent roads and proposed development.
- Development plans, drawn to scale, and specifications, including where applicable: details for anchoring structures, storage tanks, proposed elevation of lowest floor, (including basement or crawl space), types of water resistant materials used below the first floor, details of flood proofing of utilities located below the first floor and details of enclosures below the first floor. Also _____

- Subdivision or other development plans (If the subdivision or development exceeds 10 lots or 2 acres, whichever is the lesser, the applicant must provide 100-year flood elevations if they are not otherwise available).
- Plans showing the extent of watercourse relocation and/or landform alterations.
- Top of new fill elevation _____ Ft. NGVD.
For floodproofing structures applicant must attach certification from registered engineer or architect.
- Certification from a registered engineer that the proposed activity in a regulatory floodway will not result in any increase in the height of the 100-year flood. A copy of all data and calculations supporting this finding must also be submitted.
- Manufactured homes located in a Flood Hazard Area must have a West Virginia Contractor's License and a Manufactured Home Installation License as required by the Federal Emergency Management Agency (FEMA).
- Other: _____

SECTION 5: PERMIT DETERMINATION (To be completed by Floodplain

Administrator/Manager or his/her representative)

I have determined that the proposed activity (type is or is not) in conformance with provisions of the Floodplain Ordinance adopted by the County Commission of Doddridge County on May 21, 2013. The permit is issued subject to the conditions attached to and made part of this permit.

SIGNED _____ DATE _____

If the Floodplain Administrator/Manager found that the above was not in conformance with the provisions of the Doddridge County Floodplain Ordinance and/or denied that application, the applicant may appeal.

APPEALS: Appealed to the County Commission of Doddridge County? Yes No
Hearing Date: _____
County Commission Decision - Approved Yes No

CONDITIONS: _____

SECTION 6: AS-BUILT ELEVATIONS (To be submitted by APPLICANT before Certificate of Compliance is issued).

The following information must be provided for project structures. This section must be completed by a registered professional engineer or a licensed land surveyor (or attach a certification to this application).

COMPLETE 1 OR 2 BELOW:

- 1 Actual (As-Built) Elevation of the top of the lowest floor (including basement or crawl space is _____ FT. NGVD.
- 2 Actual (As Built) elevation of floodproofing is _____ FT. NGVD.

Note: Any work performed prior to submittal of the above information is at risk of the applicant.

SECTION 7: COMPLIANCE ACTION (To be completed by the Floodplain Administrator/Manager or his/her representative).

The Floodplain Administrator/Manager or his/her representative will complete this section as applicable based on inspection of the project to ensure compliance with the Doddridge County Floodplain Ordinance.

INSPECTIONS:

DATE: _____ BY: _____
DEFICIENCIES ? Y/N

COMMENTS _____

SECTION 8: CERTIFICATE OF COMPLIANCE (To be completed by Floodplain Administrator/Manager or his/her representative).

Certificate of Compliance issued: DATE: _____ BY: _____

**CERTIFICATE OF COMPLIANCE
FOR DEVELOPMENT IN SPECIAL FLOOD HAZARD AREA
(OWNER MUST RETAIN)**

PERMIT NUMBER: _____

PERMIT DATE: _____

PURPOSE –

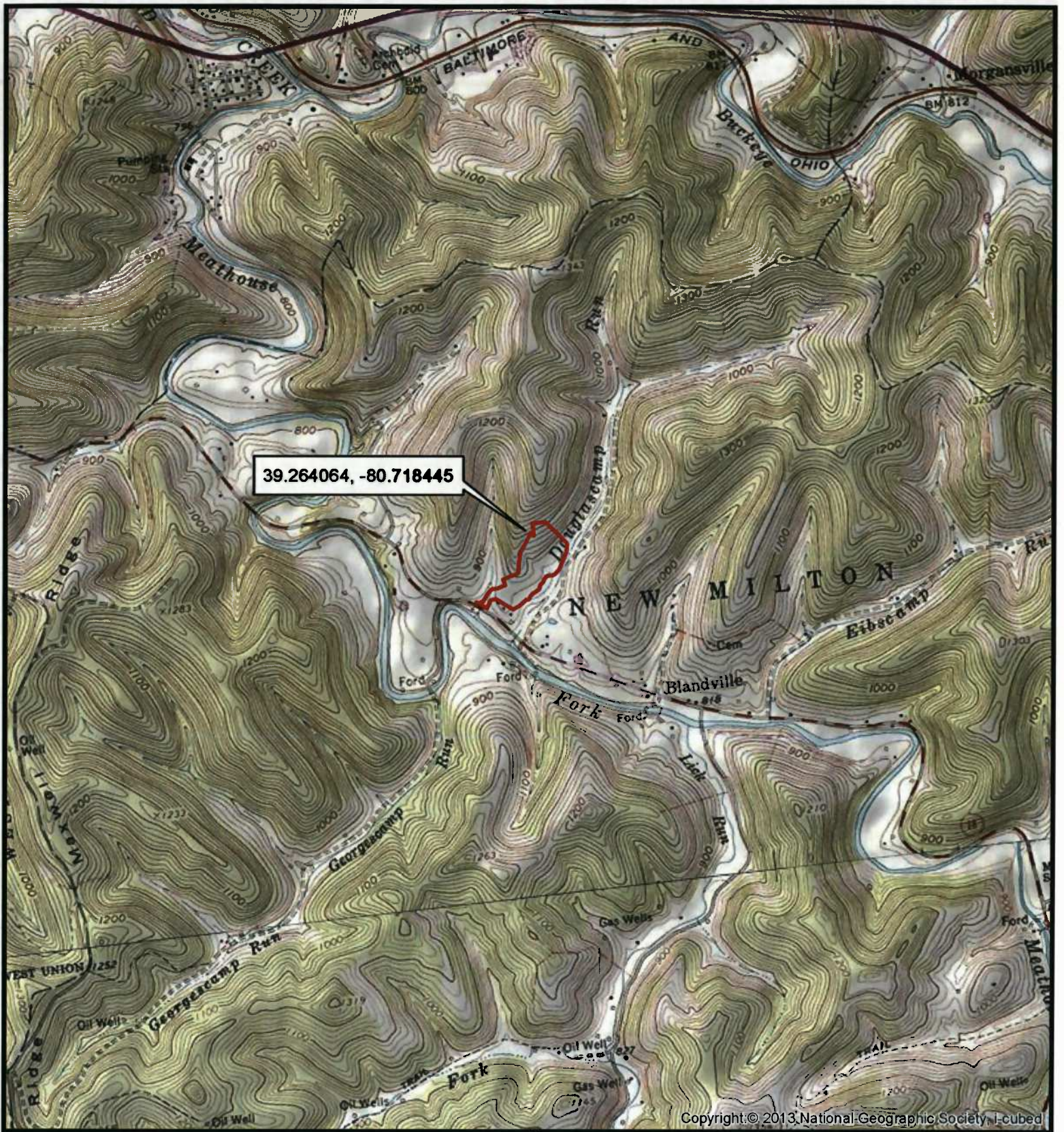
CONSTRUCTION LOCATION: _____

OWNER'S ADDRESS: _____

**THE FOLLOWING MUST BE COMPLETED BY THE FLOODPLAIN
ADMINISTRATOR/MANAGER OR HIS/HER AGENT.**

**COMPLIANCE IS HEREBY CERTIFIED WITH THE REQUIREMENT OF THE
FLOODPLAIN ORDINANCE ADOPTED BY THE COUNTY COMMISSION OF
DODDRIDGE COUNTY ON MAY 21, 2013.**

SIGNED _____ **DATE** _____



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 Limits of Disturbance

EQT Production Company

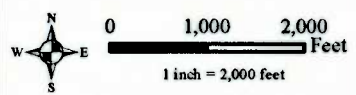
SMI 31 Pad

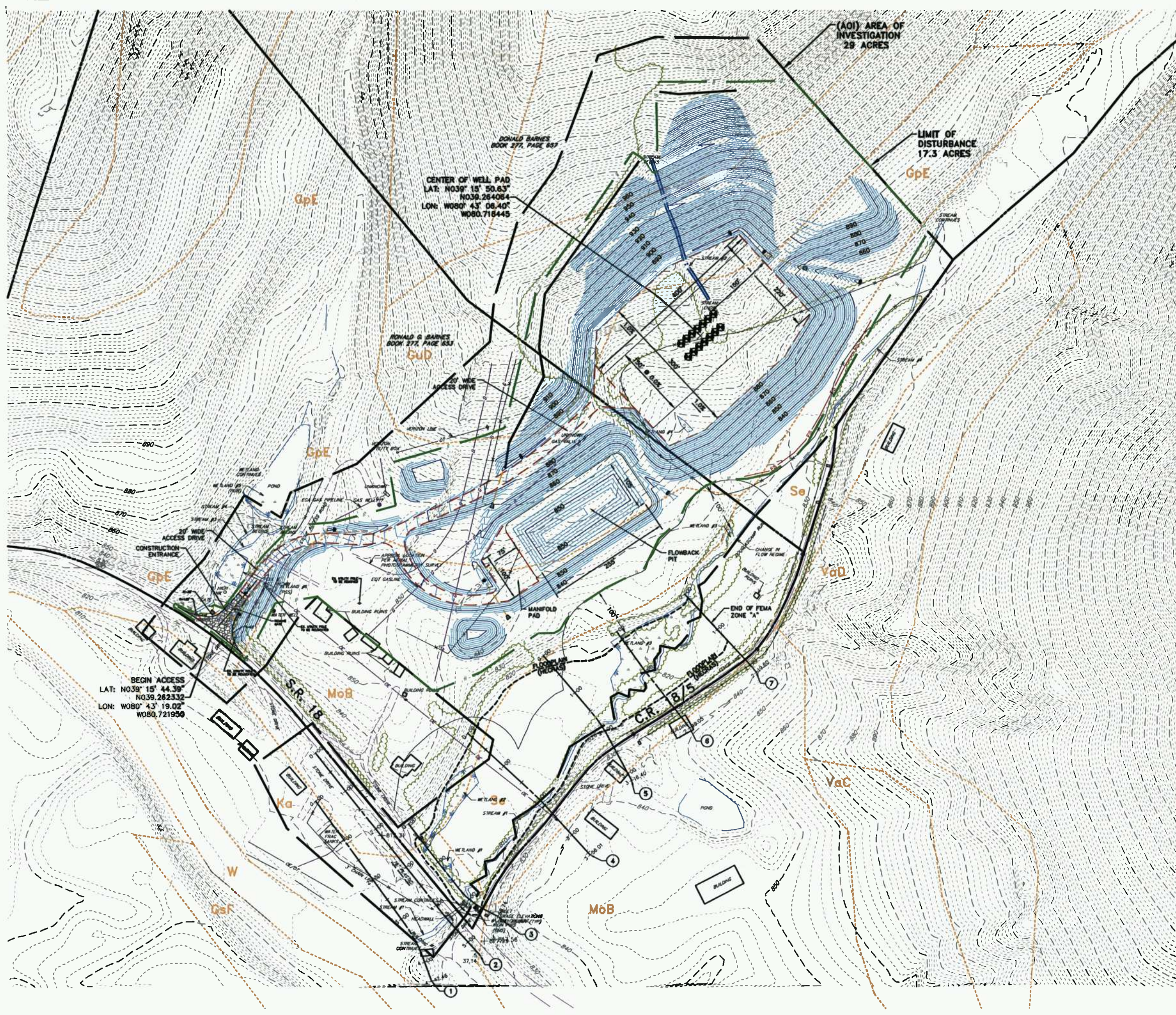
Figure 1 - Topographic Basemap

Project No: 092612019

New Milton Tax District, Doddridge County, WV
Smithburg, WV USGS 7.5' Topographic Quadrangle

12/17/2013





LEGEND

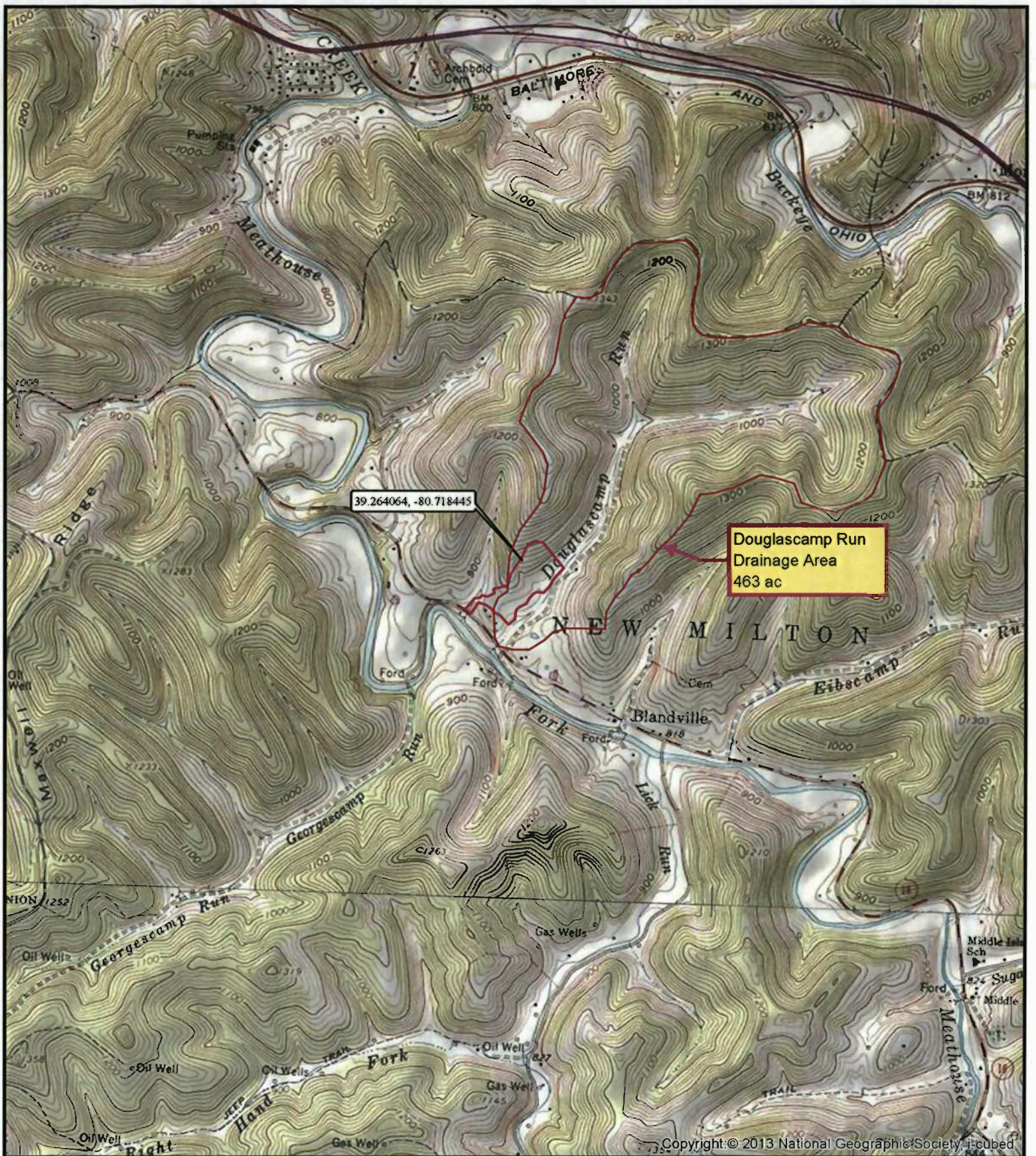
	EXISTING PROPERTY LINE
	EXISTING ABUTTER LINE
	EXISTING RIGHT-OF-WAY LINE
	EXISTING PAVEMENT
	EXISTING MAJOR CONTOUR
	EXISTING MINOR CONTOUR
	EXISTING STREAM
	EXISTING 100-YR FLOODPLAIN
	EXISTING FENCE
	EXISTING TREELINE
	EXISTING DECIDUOUS/EVERGREEN TREE
	EXISTING STONEWALL
	EXISTING WETLANDS
	EXISTING OVERHEAD TELEPHONE
	EXISTING U/G TELEPHONE
	EXISTING OVERHEAD ELECTRIC
	EXISTING U/G ELECTRIC
	EXISTING GAS PIPELINE
	EXISTING SANITARY LINE
	EXISTING SANITARY MANHOLE
	EXISTING STORM PIPE
	EXISTING STORM MANHOLE
	EXISTING STORM INLET
	EXISTING STORM HEADWALL/ENDWALL
	EXISTING WELL
	EXISTING TELEPHONE BOX
	EXISTING MAILBOX
	EXISTING UTILITY POLE
	EXISTING GUYWIRE/POLE
	EXISTING MONUMENT
	EXISTING IRON ROD
	EXISTING IRON PIPE
	SOIL TYPE BOUNDARY LINE
	SOIL TYPE DESIGNATION
	PROPOSED GRAVEL
	PROPOSED TREELINE
	PROPOSED MAJOR CONTOUR
	PROPOSED MINOR CONTOUR
	PROPOSED STORM PIPE
	PROPOSED CHANNEL LINING
	PROPOSED ORANGE CONSTRUCTION FENCE
	PROPOSED FENCE LINE
	TEMPORARY FILTER SOCK - 12"
	TEMPORARY FILTER SOCK - 18"
	TEMPORARY FILTER SOCK - 24"
	TEMPORARY FILTER SOCK - 32"
	LIMIT OF DISTURBANCE
	(AOI) AREA OF INVESTIGATION
	CROSS SECTION NUMBER

FOR RETIRE ASSOCIATES BY:		MANAGER: BRIAN D. SPRAY, PE	CHKD BY: CWW	DATE	REVISION
		DESIGN BY: DAW	CHKD BY: CWW		
		DRAWN BY: DAW	CHKD BY: CWW		
		SURV. CHIEF: FELDBOOK NO.			
		DRAWING REFERENCE:			
		EQT CORPORATION 115 PROFESSIONAL PLACE BRIDGEPORT, WEST VIRGINIA 26330			
		RETIREW Associates, Inc. 1905 Steubenville Pike, Suite 305 New Towners Pk., Steubenville, WV 26301 Phone (412) 446-1728 Email: retirew@retirew.com Website: www.retirew.com <small>Engineers • Planners • Surveyors • Landscape Architects Environmental Consultants</small>			
FLOODPLAIN STUDY SITE PLANS FOR SMI-31 WELL PAD		DODDRIDGE COUNTY, WV NEW MILTON TAX DISTRICT			
DATE: FEBRUARY 25, 2014		SHEET NO. 1 OF 1			
DWG. NO. 092612019		NOT FOR CONSTRUCTION (NOT FOR BIDDING)			

HEC-RAS Plan: Plan 04 River: Douglas Run Reach: Douglas Run Profile: PF 1

Reach	River Sta	Profile	Q Total (cfs)	Mn Ch B (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Douglas Run	1048	PF 1	448.00	821.80	824.56	824.56	824.89	0.019900	6.34	102.99	123.90	0.86
Douglas Run	843	PF 1	448.00	817.19	820.28	820.08	820.49	0.010665	5.43	139.89	146.29	0.70
Douglas Run	657	PF 1	448.00	813.99	818.10	818.10	818.42	0.013855	5.19	120.40	170.06	0.79
Douglas Run	451	PF 1	448.00	810.79	815.88	815.88	815.80	0.000319	1.55	464.42	202.25	0.14
Douglas Run	161	PF 1	448.00	805.28	815.77	808.77	815.83	0.000175	2.01	244.85	204.51	0.12
Douglas Run	108	Bridge										
Douglas Run	100	PF 1	448.00	803.75	812.95	807.68	813.07	0.000286	2.82	158.68	145.24	0.19
Douglas Run	15	PF 1	448.00	804.39	813.00	806.60	813.01	0.000016	0.76	942.67	258.42	0.05

ATTACHMENTS



Douglascamp Run
Drainage Area
463 ac


39.264064, -80.718445

EQT Production Company

SMI 31 Well Pad

Figure 1 - Site Location Map

Project No: 092612019

 Limits of Disturbance



0 1,000 2,000
Feet
1 inch = 2,000 feet



New Milton Tax District, Doddridge County, WV
Smithburg, WV USGS 7.5 Topographic Quadrangle

11/11/2013



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, I-cubed, USAF, USGS, AEX, Geomatics, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community

EQT Production Company

SMI 31 Well Pad

Figure 2 - Aerial Basemap

New Milton Tax District, Doddridge County, WV

Project No: 092612019

— Contour (20ft Interval)

— Field Delineated Stream

→ Stream Continuation Arrow

→ Wetland Continuation Arrow

— Roadway

▨ Field Delineated Wetland

▭ Soil (Hydric Status)

▭ Parcel

▭ Limits of Disturbance



0 200
F
1 inch = 200 feet

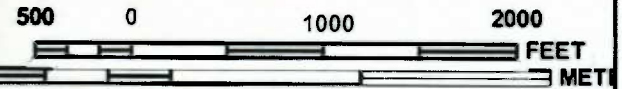


Drawn By: GSR

12/11/2013



MAP SCALE 1" = 1000'



NATIONAL FLOOD INSURANCE PROGRAM
NFIP

PANEL 0140C

FIRM

**FLOOD INSURANCE RATE MAP
 DODDRIDGE COUNTY,
 WEST VIRGINIA
 AND INCORPORATED AREAS**

PANEL 140 OF 325
 (SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DODDRIDGE COUNTY	540024	0140	C

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

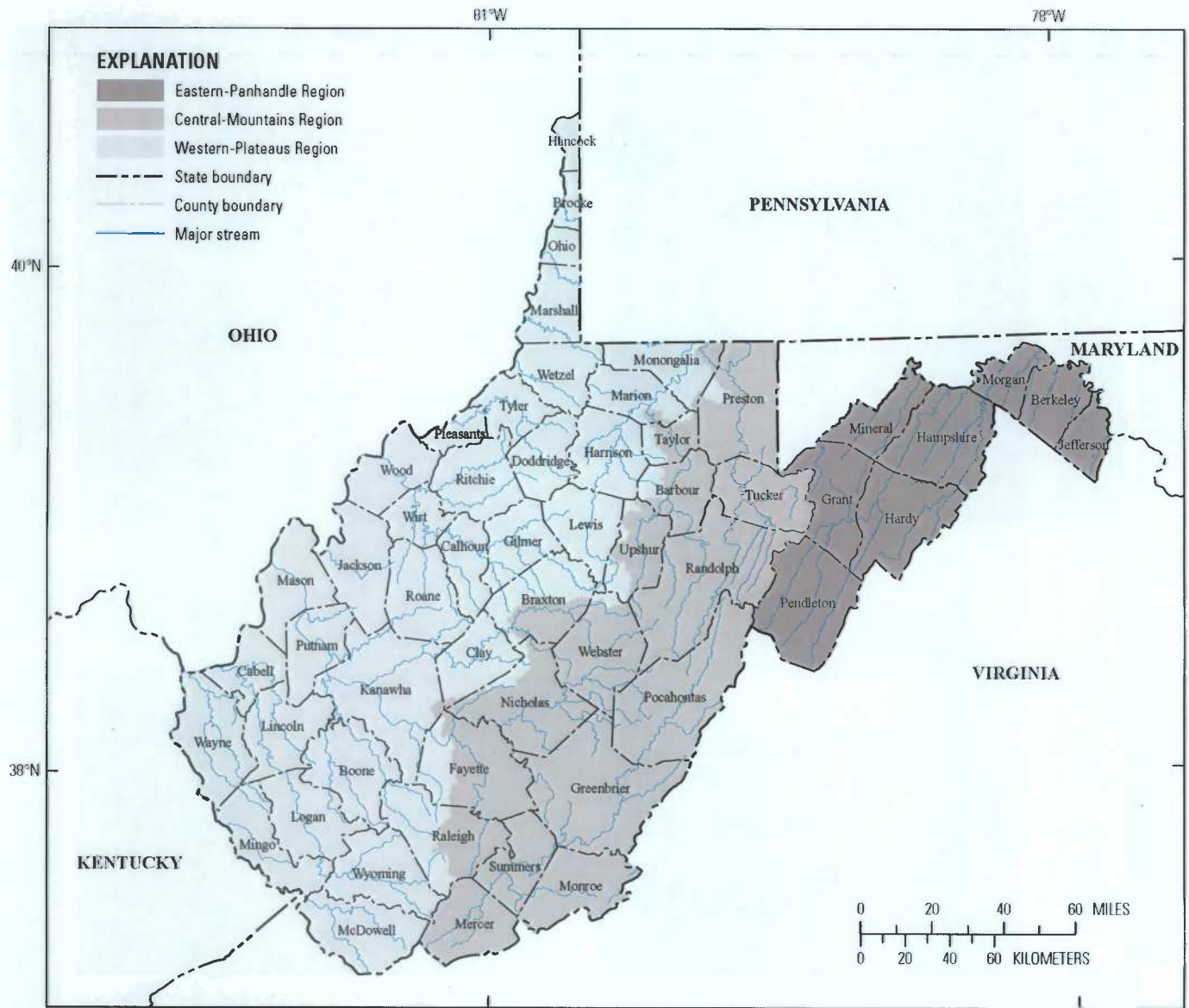


MAP NUMBER
 54017C0140C
MAP REVISED
 OCTOBER 4, 2011

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

FLOW CALCULATIONS



Base from U.S. Geological Survey 1:100,000 digital line graphics for state boundaries and streams and from the West Virginia Department of Environmental Protection 1:24,000 digital data for county boundaries. Universal Transverse Mercator projection, zone 17, NAD 83.

Figure 4. The Eastern Panhandle, Central Mountains, and Western Plateaus Regions of West Virginia for which equations for estimation of flood frequency discharges were developed in this study.

Table 4. Equations used to estimate selected flood-frequency discharges for streams in the Eastern Panhandle, Central Mountains, and Western Plateaus Regions of West Virginia.

[PK(n_n), peak discharge in cubic feet per second for the (n.n)-year recurrence interval; PK(n), peak discharge in cubic feet per second for the (n)-year recurrence interval; %, percent; AOP, annual-occurrence probability; DRNAREA, drainage area in square miles]

Equation	Standard error of the model, in percent	Average standard error of sampling, in percent	Average prediction error, in percent	Equivalent years of record, unitless
Eastern Panhandle Region (Range in DRNAREA from 0.21 to 1,461 for 57 streamgage stations)				
PK1_1(90%AOP) = 29.6 DRNAREA ^{0.818}	43.4	10.3	44.8	3.4
PK1_5(67%AOP) = 46.4 DRNAREA ^{0.828}	35.7	8.9	36.9	3.3
PK2(50%AOP) = 59.8 DRNAREA ^{0.832}	32.1	8.6	33.4	4.1
PK5(20%AOP) = 105 DRNAREA ^{0.838}	25.6	8.9	27.2	10.6
PK10(10%AOP) = 145 DRNAREA ^{0.842}	22.5	9.5	24.5	19.1
PK25(4%AOP) = 204 DRNAREA ^{0.848}	19.7	10.3	22.4	34.1
PK50(2%AOP) = 254 DRNAREA ^{0.852}	18.6	11.1	21.7	46.1
PK100(1%AOP) = 307 DRNAREA ^{0.855}	18.3	11.6	21.7	56.7
PK200(0.5%AOP) = 365 DRNAREA ^{0.859}	18.4	12.4	22.4	64.7
PK500(0.2%AOP) = 447 DRNAREA ^{0.864}	19.4	13.5	23.8	70.9
Central Mountains Region (Range in DRNAREA from 0.10 to 1,619 for 83 streamgage stations)				
PK1_1(90%AOP) = 33.4 DRNAREA ^{0.914}	40.0	8.3	41.0	2.4
PK1_5(67%AOP) = 53.8 DRNAREA ^{0.887}	34.6	7.3	35.4	2.0
PK2(50%AOP) = 69.4 DRNAREA ^{0.873}	33.4	7.3	34.2	2.1
PK5(20%AOP) = 116 DRNAREA ^{0.845}	34.1	8.0	35.1	3.2
PK10(10%AOP) = 153 DRNAREA ^{0.831}	36.3	8.6	37.4	4.0
PK25(4%AOP) = 206 DRNAREA ^{0.816}	39.9	9.8	41.2	4.8
PK50(2%AOP) = 250 DRNAREA ^{0.807}	42.9	10.6	44.4	5.3
PK100(1%AOP) = 297 DRNAREA ^{0.800}	46.2	11.3	47.9	5.6
PK200(0.5%AOP) = 347 DRNAREA ^{0.793}	49.7	12.0	51.5	5.9
PK500(0.2%AOP) = 420 DRNAREA ^{0.785}	54.3	13.1	56.3	6.1
Western Plateaus Region (Range in DRNAREA from 0.13 to 1,516 for 106 streamgage stations)				
PK1_1(90%AOP) = 56.9 DRNAREA ^{0.763}	38.2	7.6	39.1	3.8
PK1_5(67%AOP) = 97.8 DRNAREA ^{0.741}	33.4	6.5	34.1	2.8
PK2(50%AOP) = 129 DRNAREA ^{0.730}	31.6	6.1	32.2	2.8
PK5(20%AOP) = 221 DRNAREA ^{0.710}	29.3	6.5	30.0	4.4
PK10(10%AOP) = 292 DRNAREA ^{0.699}	28.9	6.5	29.7	5.9
PK25(4%AOP) = 391 DRNAREA ^{0.688}	29.4	7.3	30.3	7.9
PK50(2%AOP) = 472 DRNAREA ^{0.681}	30.2	7.6	31.3	9.1
PK100(1%AOP) = 557 DRNAREA ^{0.674}	31.4	8.0	32.5	10.1
PK200(0.5%AOP) = 647 DRNAREA ^{0.668}	32.7	8.3	33.9	10.8
PK500(0.2%AOP) = 775 DRNAREA ^{0.661}	34.8	8.9	36.1	11.4

463 ac drainage area = 0.723437sqmi
 557*(0.723437)^0.674 = 448 cfs

**Prepared in cooperation with the West Virginia Department of Transportation,
Division of Highways**

Estimation of Flood-Frequency Discharges for Rural, Unregulated Streams in West Virginia

Scientific Investigations Report 2010–5033

**U.S. Department of the Interior
U.S. Geological Survey**

Estimation of Flood-Frequency Discharges for Rural, Unregulated Streams in West Virginia

By Jeffrey B. Wiley and John T. Atkins, Jr.

Prepared in cooperation with the West Virginia Department of Transportation,
Division of Highways

Scientific Investigations Report 2010–5033

**U.S. Department of the Interior
U.S. Geological Survey**

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2010

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EXISTING HEC-RAS OUTPUT

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HEC-RAS Version 4.1.0 Jan 2010
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X      X  XXXXXX   XXXX       XXXX       XX       XXXX
X      X  X       X   X       X   X       X   X       X
X      X  X       X   X       X   X       X   X       X
XXXXXXXX XXXX     X       XXX  XXXX     XXXXXX     XXXX
X      X  X       X   X       X   X       X   X       X
X      X  X       X   X       X   X       X   X       X
X      X  XXXXXX   XXXX     X   X       X   X       XXXXX
```

PROJECT DATA

Project Title: Smithsburg 31
Project File : Smithsburg31.prj
Run Date and Time: 12/12/2013 9:36:23 AM

Project in English units

PLAN DATA

Plan Title: Plan 05
Plan File : h:\Projects\09261\092612019\LD\HECRAS\Smithsburg31.p05

Geometry Title: SMBG31
Geometry File : h:\Projects\09261\092612019\LD\HECRAS\Smithsburg31.g02

Flow Title : WSE
Flow File : h:\Projects\09261\092612019\LD\HECRAS\Smithsburg31.f03

Plan Summary Information:

Number of: Cross Sections	=	7	Multiple Openings	=	0
Culverts	=	0	Inline Structures	=	0
Bridges	=	1	Lateral Structures	=	0

Computational Information

Water surface calculation tolerance	=	0.01
Critical depth calculation tolerance	=	0.01
Maximum number of iterations	=	20
Maximum difference tolerance	=	0.3
Flow tolerance factor	=	0.001

Computation Options

Critical depth computed only where necessary	
Conveyance Calculation Method:	At breaks in n values only
Friction Slope Method:	Average Conveyance
Computational Flow Regime:	Subcritical Flow

FLOW DATA

Flow Title: WSE
Flow File : h:\Projects\09261\092612019\LD\HECRAS\Smithsburg31.f03

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Flow Data (cfs)

River Douglas Run Reach Douglas Run RS 1048 PF 1 448

Boundary Conditions

River Downstream Reach Douglas Run Profile PF 1 Upstream

Douglas Run Known WS = 813

GEOMETRY DATA

Geometry Title: SMBG31
 Geometry File : h:\Projects\09261\092612019\LD\HECRAS\Smithsburg31.g02

CROSS SECTION

RIVER: Douglas Run
 REACH: Douglas Run RS: 1048

INPUT

Description: X Section 6

Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	826.97	9.51	824.15	32.56	824.02	39.99	821.8	46.69	823.36
61.92	823.9	91.53	823.39	120.3	824.17	151.08	825.2	158.56	827.25

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.08	32.56	.04	61.92	.05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

32.56	61.92	158	205	174	.1	.3
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CROSS SECTION

RIVER: Douglas Run
 REACH: Douglas Run RS: 843

INPUT

Description: X Section 5

Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	822.51	4.65	820.96	31.96	819.7	62.18	818.81	91.91	819.71
95.11	819.76	102.28	817.19	106.14	819.52	116.98	819.6	132.01	819.52
159.29	818.88	169.74	821.19	174.51	823.02				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	95.11	.04	106.14	.05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

95.11	106.14	159	186	142	.1	.3
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CROSS SECTION

RIVER: Douglas Run
 REACH: Douglas Run RS: 657

INPUT

Description: X section 4

Station Elevation Data		num= 13		Sta Elev		Sta Elev		Sta Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	821.33	7.41	818.77	30.52	818	121.77	817.22	152.36	818.15
172.21	816.33	175.57	816.22	183.13	813.99	185.86	816.95	196.67	817.54
199.91	818.07	200.05	818.151	205.5	821.31				

Manning's n Values		num= 3		Sta n Val		Sta n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.05	152.36	.04	200.05	.08		

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	152.36	200.05		222	206		.1	.3

CROSS SECTION

RIVER: Douglas Run
 REACH: Douglas Run RS: 451

INPUT

Description: X Section 3

Station Elevation Data		num= 10		Sta Elev		Sta Elev		Sta Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	820	16.28	815.03	33.17	814.66	59.83	813.51	110.1	813.57
198.76	813.13	208.03	810.79	210.19	812.52	212.01	813.15	221.39	820

Manning's n Values		num= 3		Sta n Val		Sta n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.05	198.76	.04	212.01	.08		

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	198.76	212.01		223	290		.1	.3

CROSS SECTION

RIVER: Douglas Run
 REACH: Douglas Run RS: 161

INPUT

Description: X Section 2

Station Elevation Data		num= 23		Sta Elev		Sta Elev		Sta Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	821.93	8.05	818.43	20.54	816.82	42.35	814.91	53.68	811.24
109.81	811.07	154.1	811.13	161.42	810.7	163.57	810.35	174.4	810.17
183.72	809.5	189.74	807.41	192.23	807.25	200	805.28	201.37	805.28
206	805.28	208.87	808.76	210.65	809.93	217.1	814.17	226.7	815.74
246.97	815.89	253.34	815.28	268.74	821.64				

Manning's n Values		num= 3		Sta n Val		Sta n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.05	183.72	.04	210.65	.08		

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	183.72	210.65		239	61		.3	.5
Ineffective Flow			num=	2				

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Sta L	Sta R	Elev	Permanent
0	187	816.4	F
221	268.74	816.4	F

BRIDGE

RIVER: Douglas Run
 REACH: Douglas Run RS: 108

INPUT

Description: 6x6 culvert
 Distance from Upstream XS = 14
 Deck/Roadway width = 20
 Weir Coefficient = 2.6
 Upstream Deck/Roadway Coordinates

num= 8			
Sta	Hi Cord	Lo Cord	
0	816.7		
150	816.35		
250	816.7		

Upstream Bridge Cross Section Data

Station Elevation Data num= 23											
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	821.93	8.05	818.43	20.54	816.82	42.35	814.91	53.68	811.24		
109.81	811.07	154.1	811.13	161.42	810.7	163.57	810.35	174.4	810.17		
183.72	809.5	189.74	807.41	192.23	807.25	200	805.28	201.37	805.28		
206	805.28	208.87	808.76	210.65	809.93	217.1	814.17	226.7	815.74		
246.97	815.89	253.34	815.28	268.74	821.64						

Manning's n Values

num= 3					
Sta	n Val	Sta	n Val	Sta	n Val
0	.05	183.72	.04	210.65	.08

Bank Sta: Left Right Coeff Contr. Expan.
 183.72 210.65 .3 .5

Ineffective Flow num= 2
 Sta L Sta R Elev Permanent
 0 187 816.4 F
 221 268.74 816.4 F

Downstream Deck/Roadway Coordinates

num= 14											
Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	818.45		50	817.9		100	817.55				
150	816.92		200	816.69		250	816.63				
300	816.45		350	816.51		400	816.26				
432	816.39	809.73	438	816.4	809.73	450	816.43				
500	816.85		537	817.99							

Downstream Bridge Cross Section Data

Station Elevation Data num= 24											
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	817.45	35.04	817.31	105.95	816.87	155.53	815.59	231.27	813.28		
294.71	811.66	303.6	814.35	328.17	815.55	359.35	813.8	374.52	813.63		
385.97	814.05	402.98	813.28	413.68	811.77	416.51	811.81	426.6	809.04		
427.94	806.53	432	803.75	437.51	803.75	438	803.75	457.13	814.44		
481.02	814.23	497.82	811.05	527.01	812.03	537.14	815.97				

Manning's n Values

num= 3					
Sta	n Val	Sta	n Val	Sta	n Val
0	.05	385.97	.03	457.13	.05

Bank Sta: Left Right Coeff Contr. Expan.

385.97 457.13
 Ineffective Flow num= 2
 Sta L Sta R Elev Permanent
 0 424 816.4 F
 446 537.14 816.4 F

Upstream Embankment side slope = 10 horiz. to 1.0 vertical
 Downstream Embankment side slope = 10 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .98
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data

Energy

Selected Low Flow Methods = Highest Energy Answer

High Flow Method

Energy Only

Additional Bridge Parameters

Add Friction component to Momentum

Do not add Weight component to Momentum

Class B flow critical depth computations use critical depth
 inside the bridge at the upstream end

Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: Douglas Run
 REACH: Douglas Run RS: 100

INPUT

Description: X Section 1

Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	817.45	35.04	817.31	105.95	816.87	155.53	815.59	231.27	813.28
294.71	811.66	303.6	814.35	328.17	815.55	359.35	813.8	374.52	813.63
385.97	814.05	402.98	813.28	413.68	811.77	416.51	811.81	426.6	809.04
427.94	806.53	432	803.75	437.51	803.75	438	803.75	457.13	814.44
481.02	814.23	497.82	811.05	527.01	812.03	537.14	815.97		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	385.97	.03	457.13	.05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 385.97 457.13 98 85 113 .3 .5

Ineffective Flow num= 2
 Sta L Sta R Elev Permanent
 0 424 816.4 F
 446 537.14 816.4 F

CROSS SECTION

RIVER: Douglas Run
 REACH: Douglas Run RS: 15

INPUT

Description: X Section 0

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Station Elevation Data		num=		20					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	814.74	43.11	813.79	49.27	812.39	59.45	813.78	80.7	814.46
94.78	814.44	298.89	808.23	306.37	806.3	312.97	807.41	329.24	806.14
341.61	804.78	350	804.43	355.61	804.39	363.7	804.79	371.6	807.462
385.67	812.22	396.25	815.03	406.28	816.69	416.86	816.67	442.46	812.16

Manning's n Values		num=		3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.05	312.97	.03	371.6	.05

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	312.97	371.6		0	0		.1	.3

SUMMARY OF MANNING'S N VALUES

River: Douglas Run

Reach	River Sta.	n1	n2	n3
Douglas Run	1048	.08	.04	.05
Douglas Run	843	.05	.04	.05
Douglas Run	657	.05	.04	.08
Douglas Run	451	.05	.04	.08
Douglas Run	161	.05	.04	.08
Douglas Run	108	Bridge		
Douglas Run	100		.05	.03
Douglas Run	15	.05	.03	.05

SUMMARY OF REACH LENGTHS

River: Douglas Run

Reach	River Sta.	Left	Channel	Right
Douglas Run	1048	158	205	174
Douglas Run	843	159	186	142
Douglas Run	657	222	206	195
Douglas Run	451	223	290	247
Douglas Run	161	239	61	87
Douglas Run	108	Bridge		
Douglas Run	100		98	85
Douglas Run	15	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS

River: Douglas Run

Reach	River Sta.	Contr.	Expan.
Douglas Run	1048	.1	.3
Douglas Run	843	.1	.3
Douglas Run	657	.1	.3
Douglas Run	451	.1	.3
Douglas Run	161	.3	.5
Douglas Run	108	Bridge	
Douglas Run	100		.3

Douglas Run

15

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.1 .3