



Completed Martinsburg and Deeper Wells in West Virginia

West Virginia Geological and Economic Survey

Completed Martinsburg and Deeper Wells in West Virginia

Entire table. 41 rows.

Data are current through 1998.

Source: West Virginia Geological and Economic Survey, <https://www.wvgs.wvnet.edu/ogsummarystats/mrbg/results>

Downloaded October 30, 2026 11:26 AM

Rows 1-31 of 41. Columns, part 1 of 4.

County Name	County Code	Permit Number	Completion Date	Operator Name	Operator Well Number	Latitude (decimal degrees)	Longitude (decimal degrees)	UTM Zone 17 Easting (meters)	UTM Zone 17 Northing (meters)	Elevation (feet above mean sea level)	Datum	Total Depth (feet)	Deepest Formation Penetrated	Well Type	Completion Method
Cabell	011	537	05/03/1971	Cyclops		38.523889	82.263056	389895.9	4264493.0	667	KB	8,552	Precambrian	dry w/ o&g show	natural/open hole
Calhoun	013	2503	06/11/1974	Exxon USA		38.882500	81.101944	491157.6	4303535.0	1,238	KB	20,222	Precambrian	dry w/ o&g show	natural/open hole
Clay	015	513	09/12/1953	United Fuel Gas	8000-T	38.453056	81.263889	476974.2	4255910.5	1,142	G	8,144	Martinsburg	dry w/ gas show	natural/open hole
Grant	023	2	11/05/1965	Shell Oil	10768	39.194722	79.141667	660483.9	4339822.0	2,339	G	13,000	Beekmantown	dry	natural/open hole
Greenbrier	025	17	04/17/1967	Union Oil & Gas		38.052222	80.386667	553812.5	4211581.0	2,786	KB	9,509	Martinsburg	dry w/ gas show	natural/open hole
Hampshire	027	12	03/10/1964	Shell Oil		39.494444	78.636667	703229.7	4374105.5	938	G	13,999	Elbrook	dry w/ gas show	natural/open hole
Hancock	029	80	08/18/1965	Humble Oil & Refining		40.539722	80.556111	537591.0	4487547.5	1,040	G	10,387	Beekmantown	dry	natural/open hole
Hardy	031	3	12/09/1962	United Fuel Gas	9058-T	39.002778	78.850000	686179.0	4319075.5	1,965	G	10,584	Martinsburg	gas	acidized
Hardy	031	21	07/12/1980	Exxon USA		39.137500	78.990278	673699.6	4333750.5	1,022	G	16,075	Rome	dry	natural/open hole
Hardy	031	22	08/12/1981	Exxon USA		39.960000	78.672778	701648.8	4314706.5	1,776	G	8,977	Knox	dry	natural/open hole
Jackson	035	1366	10/14/1975	Exxon USA		38.729722	81.572500	450236.5	4286732.0	915	G	17,680	Precambrian	gas	acid+frac
Kanawha	039	2481	12/12/1970	Union Oil of California		38.141389	81.516111	454772.5	4221423.0	1,425	KB	8,075	Martinsburg	dry w/ gas show	unknown
Kanawha	039	3462	01/16/1980	Columbia Gas Transmission	20659-T	38.296667	81.370833	467572.4	4238590.5	1,252	KB	10,580	Beekmantown	dry	natural/open hole
Lincoln	043	1469	06/03/1974	Exxon USA		38.216944	81.940278	417687.0	4230098.0	772	KB	19,124	Precambrian	dry w/ gas show	natural/open hole
Lincoln	043	2678	01/17/1986	Columbia Gas Transmission	21480-T	38.085833	82.109444	402703.5	4215714.0	1,121	G	5,970	Trenton	dry	acid+frac
Logan	045	864	O-02/27/1966; D-11/29/1971	R W Adams & Assoc		37.920833	81.932222	418062.6	4197235.0	1,208	KB	7,504	Trenton	gas; dry	unknown
McDowell	047	909	09/01/1984	Conoco		37.251111	81.583333	448266.7	4122685.0	1,830	G	7,675	Martinsburg	gas	acid+frac
McDowell	047	1301	01/19/1998	Ashland Exploration	148221	37.478895	81.872224	422879.7	4148152.7	1,484	G	7,207	Martinsburg	gas	acid+frac
Marion	049	244	O-05/28/1962; W-07/14/1983	Phillips Petroleum		39.431944	80.012222	585013.9	4364968.5	1,341	G	17,111	Beekmantown	dry w/ gas show; gas	shot
Marshall	051	539	O-11/05/1969; D-01/18/1971	Occidental Petroleum		39.761667	80.530000	540259.4	4401201.0	1,439	KB	16,512	Tomstown	dry	nat; frac
Mason	053	69	08/07/1959	United Fuel Gas	8803	38.713889	82.117222	402865.2	4285413.0	609	KB	8,635	Precambrian	dry	natural/open hole
Mason	053	297	09/13/1982	Union Drilling	1809	38.623611	82.109167	403444.5	4275386.0	646	KB	10,598	Precambrian	dry	acid+frac
Mingo	059	805	02/08/1973	Columbia Gas Transmission	9674-T	37.904444	82.169444	397188.7	4195653.0	958	KB	19,600	Precambrian	dry w/ gas show	natural/open hole
Mingo	059	879	11/09/1978	Columbia Gas Transmission	20500-T	37.883611	82.262222	389000.3	4193447.5	1,105	KB	8,833	Copper Ridge	dry w/ o&g show	nat; acid+frac
Pendleton	071	1	07/ /1952	Seneca Gas & Oil		38.811111	79.362500	642177.8	4296882.0	2,248	G	3,000	Cambrian	dry	natural/open hole
Pendleton	071	6	07/15/1960	United Fuel Gas	8800	38.548056	79.512778	629602.8	4267467.0	2,985	G	13,001	Trenton	dry	natural/open hole
Pocahontas	075	18	06/16/1961	Columbian Carbon	GW1329	38.549167	79.684722	614616.5	4267362.4	3,780	G	10,805	Martinsburg	gas	acid+frac
Pocahontas	075	21	08/14/1963	Tidewater Oil	51531	38.152778	80.011389	586620.0	4223022.0	3,493	G	11,918	St. Paul Group	dry w/ gas show	natural/open hole
Preston	077	86	O-12/13/1960; D-03/31/1963	Phillips Petroleum		39.466669	79.870278	597182.5	4368965.5	1,828	G	14,594	Black River	gas; dry w/ gas show	fractured; acid+frac
Preston	077	119	03/17/1964	Columbian Carbon	GW1466	39.238056	79.573611	623104.5	4343955.5	2,172	G	9,910	Martinsburg	gas	natural/open hole
Putnam	079	764	04/18/1972	Teavee Oil & Gas	TV-86	38.502222	82.019167	411130.4	4261826.0	675	KB	7,565	Trenton	dry w/ gas show	natural/open hole

Completed Martinsburg and Deeper Wells in West Virginia (continued). Entire table. Rows 1-31 of 41. Columns, part 2 of 4.

County Name	County Code	Permit Number	Pay Zone(s)	Show Zone(s) (Gas)	Show Zone(s) (Oil)
Cabell	011	537		Big Injun (1,475); Berea (2,026); St. Peter (6,565); Rose Run (7,148); Copper Ridge (7,572)	Big Lime (1,410); Copper Ridge (7,572)
Calhoun	013	2503		Big Lime (2,285)	Up. Devonian shale (2,610); Marcellus (6,246)
Clay	015	513		Pennsylvanian (946; 1,035); Big Injun (1,805); Oriskany (5,779); Tuscarora (7,490)	
Grant	023	2			
Greenbrier	025	17		Devonian (6,073; 6,130; 6,693); Onondaga (6,909; 6,968); Salina (7,698); Tuscarora (8,662; 8,719)	
Hampshire	027	12		Rose Hill (3,239; 3,338); Tuscarora (5,244; 5,293); Juniata (6,355; 6,596); Oswego (6,596; 6,695; 6,714); Martinsburg (6,834; 6,888; 6,976; 7,007; 8,446)	
Hancock	029	80			
Hardy	031	3	Oriskany (6,838-6,845)	Oriskany (6,800)	
Hardy	031	21			
Hardy	031	22			
Jackson	035	1366	Conasauga (14,358)	Up. Devonian shale (2,520); Black River (10,487)	
Kanawha	039	2481		Salina (6,350'); Tuscarora (7,148')	
Kanawha	039	3462			
Lincoln	043	1469		Beekmantown (9,289); Conasauga (11,608)	
Lincoln	043	2678			
Logan	045	864	Lower Huron (3,825)		
McDowell	047	909	Tuscarora (7,100-7,222; 7,414-7,508)		
McDowell	047	1301	Tuscarora (7,029-7,042)	Big Lime (2,953, 3,048, 3,173); Pocono (3,395, 3,898, 4,117); Up. Devonian (4,117, 4,500, 5,095, 5,775, 6,008)	
Marion	049	244	Oriskany ?	Driller's Tully (6,281); Huntersville (7,260); Tuscarora (10,135); Martinsburg (12,450; 12,880; 13,045); Black River (13,269); Chazy (14,286; 14,320)	
Marshall	051	539			
Mason	053	69			
Mason	053	297			
Mingo	059	805		Pennsylvanian (1,013); Big Lime (1,432); Lo.Huron (2,993; 3,115; 3,186); McKenzie (4,484); Trenton (6,072); Wells Creek (8,038; 8,206); Beekmantown (8,753; 9,191)	
Mingo	059	879		Pennsylvanian (773); Beekmantown (8,045)	Pennsylvanian (773)
Pendleton	071	1			
Pendleton	071	6			
Pocahontas	075	18	Oriskany (5,465-5,590)	Tuscarora (8,490)	
Pocahontas	075	21		Tuscarora (5,553); Juniata (6,162); Martinsburg (6,267; 7,382; 7,734); Trenton (8,513; 8,586; 8,605); St. Paul (11,842)	
Preston	077	86	Oriskany (7,531-7,825)	Onondaga (7,619); Oriskany (7,714); Helderberg (7,784; 7,815; 7,940; 7,980; 8,163; 8,325); Tuscarora (10,570; 10,681; 10,733); Martinsburg (13,829); Trenton (14,016; 14,073; 14,120; 14,186; 14,256; 14,328)	
Preston	077	119	Tuscarora (7,115-7,123; 7,142-7,147; 7,151-7,156; 7,160-7,165)		
Putnam	079	764		Big Injun (1,627)	

Completed Martinsburg and Deeper Wells in West Virginia (continued). Entire table. Rows 1-31 of 41. Columns, part 3 of 4.

County Name	County Code	Permit Number	Dry Completions	Plugged Date	Logs Available	Gross Logged Interval (feet)	Cores Available	Samples	Sample Descriptions	Top: Onondaga	Top: Tuscarora	Top: Trenton
Cabell	011	537		7/26/1971	GR,D,I,N,*	100-8,550		200-8,550		3,333	4,395	5,270
Calhoun	013	2503		6/11/1974	GR,D,I,N,S,*	2,600-19,392	17,154-17,248; 18,108-18,577			6,246	8,591	10,628
Clay	015	513		2/25/1954	I,*	5,615-7,503	7,436-7,499	418-8,140	File	5,595	7,420	
Grant	023	2		11/30/1965	GR,D,N,*	50-12,993		0-8,660; 8,940-11,050				5,103
Greenbrier	025	17		4/20/1967	GR,N,S,*	100-9,498		5,970-9,509		6,858	8,594	
Hampshire	027	12		3/19/1964	GR,I,N,S,*	303-1,241	10,522-10,526; 13,958-13,999	0-13,999			4,144	8,707
Hancock	029	80		8/18/1965	GR,D,*	720-10,380		1,400-10,385	File	4,670	6,806	8,965
Hardy	031	3		12/11/1962*	GR,D,I,*	0-7,558		0-10,584			9,350	
Hardy	031	21		7/12/1980	GR,D,I,N,S,*	100-16,055					2,757	5,495
Hardy	031	22		8/12/1981	GR,D,I,N,*	644-8,952						848
Jackson	035	1366		7/9/1978	GR,D,S,T,*	20-17,680	9,235-16,502	100-2,600; 5,420-17,675		5,220	6,073	8,723
Kanawha	039	2481		3/19/1992	GR,D,N,T,*	21-7,244				5,722	7,066	
Kanawha	039	3462		3/11/1980	GR,D,I,S,T,*	100-10,504		2,730-10,580		5,595	7,150	8,777
Lincoln	043	1469		7/19/1974	GR,D,I,N,S,T,*	269-19,110	12,124-12,184; 16,897-16,941	0-9,900; 11,900-18,680		4,333	5,645	6,790
Lincoln	043	2678	Big Lime (1,836); Newburg (4,780); Tuscarora (5,504)	4/23/1986	GR,D,I,N,T,*	50-4,370				4,220	5,440	5,880
Logan	045	864		12/09/1971*	GR,D,I	100-7,496		4,560-7,000		4,422	5,713	6,814
McDowell	047	909			GR,D,I,N,T,*	276-7,666		290-6,510		6,250	7,022	
McDowell	047	1301								6,068	6,897	
Marion	049	244		4/21/1963	GR,D,N,*	0-17,029		60-17,111	File	7,190	10,062	13,058
Marshall	051	539		1/18/1971?	GR,D,I,N,S,*	0-16,505		3,920-16,510		7,575	10,190	12,870
Mason	053	69		8/14/1959	GR,*	100-8,632		1,105-8,635	B-23	3,310	4,480	5,550
Mason	053	297	Beekmantown; Rome	12/28/1982	GR,D,I,N,T,*	2,000-10,587				3,704	4,844	
Mingo	059	805		2/17/1973	GR,D,I,N,S,T,*	100-19,533	16,201-16,261	240-19,591		3,777	4,910	5,964
Mingo	059	879	Beekmantown (8,422; 8,558); Rose Run (8,602); Copper Ridge (8,782)	5/7/1979	GR,D,I,T,*	2,400-8,126		1,500-5,000; 7,200-8,108		3,850	4,928	5,850
Pendleton	071	1		7/24/1957	GR,*	0-2,379		0-3,002	File			7
Pendleton	071	6		2/11/1977	GR,N,T,*	0-12,996		50-13,000				10,035; 11,480
Pocahontas	075	18		6/22/1961*	GR,I,N	1,600-10,787		110-10,805			8,416	
Pocahontas	075	21		8/21/1963	GR,N,*	500-11,826		18-11,918			284; 1,360; 5,360	8,460
Preston	077	86		5/23/1963	GR,D,N,T,*	10-14,590		20-14,494		7,520	10,356	14,010
Preston	077	119		7/8/1985	GR,D,I,N,*	0-9,909	7,165-7,432	100-1,760; 1,960-6,200				
Putnam	079	764		8/12/1972						3,980	5,316	6,700

Completed Martinsburg and Deeper Wells in West Virginia (continued). Entire table. Rows 1-31 of 41. Columns, part 4 of 4.

County Name	County Code	Permit Number	Top: Beekmantown	Top: Rose Run	Top: Conasauga-?	Top: Basement	Notes	Most Recent Production: Year	Most Recent Production: Volume (Mcf)	Most Recent Production: Operator Reporting
Cabell	011	537	6,608	7,216	8,007	8,516				
Calhoun	013	2503	13,550		15,615	20,050				
Clay	015	513								
Grant	023	2	8,570				faults in the Ordovician?			
Greenbrier	025	17								
Hampshire	027	12	9,880							
Hancock	029	80	9,915							
Hardy	031	3					plugged back to the Oriskany			
Hardy	031	21	6,894				faulted; repeated sections in the Cambrian			
Hardy	031	22								
Jackson	035	1366	10,487	11,660	12,711	17,626				
Kanawha	039	2481								
Kanawha	039	3462	10,522							
Lincoln	043	1469	9,289		11,608	19,074				
Lincoln	043	2678					plugged back to the Devonian Shale			
Logan	045	864								
McDowell	047	909						1998	133,888 Mcf	Waco Oil & Gas Co.
McDowell	047	1301								
Marion	049	244	16,012				plugged in 1963, reworked in 1983	1998	1,021 Mcf	Columbia Natural Resources
Marshall	051	539	13,956	16,090						
Mason	053	69			8,020	8,558				
Mason	053	297	7,438	8,066		10,564				
Mingo	059	805	8,522	9,300	10,650	19,570				
Mingo	059	879	7,808	8,578						
Pendleton	071	1	820							
Pendleton	071	6	1,682				major thrust fault at 10,035'; see Perry, 1964, AAPG Bull, v.48, #5, p.659-669			
Pocahontas	075	18					faulted; plugged back to the Oriskany	1998	37,676 Mcf	Cabot Oil & Gas Corp.
Pocahontas	075	21					faulted; repeated sections in the Silurian			
Preston	077	86								
Preston	077	119								
Putnam	079	764								

Completed Martinsburg and Deeper Wells in West Virginia (continued). Entire table. Rows 32-41 of 41. Columns, part 1 of 4.

County Name	County Code	Permit Number	Completion Date	Operator Name	Operator Well Number	Latitude (decimal degrees)	Longitude (decimal degrees)	UTM Zone 17 Easting (meters)	UTM Zone 17 Northing (meters)	Elevation (feet above mean sea level)	Datum	Total Depth (feet)	Deepest Formation Penetrated	Well Type	Completion Method
Randolph	083	101	O-10/07/1958; D-01/19/1960	Columbian Carbon	GW1293	38.784444	79.698889	613011.3	4293453.0	2,920	G	9,820	Oswego	gas; gas	acid+frac
Randolph	083	103	03/09/1961	Hope Natural Gas	10228	38.707223	79.969167	589631.4	4284584.0	2,036	G	13,121	Trenton	dry w/ gas show	acid+frac
Roane	087	19	01/16/1932	United Fuel Gas	4053	38.781389	81.503889	456232.0	4292430.5	823	B	9,104	Trenton	dry w/ o&g show	natural/open hole
Wayne	099	284	O-07/24/1943; D- / /1949	Owens, Libbey-Owens	663	38.307778	82.423056	375577.2	4240716.0	570	G	4,750	Martinsburg	gas; dry	natural/open hole
Wayne	099	465	08/05/1949	United Fuel Gas	6181	37.892222	82.393889	377435.2	4194567.5	688	G	7,900	Conococheague	dry w/ o&g show	shot
Wayne	099	1572	11/19/1974	Exxon USA		38.221667	82.534722	365655.0	4231317.0	622	KB	14,625	Precambrian	dry	natural/open hole
Wayne	099	1870	07/27/1993	Cabot Oil & Gas	A-18	37.946389	82.335278	382675.0	4200502.0	1,253	G	5,062	Martinsburg	gas	acid+frac
Wood	107	351	02/18/1955	Hope Natural Gas	9634	39.256944	81.272500	476488.7	4345117.5	1,065	KB	13,331	Precambrian	dry w/ o&g show	natural/open hole
Wood	107	518	03/17/1965	Phillips Petroleum	P-1575	39.262778	81.282778	475604.1	4345768.0	970	KB	11,905	Copper Ridge	dry	acid+frac
Wood	107	756	12/06/1976	Exxon USA		39.080556	81.508333	456031.4	4325630.5	726	KB	13,266	Precambrian	dry	natural/open hole

Completed Martinsburg and Deeper Wells in West Virginia (continued). Entire table. Rows 32-41 of 41. Columns, part 2 of 4.

County Name	County Code	Permit Number	Pay Zone(s)	Show Zone(s) (Gas)	Show Zone(s) (Oil)
Randolph	083	101	Huntersville (4,610-4,650); Oriskany (4,860-4,962); Tuscarora (7,376-7,403)		
Randolph	083	103		Tuscarora (5,740); Juniata (7,188; 7,244); Martinsburg (8,244; 8,555); Trenton (10,245; 10,337; 10,490; 11,453)	
Roane	087	19		Salt Sands (1,579); Berea (2,397); Rhinestreet (4,845); Huntersville (5,236); McKenzie (6,407)	Big Dunkard (1,020); Helderberg (5,896); McKenzie (6,407)
Wayne	099	284	Huron (2,882-2,892); Keefer (3,904-3,907)		
Wayne	099	465		Maxton (1,064); Bedford (1,968); Chagrin (2,220); Onondaga (3,140; 3,286); Keefer (3,774); Trenton (6,360; 6,543; 6,615); Knox (7,162; 7,265; 7,351; 7,763; 7,887)	Maxton (1,064); Trenton (6,360; 6,459); Knox (7,176)
Wayne	099	1572			
Wayne	099	1870	Maxton (1,580-1,613); Big Lime (1,710-1,719; 1,793-1,825); Big Injun (1,862-1,874); Berea (2,416-2,460); Lower Huron (3,268-3,376)		
Wood	107	351		Huntersville (4,041); McKenzie (7,102); Keefer (7,229); Tuscarora (7,811); Martinsburg (9,065); Trenton (9,899); Black River (10,154); Trempealeau (11,920); Mt. Simon (13,272)	Tuscarora (7,811)
Wood	107	518			
Wood	107	756			

Completed Martinsburg and Deeper Wells in West Virginia (continued). Entire table. Rows 32-41 of 41. Columns, part 3 of 4.

County Name	County Code	Permit Number	Dry Completions	Plugged Date	Logs Available	Gross Logged Interval (feet)	Cores Available	Samples	Sample Descriptions	Top: Onondaga	Top: Tuscarora	Top: Trenton
Randolph	083	101	Tuscarora (7,566; 7,611; 7,772); Oswego (9,782)	04/08/1960*	GR,I,T,*	20-7,415		425-9,815		4,552	7,137	
Randolph	083	103	Oriskany (2,819); Trenton (10,350; 10,400; 10,492)	3/27/1961	GR,D,I,N,S,*	6,282-13,101	12,679-12,726			2,480	5,703	10,118
Roane	087	19		/ /1932				1,155-9,055	V-7, V-11	5,216	7,040	8,865
Wayne	099	284		/ /1949*				3,781-4,745		3,197	4,320	
Wayne	099	465	Knox (7,189; 7,524)	1/5/1950	GR	0-7,100		12-2,460; 2,534-4,996	File	3,108	4,185	5,096
Wayne	099	1572		8/6/1975	GR,D,I,S,*	960-14,582	11,135-11,193; 13,735-13,740			2,856	3,926	4,854
Wayne	099	1870								3,750	4,845	
Wood	107	351		3/8/1955	GR,I,N,T,*	0-12,330	13,004-13,172; 9,416-13,327	4,338-13,000	RI-14, RI-18	4,022	7,679	9,065
Wood	107	518	Newburg (6,636); Tuscarora (7,598)	4/2/1965	GR,D,I,N,*	100-11,896				5,518	7,485	9,423
Wood	107	756		7/12/1977	GR,D,I,S,*	0-13,261	12,445-12,465; 12,585-12,604	40-13,260		5,011	6,800	8,540

Completed Martinsburg and Deeper Wells in West Virginia (continued). Entire table. Rows 32-41 of 41. Columns, part 4 of 4.

County Name	County Code	Permit Number	Top: Beekmantown	Top: Rose Run	Top: Conasauga-?	Top: Basement	Notes	Most Recent Production: Year	Most Recent Production: Volume (Mcf)	Most Recent Production: Operator Reporting
Randolph	083	101					plugged back to the Tuscarora			
Randolph	083	103								
Roane	087	19								
Wayne	099	284								
Wayne	099	465								
Wayne	099	1572	6,530	7,260	8,482	14,548				
Wayne	099	1870						1998	13,222 Mcf	Cabot Oil & Gas Corp.
Wood	107	351	10,706			13,272				
Wood	107	518		11,454						
Wood	107	756		10,628	11,355	13,254				

Keys: Completed Martinsburg and Deeper Wells in West Virginia

Field Definitions

Completion Date	date that total depth was reached; month/day/year (mm/dd/yyyy); O=original drilling, D=deepening, W=workover
Total Depth	depth of the well, measured in feet from the surface datum to the bottom of the well
Well Type	if more than one episode of drilling, given in order by date of episode
Pay Zone(s)	formations, with the depth to the completed interval or the base of the zone, in feet below the surface datum
Plugged Date	date the well was plugged; month/day/year (mm/dd/yyyy)
Mechanical Logs	logs on file at the Survey
Cores Available	cores available in the Survey's Core and Sample Library
Samples Available	samples available in the Survey's Core and Sample Library
Sample Descriptions	availability and source of written descriptions of the cuttings or cored intervals; File = on file at the Survey
Most Recent Production Reported	production reported to WV-DEP, the State regulatory authority for oil and gas

Datum Types

G	ground level
KB	kelly-bushing

Log Types

GR	gamma ray
D	density
I	induction
N	neutron
S	sonic
T	temperature
*	other

WVGES Pubs

B	Bulletin
RI	Report of Investigation
V	Volume

Volume Units

Mcf	thousand cubic feet of gas
bo	barrels of oil

Data were compiled by Katharine Lee Avary, West Virginia Geological & Economic Survey

Data are current through 1998.

Permission to reproduce this material is granted if acknowledgement is given to the West Virginia Geological and Economic Survey.