A Study of the Self-Purification of Strouble's Creek

by

Lee Edwards Sutton

A STUDY OF THE SELF-PURIFICATION OF STROUBLE'S CREEK.

THESIS

IN

BACTERIOLOGY

FOR

DEGREE OF BACHELOR OF SCIENCE.

VIRGINIA POLYTECHNIC INSTITUTE.

1914.

SUBMITTED BY-

Lee Edwards Sutton, Jr.

Appr. H. S. Reed,
Prof. of Mycology and Bact.

Stroubles Creek is a small stream that is situated among the mountains of Montgomery County, Virginia. It has its source from two large springs at the eastern edge of the town of Blacksburg, called Palmer's and Painter's springs respectively. The course of the stream is in a southern direction, through the town of Blacksburg, then through the campus of the school, and winding among the mountains until it reaches New River, its length being about nine miles. From there the water flows to the Mississippi river. The topography of the surrounding county is hilly and rough, which gives to the creek numerous water-falls and rapids, and brings about a steady fall of the water.

It has been found by earlier studies that portable water may become contaminated from sewage and other sources, and then through natural processes purify itself. The natural agencies that bring this change about are agitation, sunlight, dilution, and sedimentation. The first is the most important since the bed of this stream is broken by numerous ripples, rocks, etc. Other agencies considered are, the geological formation of the country through which the stream flows, the mineral constituents of the soil, and the drainage area, all of which play an important part in the sanitary conditions of the stream.

During the Month of July, 1913, I made an examination of Strouble's Creek and several neighboring springs for the purpose of determining its bacterial content.

All samples were drawn in sterile glass bottles and taken immediately to the laboratory for analysis. Then plate cultures were made to determine the number of bacteria per cubic centimeter. For this work the standard methods of the American Public Health Association for preparation of the following media, Nutrient gelatin, nutrient agar, litmus lactose agar, Heyden Nährstaff agar, and lactose bile were used. The results are shown by the following tables and respresented graphically by curves.

The number of bacteria represented in the ~~above~~ tables are approximately, and are taken from an average of counts. When there are more than two hundred colonies to a cubic centimeter, the water under examination was diluted with distilled water to a certain extent so as to obtain as near as possible that count on a plate. In order to avoid fictitious accuracy and yet to express the numerical results by a method consistent with the precision of the work the rules given below were followed.

					Number of bacteria per c.c.
From	1	to	50		recorded as found.
"	51	"	100	"	to the nearest 5.
"	101	"	250	"	" " " 10.
"	251	"	500	"	" " " 25.
"	501	"	1000	"	" " " 50.
"	1001	"	10000	"	" " " 100.
"	10001	"	50000	"	" " " 500
"	50001	"	100000	"	" " " 1000.
"	100001	"	500000	"	" " " 10000.
"	500001	"	1000000	"	" " " 50000.
"	1000001	"	10000000	"	" " " 100000.

In attempting to corelate the bacterial content of the water with its sanitary quality, the most widely used, and the most valuable of the tests is the "color test". This is based upon the circumstance that the color bacillus, B.Coli. is a common inhabitant of the human intestine and is found in great abundance in sewage, (as many as 100,000 per cubic centimeter in fresh sewage). Its close biological relationship to the typhoid bacillus, and the fact that like the latter organism, it finds its way into the sewage chiefly through the discharge of the body renders its presence, when in large numbers, particularly suggestive.

For the purpose of determining the presence of the Bacillus coli, fermentation tubes containing sterile lactose bile were inoculated with different amounts of the water according to the pollution of the stream. These tubes are so constructed that gases arising from fermentation are collected in a closed arm and there may be analyzed. If Bacillus coli is present the ratio of CO_2 to H is 1 to 2. The following table will give the results obtained. All of the tubes reading above 33 1/3% are regarded as positive, while those below, negative. A graphical curve also represents the results.

The estimation of chlorine is another important factor in determining the sanitary conditions of water. Its presence in the form of a common salt is either washed from the air or soil, or is added as one of the constituents of sewage. In regions near the sea the water is naturally salty on account of the nature of the soil, and the sanitary conditions be perfect. This goes to show that the nature of the soil will have to be taken into consideration before water can be declared to be polluted by the contents of chlorine. The following table and graphical curve will give the estimation of the salt.

The water supply of Strouble's Creek arises from numerous springs located at various points along the course of its drainage area. The water of these springs is of extreme hardness. Analyses show that there are about 169 parts per million of total solids. This is probably due to the geological formation of the territory, namely a limestone area. This is the Hagerstown Silt Loam, a soil derived from the limestone of the Shenandoah or valley series, which is one of the oldest formation and is about one mile in thickness. Limestone rock is commonly laid down in horizontal strata and it is not porous. Therefore, fissues and passages are formed and enlarged by the gradual solution and removal of the rock by the passing water. There is always the possibility of the formation of channels in the soil or rocks through which water passes, and in this way very little purification takes place. For this reason, contaminated water may flow for a long distance without undergoing purification.

Strouble's Creek gradually increases in size by the addition of several branches and a great many springs. After it leaves Blacksburg the flow is through pasturage and cultivated fields for the first two or three miles. The rest of the country is wooded and many streams from coal mines empty into it. In its course, contamination is received as it flows through Blacksburg on account of the nearness of numerous stables and privies, and at a place about a mile below the town, where the septic tank from the college buildings of the Virginia Polytechnic Institute empty into it.

The effluent from the septic tank which is discharged into the stream causes more or less nuisance and disagreeable odors in the immediate neighborhoods. How much of a nuisance is caused is not determined, as the nearest residence, which is Smithfield, is a distance little over a quarter of a mile from the tank. However, if the territory along that part of Strouble's Creek is developed and the number of inhabitants increased, it will be necessary to treat the sewage in another manner.

After it passes Smithfield the water improves in its condition and loses its color that it obtains from the effluent of the septic tank. A topographical map enclosed at the end will give an idea of the course of the stream, stations where the samples were taken, and the surrounding country.

The next thing to be considered is how bacteria get into water supplies and what their presence signifies. The soil is the most fertile source of the water bacteria since it contains large numbers. Hence the rain water which drains from off the surface of the fields comes in contact with enormous numbers of bacteria and removes many of them to the water courses As rain falls upon the soil and percolates downward it carries along many of these bacteria, and this class of bacteria from a large proportion of those found in natural waters. In some soils this carrying of bacteria is stopped by the fine pores of the soil and the bacteria are strained out. In this region in which Strouble's Creek lies, the soils are of limestone rock, and there is always the possibility that the water may pass through the soil with scarcely any filtering action whatever.

Bacteria also find their way into the water by being attached to the dust particles floating in the air and the rain washing them down. The winds, also, contaminate the water by carrying with them numbers of bacteria which comes to rest in the water ofer which they flow.

Many kinds of bacteria get into the water, but only those that are best suited will exist on account of lack of suitable food or being worsted by other bacteria. A high number of bacteria present, signifies that there is a large amount of putrefying organic material, which indicates pollution. The following table has been adopted by the American bacteriologists as a standard for judging the purity of the water.

0 to 50	Very good.
50 " 500	Good.
500 " 3000	Passable.
3000 " 5000	Poor.
5000 " 10000	Bad.
10000 upward,	Very bad.

During the winter and spring months the number of bacteria will be quite large, but so far as health is concerned they are not objectionable unless their number is too great. From the report of the bacteriological examinations of the water supply, which comes from a spring similar to those which feed Strouble's Creek, of the Virginia Polytechnic Institute, by Dr. Howard S. Reed, there is given the count of the number of bacteria by months in the college spring. The general results are shown by the accompanying table, the counts of which were made from gelatin.

Months of 1911.	Number of bacteria per c.c.
January 1,	250
February 1,	210
March 1,	300
April 1,	200
May 1,	80
June 1,	110
July, 1,	46
August 1,	56
September 1,	50

From the preceding table, it is shown that the number of bacteria was the greatest in the months of March, January, February, April, etc., in the order named.

Not only are the springs higher in count in the winter but also the streams. The following table will show the difference in the counts on Heyden Nährstaff agar, of several of the stations on Strouble's Creek during the months of March and July:

Samples drawn from	Number of bacteria per cc. Heyden Agar March 1913.	July 1913.
Baptist Church	37,000	11,800
Argabrite's Stable	1,255,000	480,000
Below meeting of 2 streams	40,000	31,500
Above septic tank	14,500	16,000
At septic tank,	2,950,000	850,000
100 yds. below septic tank,	900,000	222,000
200 " " " "	200,000	70,000
300 " " " "	129,500	52,000
400 " " " "	161,000	44,000
500 " " " "	70,500	36,000
600 " " " "	62,700	33,500
880 " " " "	31,600	25,000

As was mentioned above, the standard media that were used in the methods for determining the bacterial count were beef peptone agar, gelatin, litmus lactose agar, and Heyden Nährstaff agar. In making counts the standard beef peptone gelatin is generally used by all bacteriologists. In recent years, Heyden Nährstaff, a nutrient preparation has attracted the attention of these men. The advantage in using it consists in the fact that the Heyden agar gives higher counts and can be prepared so easily. No need of adjusting reaction. Beef peptone agar is not so reliable for counting water bacteria since it appears to be unsuited for the growth of many classes of these organisms. Furthermore, from the Nährstaff agar it is possible to make some classification of the organisms. The chief objection against using Nährstaff agar seems to be that the harmless water bacteria develop in proportionately larger numbers than the undesirable bacteria coming from the intestines of warmer blooded animals. Hence the count of good waters is apt to be high while the count of waters polluted with sewage is not as high as it should be. The litmus lactose agar is used in order to show the number of acid forming colonies which are found in streams contaminated with sewage and organic matter. On this media, the acid forming organisms change the blue litmus giving it a red color. The number of red colonies will show the quantity of acid forming bacteria.

FERMENTATION TESTS.

No.	Samples taken from	Chlorine p.p.m.	Lactose Bile Per Cent Gas. For 24 hrs. 1 cc.	For 24 hrs. .1 cc.	For 48 hrs. 1 cc.	For 48 hrs. .1 cc.	For 72 hrs. 1 cc.	For 72 hrs. .1 cc.
1	Palmer's Spring	7	28	---	38	--	38	--
2	Baptist Church	10	17	24	33	38	50	47
3	Argabrite's Stable	10½	--	42	--	59	--	62
4	Below meeting of 2 streams	10	25	37	40	45	45	48
5	In front of Agr. Hall	9	19	43	32	56	42	60
6	Just above septic tank	8	20	33	30	44	38	45
7	At Septic Tank	16	--	55	--	65	--	70
8	100 yds. below septic tank	10	--	33	--	49	--	64
9	200 " " " " " "	10	97	46	99	65	99	77
10	300 " " " " "	10	80	45	83	65	85	77
11	400 " " " "	9	72	--	76	--	78	--
12	500 " " " "	9	90	40	99	50	99	53
13	600 " " " "	8½	70	38	85	44	99	66
14	880 " " " "	8½	44	34	60	44	65	65
15	1 mile " " "	9	22	30	28	61	43	68
16	2 miles " " "	8	45	25	64	78	70	86
17	3 " " " "	9	21	9	40	31	53	48
18	Painter's Spring	4	0	--	3	--	3	--
19	Hoge's "	16	34	33	42	40	43	41
20	Conner's "	13	28	2	38	7	40	7
21	Henderson's "	20	23	0	39	0	58	0
22	Campbell's "	11	40	11	60	77	64	85
23	Sulphur "	7	0	0	0	0	0	0
24	College "	6	0	0	0	0	0	0
	Tap in Laboratory	6	0	0	0	0	0	0

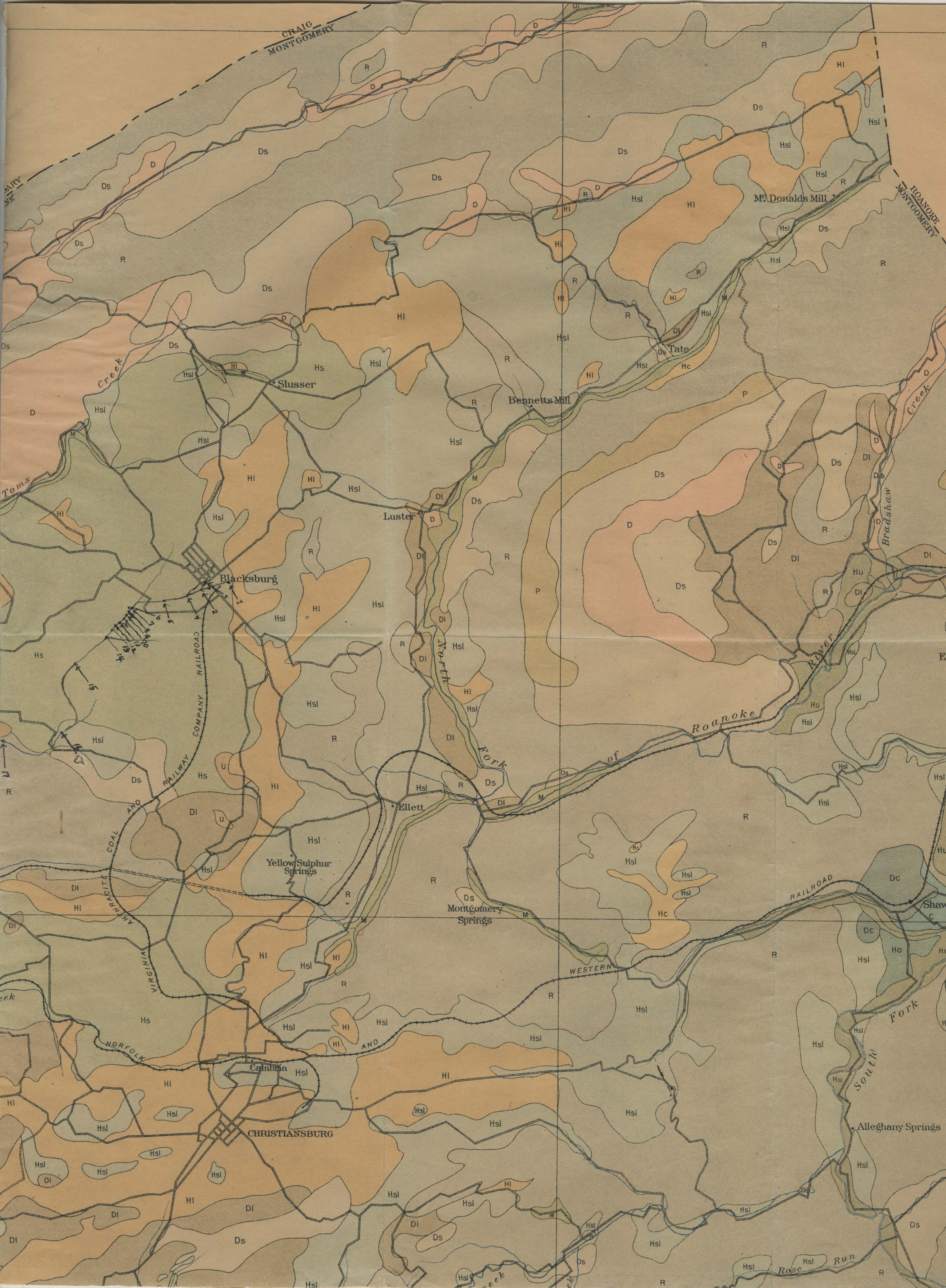
Bacteriological Examination of Water.

Samples collected and analyzed by Lee Sutton, July 9th, 1913.

No.	Samples drawn from.	Number Bacteria per cubic centimeter. Beef Peptone Agar.	Heyden Agar.
1	Palmer's Spring	18	41
2	Baptist Church	6,400	11,500
3	Argabrite's Stable	200,000	480,000
4	Below meeting of two streams	7,700	31,500
5	In front of Agricultural Hall	6,500	19,500
6	Just above septic tank	4,000	16,000
7	At septic tank,	850,000	850,000
8	100 yds. below septic tank	70,000	220,000
9	200 " " " "	68,000	70,000
10	300 " " " "	48,000	52,000
11	400 " " " "	36,500	44,000
12	500 " " " "	38,000	36,000
13	600 " " " "	33,500	33,500
14	880 " " " "	18,500	25,000
15	1 mile " " "	12,500	18,000
16	2 miles " " "	7,300	16,000
17	3 " " " "	7,100	- - - -
18	Painter's Spring	120	180
19	Hoge's "	850	2,400
20	Conner's "	450	2,600
21	Henderson's "	750	1,800
22	Campbell's "	400	950
23	Sulphur "	800	650
24	College "	65	85
25	Tap, in laboratory (Strouble's Creek)	120	170

No.	Samples drawn from.	Gelatin Plates. Liquifiers	Total	Litmus Lactose Agar. Red Colonies	Total
1	Palmer's Spring	1	14	0	Spreaders
2	Baptist Church	100	700	500	2,200
3	Argabrite's Stable	0	15,000	10,000	160,000
4	Below meeting of two streams	100	1,200	400	2,500
5	In front of Agricultural Hall	Lost	1,200	300	1,800
6	Just above septic tank	50	700	1,100	2,200
7	At septic tank	5,000	250,000	160,000	440,000
8	100 yds. below septic tank	5,000	60,000	130,000	170,000
9	200 " " " "	500	60,000	10,000	22,000
10	300 " " " "	700	32,500	9,900	15,000
11	400 " " " "	0	6,400	5,200	10,000
12	500 " " " "	300	27,500	6,700	15,000
13	600 " " " "	600	22,500	1,000	8,200
14	880 " " " "	0	9,600	0	Spreaders
15	1 mile " " "	300	9,200	1,900	4,900
16	2 miles " " "	500	13,000	200	3,200
17	3 miles " " "	300	4,50[illegible]	1,400	Spreaders
18	Painter's Spring	1	70	2	55
19	Hoge's "	30	600	60	300
20	Conner's "	170	1,700	50	210
21	Henderson's "	40	800	50	220
22	Campbell's "	50	950	10	325
23	Sulphur "	20	275	120	325
24	College "	3	70	0	Spreaders
25	Tap, in laboratory (Strouble's Creek)	10	115	0	"

37°20'
10'
CRAIG
MONTGOMERY
GILES
MONTGOMERY
CO.
CO.
BOUNDARY LINE
Blacksburg
Slusser
Prices Fork
Cowans Mills
Yellow Sulphur Springs
Vicar Switch
Cambria
CHRISTIANSBURG
EAST RADFORD
RADFORD
Toms Creek
Poverty Creek
Norris Run
Stroubles Creek
Walton Creek
Plum Creek
Radford Branch
VIRGINIA ANTHRACITE COAL AND RAILWAY COMPANY RAILROAD
NORFOLK
1. Palmer's Spring
2. Baptist Church
3. Argabrite's Stable
4. Where 2 streams meet
5. In front of agriculture Hall
6. Just above septic tank
7. At septic tank
8. 100 yds below septic tank
9. 200 " " " "
10. 300 " " " "
11. 400 " " " "
12. 500 " " " "
13. 600 " " " "
14. 880 " " " "
15. 1 mile " " " "
16. 2 " " " "
17. 3 " " " "


CRAIG
MONTGOMERY
ROANOKE
MONTGOMERY
McDonalds Mill
Tate
Slusser
Bennetts Mill
Luster
Blacksburg
Toms Creek
North Fork
Roanoke River
Bradshaw Creek
Ellett
Yellow Sulphur Springs
Montgomery Springs
VIRGINIA ANTHRACITE COAL AND RAILWAY COMPANY RAILROAD
NORFOLK AND WESTERN RAILROAD
Cambria
CHRISTIANSBURG
Alleghany Springs
South Fork
Rose Run

37°20'
10'
LEGEND
Hsl Hagerstown stony loam
Hu Huntington loam
Hl Hagerstown loam
H Huntington silt loam
Hs Hagerstown silt loam
T Toxaway fine sandy loam
Hc Hagerstown clay loam
In Indian loam
Ds Dekalb stony loam
Rl Radford loam
D Dekalb fine sandy loam
P Paris loam
Dl Dekalb silt loam
U Upshur silt loam
Pg Pilot gravelly loam
Ho Holston silt loam
Pl Pilot loam
Dc Decatur clay loam
Cg Cumberland
M Meadow
ROANOKE CO.
MONTGOMERY CO.
BOUNDARY LINE
McDonalds Mill
Tate
Bennetts Mill
Bradshaw Creek
Lafayette
Elliston
Roanoke River
Fork of Roanoke
Shawsville
RAILROAD
WESTERN
South Fork of
Alleghany Springs
Rose Run


GILES CO.
MONTGOMERY CO.
BOUNDARY LINE
Blacksburg
Slusser
Bennetts Mill
Tate
Luster
Prices Fork
Cowans Mills
Ellett
Yellow Sulphur Springs
Montgomery Springs
Vicar Switch
Toms Creek
Poverty Creek
Norris Run
Stroubles Creek
North Fork of Roanoke
Crab Creek
Walton
VIRGINIA ANTHRACITE COAL AND RAILWAY COMPANY RAILROAD
WESTERN
1. Palmer's Spring
2. Baptist Church
3. Argabrite's Stable
4. Where 2 streams meet
5. In front of agriculture Hall
6. Just above septic tank
7. At septic tank
8. 100 yds below septic tank
9. 200 " " " "
10. 300 " " " "
11. 400 " " " "
12. 500 " " " "
13. 600 " " " "
14. 880 " " " "
15. 1 mile " " "
16. 2 " " " "
17. 3 " " " "


BOUNDARY LINE
Toms Creek
Slusser
Blacksburg
Luster
North Fork
Prices Fork
Creek
VIRGINIA ANTHRACITE COAL AND RAILWAY COMPANY RAILROAD
Ellett
Yellow Sulphur Springs
Montgomery Springs
Vicar Switch
Creek
NORFOLK AND
Cambria
CHRISTIANSBURG