Mine Pools as a Valuable Municipal and Economic Water Resource in the Central Appalachian Coalfields

2022 WV Mine Drainage Task Force Symposium
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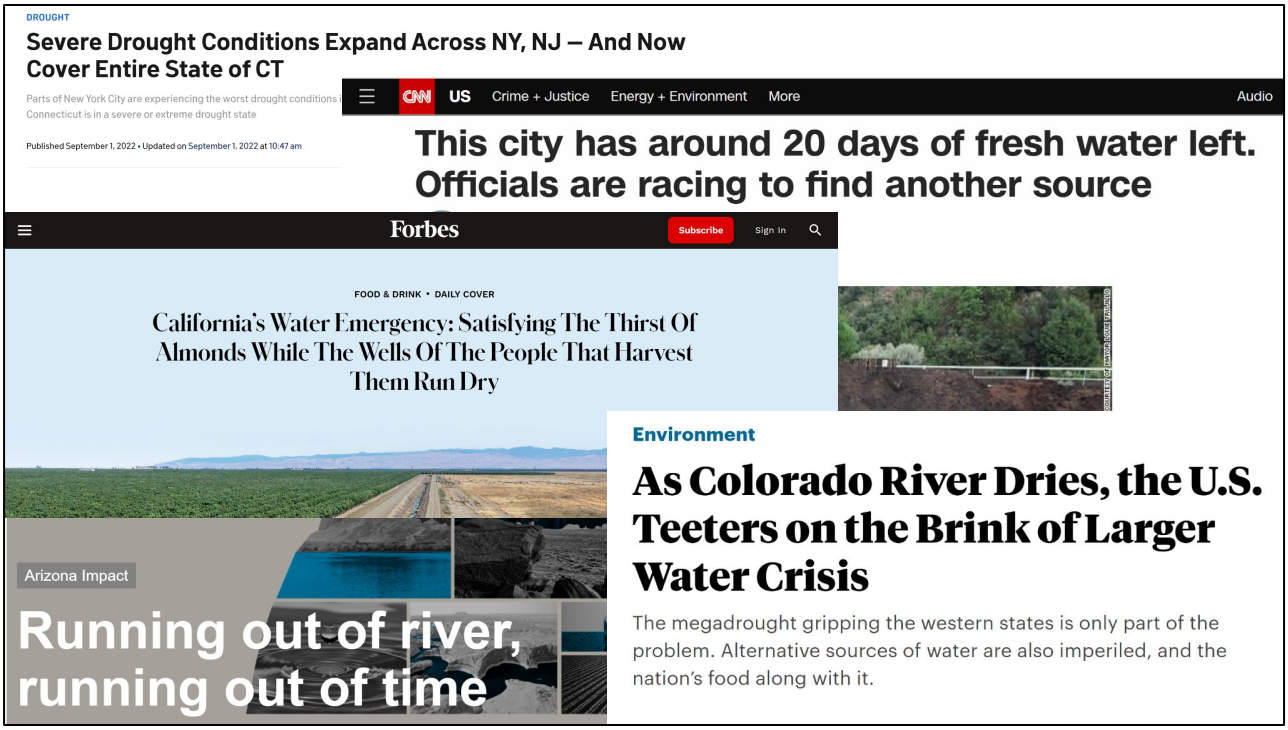
These speaker notes will be included in the post-presentation .pdf file.

Overview

1. Rebuffing the antihero reputation of mine water
2. Historical trends in mine pool use
3. Mine pools as a potable drinking water source
4. Current and projected mine water projects

Overview of presentation



As the country struggles with the impact of drought on surface water sources and drinking water needs,

The Preston County News & Journal

GOT NEWS? SEPTEMBER 26, 2022

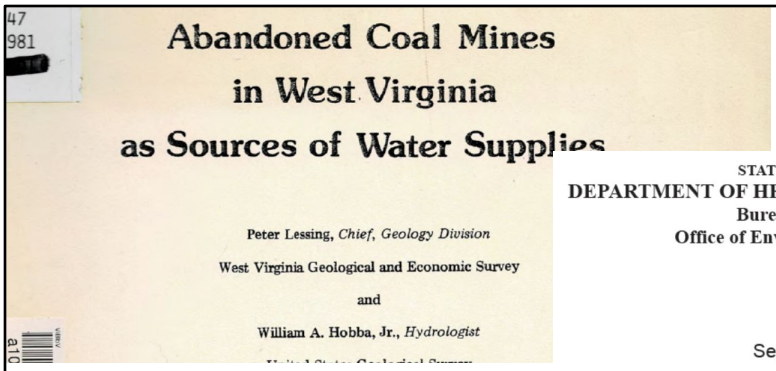
HOME NEWS SPORTS OBITS OPINION RECORDS DELIVERY E-EDITION CLASSIFIEDS DEALS WV TV

PREV

West Virginia only state without any drought, according to U.S. Drought Monitor

by Josiah Cork STAFF WRITER Aug 30, 2022 0

West Virginia has the unique ability to utilize a variety of both traditional and, perhaps, nontraditional water resources to meet drinking water demand.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Abandoned Coal Mines in West Virginia as Sources of Water Supplies

Peter Lessing, *Chief, Geology Division*
West Virginia Geological and Economic Survey
and
William A. Hobba, Jr., *Hydrologist*

STATE OF WEST VIRGINIA
DEPARTMENT OF HEALTH AND HUMAN RESOURCES
Bureau for Public Health
Office of Environmental Health Services

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September 13, 2022

year	POTW	people	MGD
1981	72	81,600	7
2022	30	78,380	?

As a baseline of PROVEN deep mine pool water use, I refer to a 1981 WVGS publication that indicated 72 treatment systems provided drinking water for over 80,000 West Virginians. Recently, the WV Sourcewater Program at the DHHR summarized that there are currently 30 publicly operated treatment works (some of them were not in place in 1981) that provide water for over 78,000 citizens.

It is remarkable that in over 40 years, as WV lost over 150,000 people (1980 census 1.95 million, 2022 1.8 million), a higher percentage of folks now rely on underground mine pools for drinking water. Some rather large communities abandoned their mine pools. Other large ones maintained or expanded their systems to include mine pools as sourcewater.

Homeland Security is now involved in the inventory and cannot reveal the actual location of the source or the volume of water.

That is a lot of water. The report estimated that flooded mine pools in WV total over 250 billion gallons which is about the size of the flood pool for Bluestone Lake. If you have seen it at normal pool 11 miles long or 2000 acres, the flood pool is 3 times that or 36 miles long. Summersville is only 2700 acres. So the mine pools in WV exceed some of our largest surface water impoundments by a factor of 3.

These mine pools maintain their water levels after reaching hydraulic equilibrium with the ground and surface waters and can be accessed by discharges from openings to the surface or pumped.

While the proceedings of this symposium over the last 40 years have largely focused on problematic mine drainage or where water resources uses are compromised by mine drainage, MUCH of the mine pool drainage in WV, even in Appalachia is of good quality, suitable for a potable supply with only disinfection needed.

Mine Pools as Potable or Industrial Water Supply

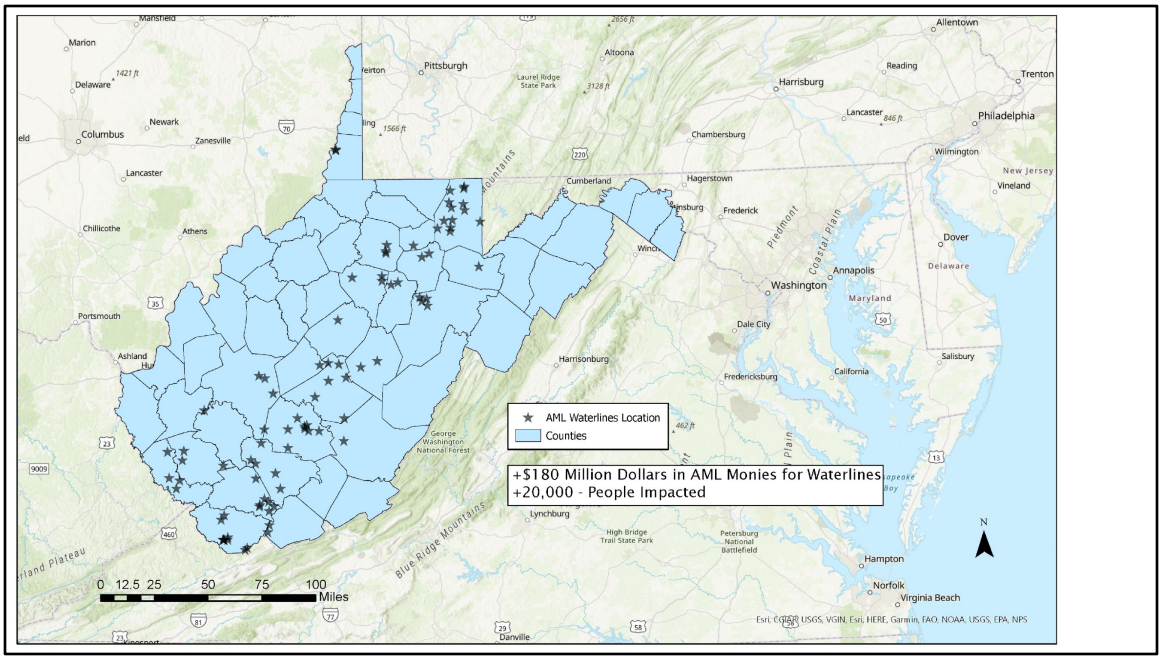
Problems

- Quality? Consumer Perception?
- Might be variable
- Only 10 counties (9 in South)
- Subsidence?

Benefits

- Quality
- Large Pools are ~Stable
- Inexpensive – may be gravity flow
- Reliable (no evaporation)
- Security (vs Surface water)

It was obvious why these communities prior to 1981 chose mine water and why many still choose mine water today.
It's like having your free water tank or reservoir out of sight, and out of harm's way.
While we are focusing on potable water sources, bear in mind that there is growing demand for large quantities of water for industrial use. The WVGS in its Mine Pool Atlas of 2012 listed these uses as aquaculture, public supply, coal-to-liquid hydrocarbons, hydraulic fracturing for gas wells, power plant cooling.



This map was provided by Mike Richardson of the Charleston, WV OSM office.

This August, 2022 map shows waterline locations, cost and people served completed by the WV AML program to date.

Basically, all the water lines installed in the south were replacement of old, existing systems that used abandoned deep mines as their source water.

Most of the waterlines in the north are for quality/ quantity issues associated with AMD and/or subsidence.

Water line installation is still a big part of the AML program utilizing the original fee-based funding, the Abandoned Mine Lands Economic Revitalization program funding, and the proposed Infrastructure Bill funding.

1981 POTW Mine sources NOW available?

Name	County	Coal Seam	1981 population	1981 connections	1981 GPD
Twilight-Robin Hood	Boone	Winfred/D	200	72	
Arbuckle PSD	Fayette	Sewell?	1400	340	58,250
Cannelton	Fayette	Sewell, Ca	600	168	22,600
Cliffton-Winding Gulf	Fayette	Firecreek	40	8	12,000
Fayetteville Municipal Water Board	Fayette	Sewll, Kay	5110	1460	250,000
Minden (part of Arbuckle PSD)	Fayette	Sewell	1368	289	67,000
Mossy PSD	Fayette	Sewell, Oa	900	240	24,200
Mt. Hope Water System	Fayette	Sewell	3500		
Oak Hill- WV Water Co.	Fayette	Sewell/Mi	17500	5000	1,346,330
Salem, Gatewood PSD	Fayette	Sewell	1900	590	118,600
Smithers Utility Co.	Fayette	#2 Gas, Ea	2000	176	352,000

So there are many mine pools that were once serving large municipalities (Oak Hill, Fayetteville) that are no longer being used at all. They represent a PROVEN source of good water available for development. This slide shows the abandoned pools with proven water quality and quantity in **Boone and Fayette** counties.

1981 POTW Mine sources NOW available?

Name	County	Coal Seam	1981 population	1981 connections	1981 GPD
Amherst- Buffalo Ck. PSD	Logan	?	1122	374	360,500
Chauncey-Enaloc Water Corp.	Logan	Cedar Gro	1782	369	
Dehue- Dinguss Rum Coal Co.	Logan	?	600	127	80,000
Holden- Southern PS Co.	Logan	Eagle, Isla	3200	800	250,000
Logan PS Co.	Logan	?	1232	465	120,330
Manitoba - Dinguss Rum Coal Co.	Logan	Chilton, Et	444	148	20,000
Orville - Dingess Rum Coal Co.	Logan	Chilton, Yc	88	22	15,000
Switzer- Logan Water Co.	Logan	?	1188	297	48,000
Yolyn- Dinguss Rum Coal Co.	Logan	Chilton, Yc	240	67	20,000

ALL the communities in **Logan** county that once drew from deep mines are now on PSD supplied water that draws from surface sources. Many of them here and elsewhere were visited, sampled, and flow measured in 1996 for The Conservation Fund's Freshwater Institute "West Virginia Mine Water inventory Site Summary.

1981 POTW Mine sources NOW available?

Name	County	Coal Seam	1981 population	1981 connections	1981 GPD
Algoma - United Pocahontas	McDowell	Pocahonta	100	35	12,000
Bottom Creek	McDowell	?	88	25	
Buchannan - McDowell Co. Water Co.	McDowell	?	56	16	38,880
Caretta- McDowell Co. Water Co.	McDowell	Beckley, C	808	210	236,000
Elkhorn, Crozier, Ennis - Elkhorn PS Co.	McDowell	Pocahonta	348	116	150,000
Gary #14 Mine- Munson	McDowell	Pocahonta	400		60,000
Havaco - McDowell Co. Water Co.	McDowell	Pocahonta	443	124	38,880
Hemphill -McDowell Co. Water Co.	McDowell	Pocahonta	519	148	230,400
Indian Ridge -United Pocahontas	McDowell	Pocahonta	100	31	
JenkinJones	McDowell	Pocahonta	1000	145	75,000
Premier -McDowell Co. Water Co.	McDowell	Pocahonta	440	44	100,800
Superior	McDowell	?	300	75	10,000
Tidewater, Vivian, Kimball Light & Water Co.	McDowell	Pocahonta	450	104	110,000
Twin Branch Water Co.	McDowell	Sewell	175	50	

McDowell County had many communities that have now come under a more centralized county PSD, and many of them still use mine water. These 14 mine pools that are NOT currently being used are likely good locations for water development.

1981 POTW Mine sources NOW available?

Name	County	Coal Seam	1981 population	1981 connections	1981 GPD
Giatto	Mercer	Pocahonta	200	72	4,000
Hiawatha Water System	Mercer	?	105	30	
Blaine Community	Mineral	?	88		
Ragland- Appalachian Utilities	Mingo	Lower Cec	308	88	17,000
Redjacket - Appalachian Utilities	Mingo	?	658	188	
Amigo Water System	Raleigh	Pocahonta	225	70	16,110
East Gulf Water Works	Raleigh	?	175	50	35,000
Epperly-Winding Gulf	Raleigh	Beckley	191	55	24,000
Helen Water Service	Raleigh	Pocahonta	500	111	24,550
McAlpin - winding Gulf Coal	Raleigh	Beckley	80	20	11,450
Stoco	Raleigh	Beckley, Pl	2500	477	121,315
Stotesbury Water Service	Raleigh	Beckley	240	40	10,000
Sullivan Water Service	Raleigh	?	110	33	15,000
Whitby	Raleigh	?	200	55	9,000
Alpoca Water Works	Wyoming	Pocahonta	500	160	85,000
Marianna - Appalachian Utilities	Wyoming	?	130	41	
Otsego -Brookside Water Service	Wyoming		100	25	12,000

And **Mercer, Mingo, Raleigh and Wyoming** also have mine pool sources available.

1981 POTW Mine sources NOW available?

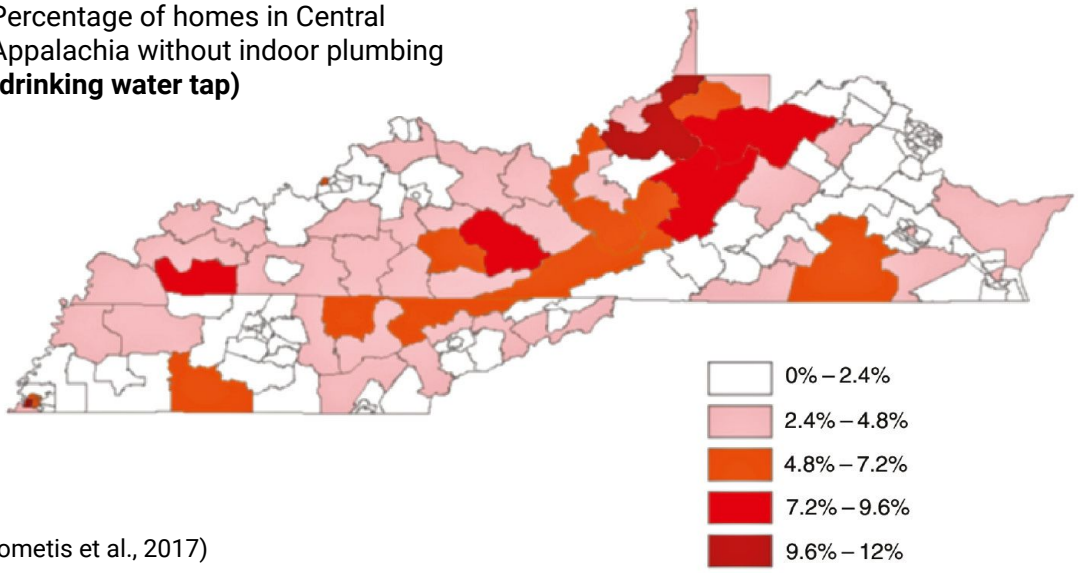
Totals
55,951 people
13,650 taps
4,611,195 GPD

So when we look at the deep mine pools abandoned by the communities and PSDs we see we have sufficient water for
56,000 people and over 4 Million Gallons per day.
PROVEN capacity. Of course the current **quality** must be verified.
But it is available.

In the Central Appalachian region, mine pools are used as a drinking water source for both public and private water supplies.

Drinking Water Sources in Central Appalachia

Percentage of homes in Central Appalachia without indoor plumbing **(drinking water tap)**



(Krometis et al., 2017)

In 2017, Krometis et al., performed an analysis of environmental health disparities in the Central Appalachian region. This map was generated using US Census Bureau's Public Use Microdata Areas (PUMAs) between 2010 and 2014. The map depicts that in the Central Appalachian region, there are counties where over 10% of homes lack access to indoor plumbing, including a drinking water tap. For extra context, there are also counties in which over 5% of homes lack an indoor toilet all together.

Roadside Springs as a Drinking Water Source

Lamar Water Hole located near Matoaka, WV

- Untreated and unregulated
- Appalachian springs have consistently tested positive for total coliform and *E. coli* bacteria. (Swistock et al., 2015; Krometis et al., 2019; Patton et al., 2020)
- Many water sources colloquially known as "springs" are actually mine pools

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Where are people getting their drinking water if they do not have access to drinking water in their home or, if they do not trust the quality of the drinking water from their home taps? While some individuals choose to set up rain barrels to collect water to route into their homes, others buy bottled water from local grocery stores, which requires a considerable financial demand and time commitment. Other individuals choose to collect water from roadside springs for drinking water and for daily household use. This is a concern as roadside springs are untreated and unregulated. Many springs in the Appalachian region have tested positive for total coliform and *E. coli* bacteria. In a study by Krometis et al. completed in 2019, out of 83 water samples collected from 21 total roadside springs across the Appalachian region, 99% were positive for total coliform bacteria and 86% of samples were positive for *E. coli* bacteria, indicating fecal contamination of these water sources. This suggests that these roadside springs, when untreated, can be a risk to human health. In addition to physical spring sampling, we also surveyed spring users in the Appalachian region. Of 35 surveys returned, 86% of respondents said that they use spring water directly for drinking, and 63% indicated that they visited a spring at least once per week for water. Based on this study, we know that folks are utilizing roadside spring water as a drinking water source, and we know that this water often contains fecal contamination. A final, and very important component of roadside spring use is that many of these "springs" are in fact, not springs at all, they are mine pools.

Roadside Spring Water Chemistry

- Sampled springs did not exceed SDWA **health-based** standards for **metals**
- Several springs exceeded SDWA taste/aesthetic guidelines (Mn, Al)
- Several springs exceed the Na guidance level

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Looking at water chemistry in roadside springs in the Central Appalachian region, the majority of the springs we sampled during the spring study were in accordance with the Safe Drinking Water Act health-based standards for metals, used to regulate municipal drinking water supplies. Two springs exceeded the SDWA secondary maximum contaminant level (SMCL) for manganese (ppm) and six springs exceeded the SMCL for aluminum (ppm) at least once. The SMCL guidelines are established for taste and aesthetic and are not considered to be health-based guidelines. Interestingly, two springs exceeded the EPA guidance level for sodium of 20 ppm at least once. The guidance level for sodium is based on individuals who are pursuing a low sodium diet for health reasons. This is noteworthy because many individuals do not factor sodium in drinking water into their diet, especially if they are collecting their drinking water from a spring that does not come with nutritional facts.

Roadside ~~Spring~~ Mine Pool Water Quality

Mine pool used as a drinking water source on Rt. 52 in McDowell County, WV

- Sampled 16 times since 2018
- 88% have tested positive for total coliform, 13% have tested positive for *E. coli*
- 0% of samples exceeded EPA Safe Drinking Water Act Maximum Contaminant Levels for heavy metals

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This is a “roadside spring” fed by a mine pool on Rt. 52 in McDowell County, WV. We’ve sampled this spring 16 times since April of 2018. 88% of the samples tested positive for total coliform, which is perhaps unsurprising as total coliform is found in many different elements of the natural environment such as soil. 13% of the samples have tested positive for *E. coli* which is indicative of fecal contamination of the water source. It is important to note that, aside from bacteriological contamination, 0% of samples exceeded SDWA MCL levels for heavy metals.

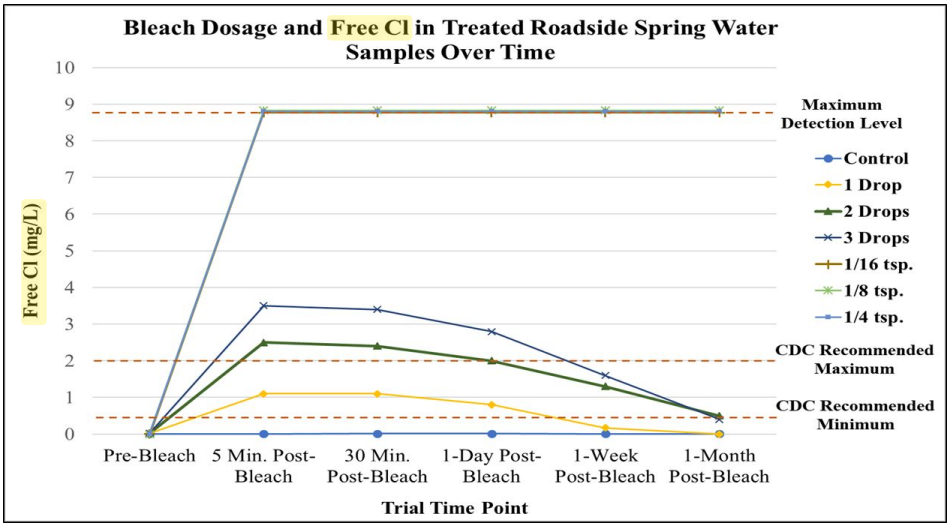
Roadside Mine Pool Water Chemistry

	pH	SPC (µs/cm)
Avg.	6.71	303.9
Max.	7.57	349

	As (ppb)	Ba (ppb)	Cd (ppb)	Cr (ppb)	Cu (ppb)	Pb (ppb)	S (ppm)	U (ppb)	Na (ppm)	Sr (ppm)	Al (ppb)	Cl (ppm)	Fe (ppb)	Mn (ppb)
Avg.	0.02	49.6	0	0.23	0.4	0	63.8	0.1	7.6	0.9	10.5	1.9	19.9	0.21
Max.	0.1	53	0	0.4	0.6	0	69.7	0.2	8.2	1.0	49.3	5.0	85.1	0.5

The table here depicts maximum and average water parameters and heavy metals concentrations recorded since we began sampling this spring in 2018. We saw an average pH of 6.71 and an average SPC of 303.9 µs/cm. As previously mentioned, this spring did not violate any SDWA health-based metals violations and, thus far it has not exceeded any aesthetic, taste, or sodium guidelines.

Development of a simple at-home disinfection strategy to reduce harm from roadside spring use



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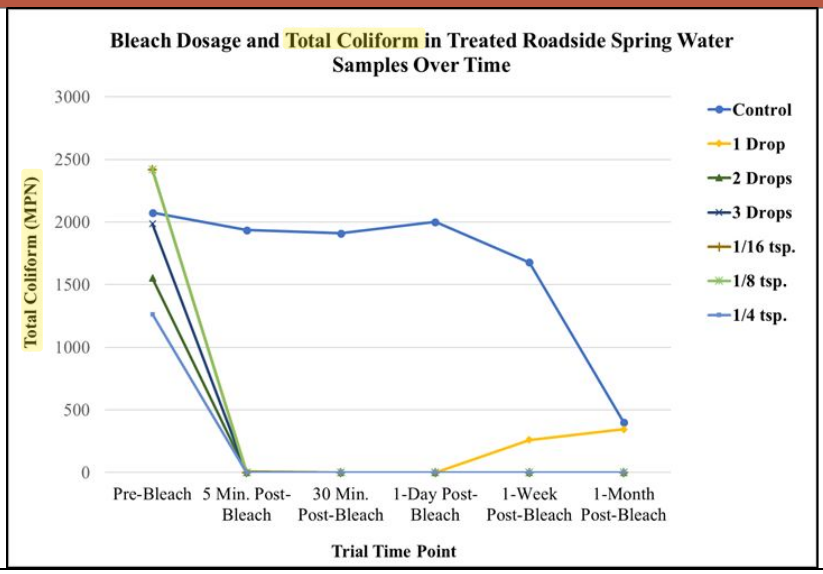
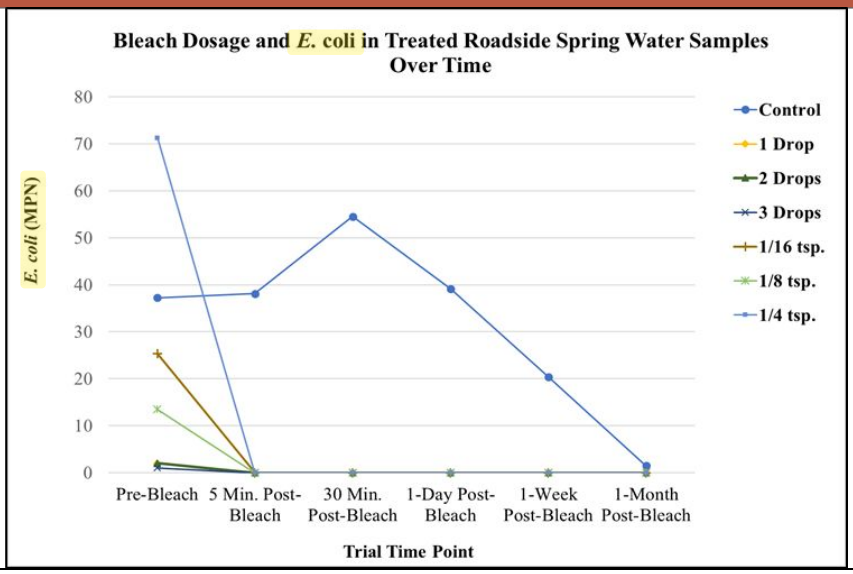
After our initial spring study, we knew that people were drinking untreated and unregulated roadside spring water and we knew that this water often contained fecal indicator bacteria that poses a significant risk to human health. We wanted to devise a point–of-use treatment method for spring users to treat the spring water for bacteria without imposing a significant financial and time burden. Ben suggested the use of a small amount of household bleach to disinfect spring water. We decided to devise a method of disinfecting collected spring water with household bleach with the goal of maintaining a free Cl residual level that is high enough to successfully remove bacteria in the water for an extended period of time, but low enough not to drastically impact the aesthetics of the spring water. It is important to note that the collection of roadside spring water has both functional and cultural significance in the lives of many Appalachian people. We wanted our method to make the water safer while acknowledging how important the taste of the water is to so many people. In short, I collected roadside spring water from several local springs in 1 gallon plastic milk jugs, as is common practice, and tested 7 different volumes of bleach over a 1-month period, a common timeline for collecting and storing spring water. We determined that 2 drops, approximately 0.10 mL, of unscented household bleach consistently met our criteria and maintained an appropriate Free Cl level over the 1-month study period.

Development of a simple at-home disinfection strategy to reduce harm from roadside spring use



Two drops of unscented household bleach also successfully removed total coliform and *E. coli* from the spring water, even after 1-month of room temperature storage.

Development of a simple at-home disinfection strategy to reduce harm from roadside spring use



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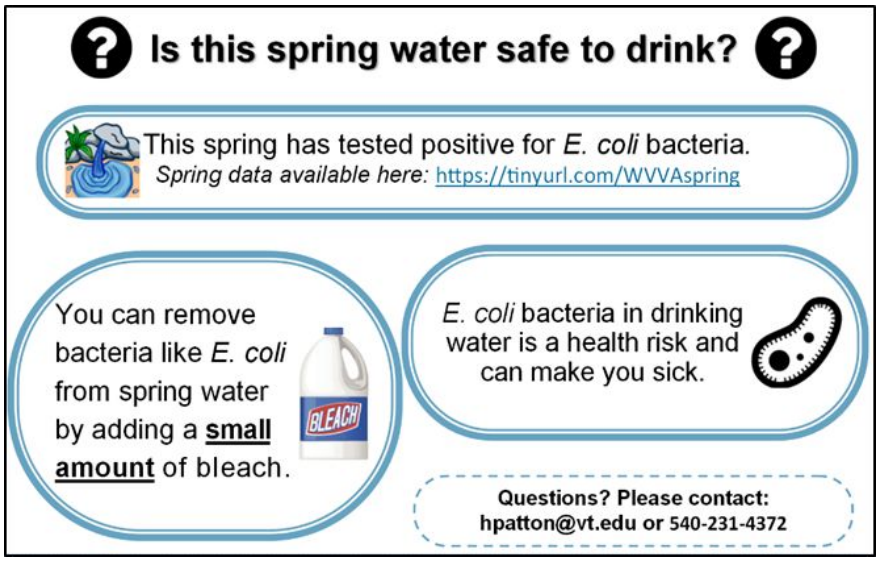
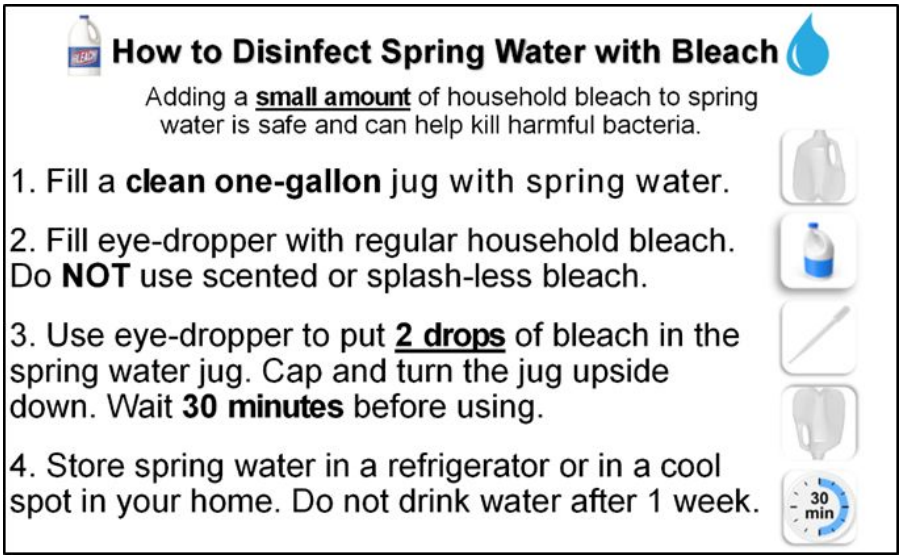
Bleach Protocol Infographic



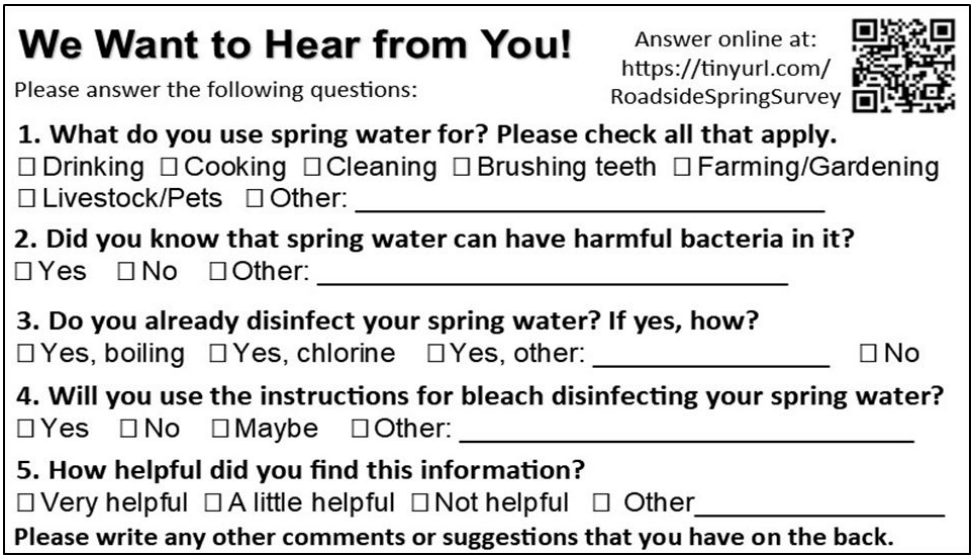
After finishing the lab study, we created an infographic with our protocol to distribute, along with a survey and a plastic eye dropper, at 5 roadside springs in SWVA and Southern WV. Pictured here is the front of the laminated infographic, providing general information on spring water quality as well as a website where people can look up recent water quality measurements at local springs.

Bleach Protocol Infographic



Pictured here is the back of the infographic, providing instructions for our bleach protocol.

Bleach Protocol Infographic Survey



We Want to Hear from You!

Please answer the following questions:

Answer online at: https://tinyurl.com/RoadsideSpringSurvey

1. What do you use spring water for? Please check all that apply.

☐ Drinking ☐ Cooking ☐ Cleaning ☐ Brushing teeth ☐ Farming/Gardening
☐ Livestock/Pets ☐ Other: _____

2. Did you know that spring water can have harmful bacteria in it?

☐ Yes ☐ No ☐ Other: _____

3. Do you already disinfect your spring water? If yes, how?

☐ Yes, boiling ☐ Yes, chlorine ☐ Yes, other: _____ ☐ No

4. Will you use the instructions for bleach disinfecting your spring water?

☐ Yes ☐ No ☐ Maybe ☐ Other: _____

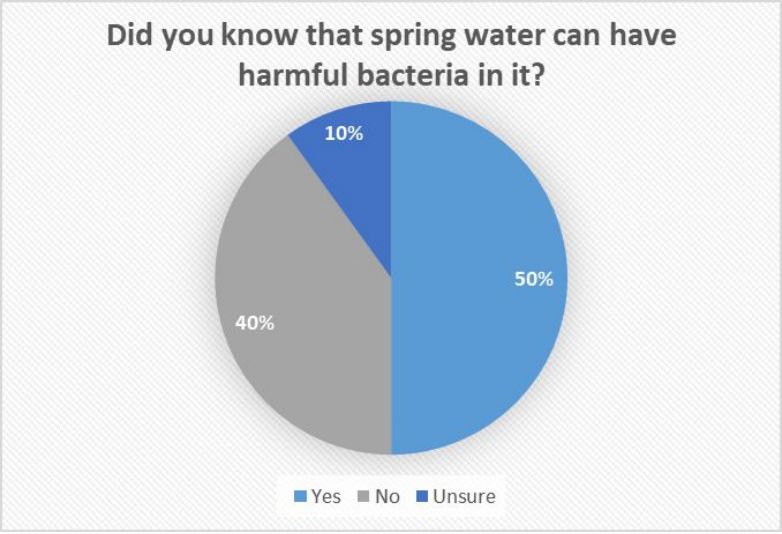
5. How helpful did you find this information?

☐ Very helpful ☐ A little helpful ☐ Not helpful ☐ Other_____

Please write any other comments or suggestions that you have on the back.

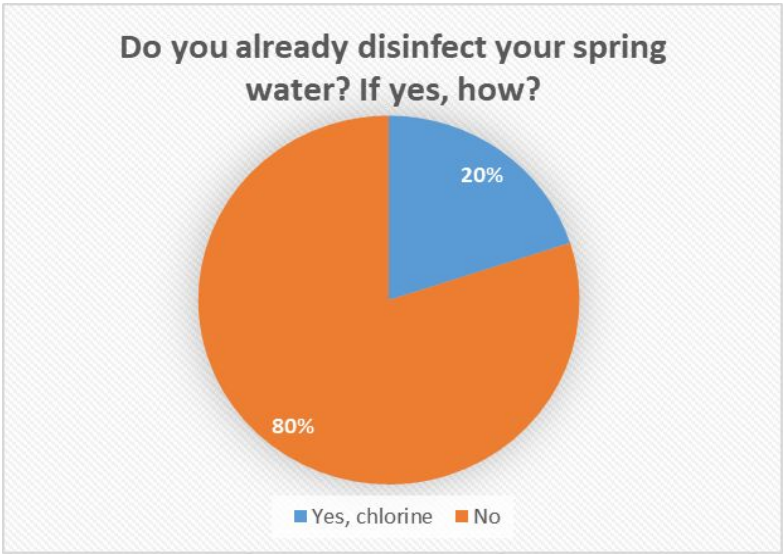
Pictured here is the survey that we distributed. Thus far, survey results have been pretty evenly split between spring users who found the information helpful and those who found the information unhelpful.

Bleach Protocol Infographic Survey



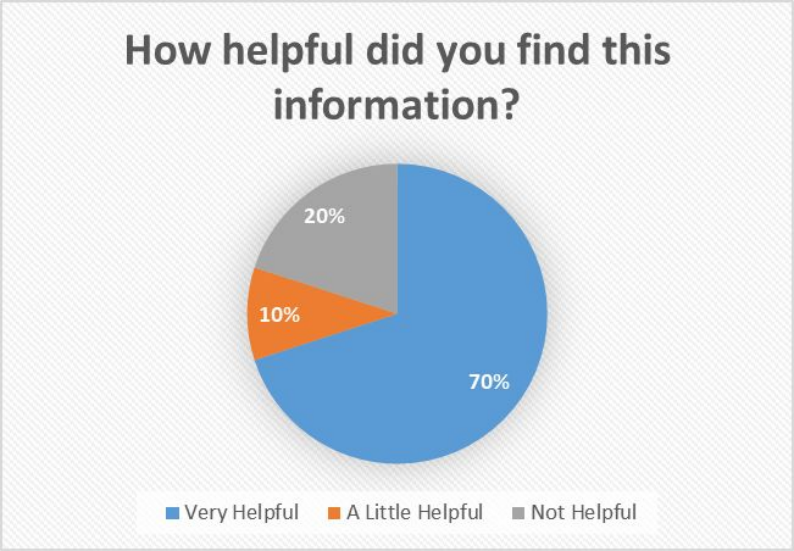
Exactly half of spring survey respondent were already aware that spring water could have harmful bacteria in it.

Bleach Protocol Infographic Survey



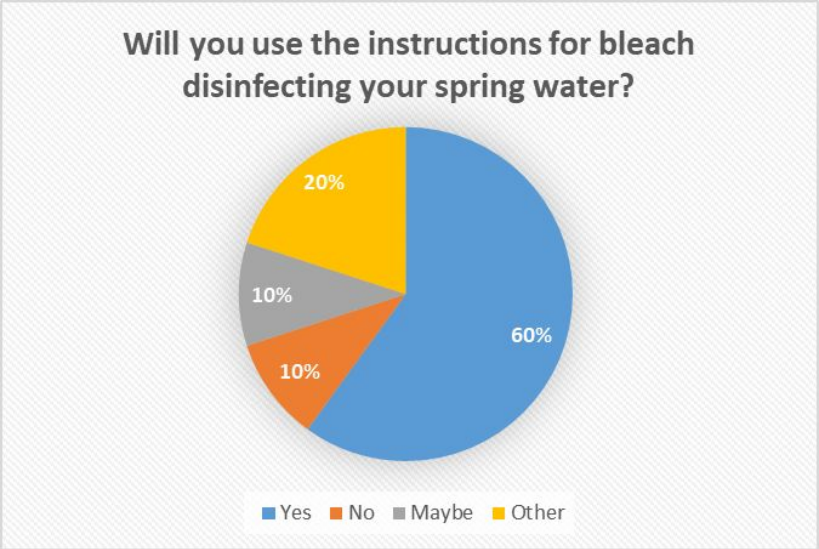
Despite this, less than a quarter of survey participants report disinfecting the spring water they collect.

Bleach Protocol Infographic Survey



When looking at the impact of the infographic specifically, we see that 80% of survey respondents found the information provided in the infographic to be at least a little helpful.

Bleach Protocol Infographic Survey



However, when we look at how many individuals plan to use the instructions we provided for disinfection, we see that only 60% of spring users responded in the affirmative. This feedback suggests that perhaps the infographic needs to be further fine-tuned to reach our target audience, or that an entirely different method of information distribution or even point-of-use treatment may be in order.

Rt. 52 Mine Pool - McDowell County, PSD

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https://travisdewitz.com/SERIES-%26-PROJECTS/CUT-THROUGH-THE-VEIN/7

As Ben previously described, there are many people in West Virginia who are served by a public water system utilizing mine pool water. The Rt. 52 mine pool that is so often used as a private drinking water source, is a great example of this as it is also utilized by the McDowell County Public Service District. A portion of the mine pool is now diverted to a small plant

where the PSD disinfects the water with chlorine and then distributes it to over 1,600 residents NEAR the town of Maybeury, WV. This gravity discharge represents the “overflow” of the mine pool.

Growing fish in mine water is nothing new. Here in 2001 two young Faulkner men learn from Task Force member Jim Ashby how the State of Maryland grows trout in Mettiki Coal's polishing ponds downstream of their AMD Treatment plant. That has been ongoing since 1994. That coal mine is "GROUND ZERO" for trout grow-out and now hatchery in the State of Maryland. See Jim Ashby for details.

'Minefish' thriving in Fayette County

by Dan Miller

The Meadow River Coal Co. belies the big coal image of its parent, Pittston Coal Co. Operating two small mines nestled on the green hillside of the New River Gorge in Fayette County, Meadow River blends in so well with its rustic environment that most folks probably don't know about the effect the company has had on the local fish count.

In addition to its mining operation, Meadow River Coal Co. is where Edsel Redden raises trout. Redden is a West Virginia University Extension Agent in Raleigh County. Part of his job is to conceive, organize and execute experimental projects for the benefit of wildlife, agriculture and West Virginia life in general.

A few years ago, he had this idea about raising trout. "All you need to raise trout are cool, clean, moving water, oxygen and food," he says, understating the rarity of that combination of elements. The main obstacle is the moving water part.

The hills of southern West Virginia are full of little underground springs. The water is clean, it's cool and it moves. The problem is volume. Most of these springs do not generate the high flow capacity needed to sustain trout.

But, Redden, a Raleigh County native and former coal miner, knew that worked-out mine shafts collect underground spring water. "There's a tremendous amount of water in old deep mines in this area," he says. "They're really like underground lakes. Several of these springs collect in the old shaft areas and come out of the ground as one stream, clean, cool and with a terrific flow capacity."

Meadow River's Rainbows are growing from four inches to about a foot in length during their six months in the tank.

That's what brought Redden and the mining industry back together. "Coal miners have stocked trout in sediment ponds for years," Redden observes. "There is no question about the fish thriving in that environment. What I wanted to do was to see if trout could be raised in mine water. And I was fairly confident that it would work, simply because everything we need is there."

Even with Mother Nature on his side, Redden needed the cooperation of several other parties to get the project off the ground. WVU approved the experiment. The Freshwater Institute, headquartered near Shepherdstown, explores economically feasible, scientifically valid, innovative approaches to the wise use of inland water resources. The Freshwater Institute provided $25,000, through a grant for from the U.S. Department of Agriculture, the Appalachian Regional Commission, the Benedum Foundation and the Steele-Reese Foundation.

Water is oxygenated before flowing into the fish tanks by a simple mechanical means of exposing to to fresh air.

The Pittston Coal Group was really the key player, lending its mine site, manpower, expertise, additional funding and general cooperation.

"This project has proven to be the perfect marriage of industry and environment," says Redden. "I can't overemphasize the effort put into this by Pittston. Mine Manager Vince Calvert and Superintendent Jim Lively have been particularly helpful.

"What we've been doing for the last two years in mainly perfecting fish management techniques for this environment. Vince, Jim and their people have been invaluable in that regard. You know, mining people are some of the greatest innovators around. They're used to problem solving and that's the kind of role they've played here. Without Pittston, this project just wouldn't have gone anywhere."

The result is the first known instance of fish being raised in quantity on an active mine site.

The mechanics of the "minefish" operation are remarkably uncomplicated. At the New River Mine, water comes out of the old Kayford underground mines at the rate of 1000 gallons a minute, ten times the rate needed for trout. Some of the water is used for the active mine operation. The excess is diverted through a simplified oxygenation system into eight six-foot round holding tanks where it serves as a thriving environment for rainbow trout. The trout water and the mine water, both untreated, drain into a sediment pond, then flow down the mountain to the New River, clean as a whistle.

At the Meadow River Mine, water is pumped 400 feet through ten holding tanks and on to the pond. The trout tanks actually sit between the mine and the sediment pond.

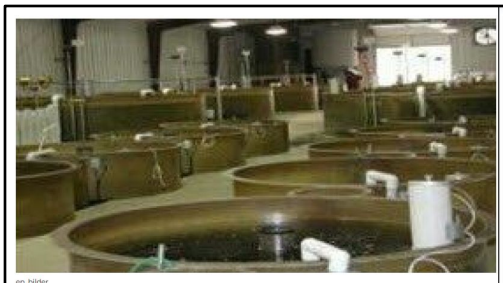
Initially, the holding tanks were "stocked" with 400 4-inch fish. Redden and his Pittston partners provided food, monitored the water for oxygen content and shipped a few fish off for health test purposes.

"We have yet to experience a health problem with our fish," reports Redden. "In fact, they are doing so well that the growth rate has been around 1.5 inches per month, which is very good." At that rate, the fish are a foot long and ready for market after about six months.

"Market" is part of the point of the experiment. Most of the trout consumed worldwide come from "fish farms." The leading U. S. producer is Idaho.

At the Meadow River Mine, the trout tanks are situated directly between the mine and the sediment pond, demonstrating the ability of the fish to thrive in untreated mine water.

Even before that, we see in the 1993 Green Lands magazine (available on the Task Force website) Pittston was growing trout at both the New River Mine and the Meadow River Mine in Fayette County. The effort was spearheaded by Edsell Redden who was WVU Extension Agent in Raleigh County.



ep_bilder

West Virginia company starts eco-trout production

Tor-Eddie Fossbakk

PUBLISERT Saturday 24. February 2018 - 12:53

Tor-Eddie Fossbakk

ADVERTISEMENT

THE STATE JOURNAL

Virginia Firm Buys West Virginia Aqua, Shifts Production to Salmon, Trout

Posted Friday, January 4, 2008 ; 03:50 PM

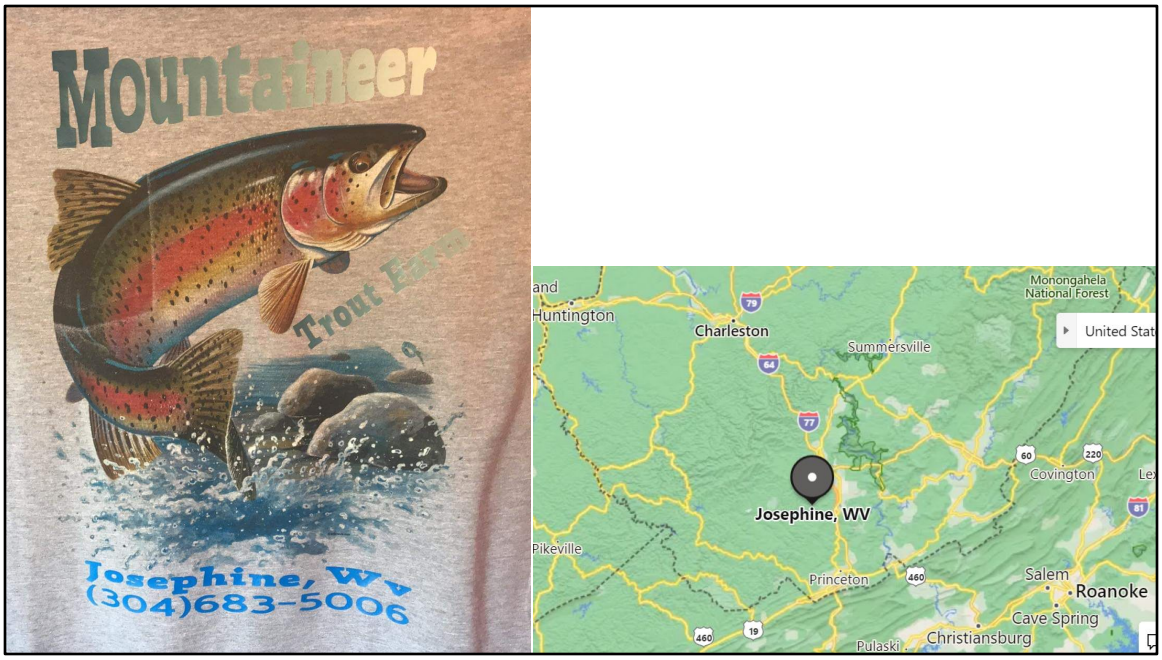
Blue Ridge Aquaculture Inc. of Martinsville, Va., purchased Mingo County-based West Virginia Aqua LLC

Story by Paul Darst
Email | Bio | Other Stories by Paul Darst

A different kind of fish soon could be swimming in West Virginia.

Mr. Buck Harless and others had an aquaculture facility in Mingo county in 2008. It raised Steelhead Trout, Artic Char and then Atlantic Salmon.

Dan Miller of Potesta & Associates assisted Consol Energy to grow trout at its Dogwood Run AMD Treatment facilty near Morgantown for quite some time. He is available for those who are interested in an aquaculture venture.



I visited the Mountaineer Trout Farm in Josephine, WV just west of Beckley last week.

The location is ideal. The Pocahontas #6 mine is partially flooded and has a gravity discharge that is diverted to the degasification tower, then to the hatchery tanks and the raceways. The outlet enters the creek at the downstream end of the facility.

The mine portal is secure with a splitter box that allows for overflow to the creek. It was developed by Edsell Reddin in the late 1980's.

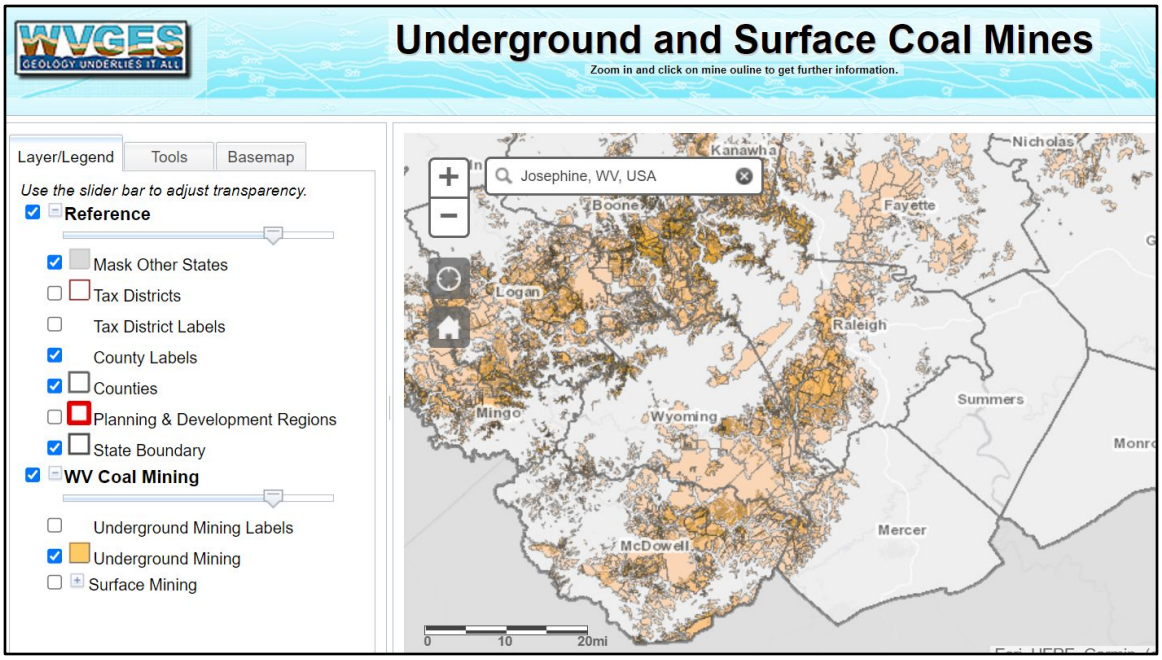
It is piped to the degassification tower

And then to the hatchery to 120,000 eggs every other month. All rainbow trout. No hybrids or GMO.

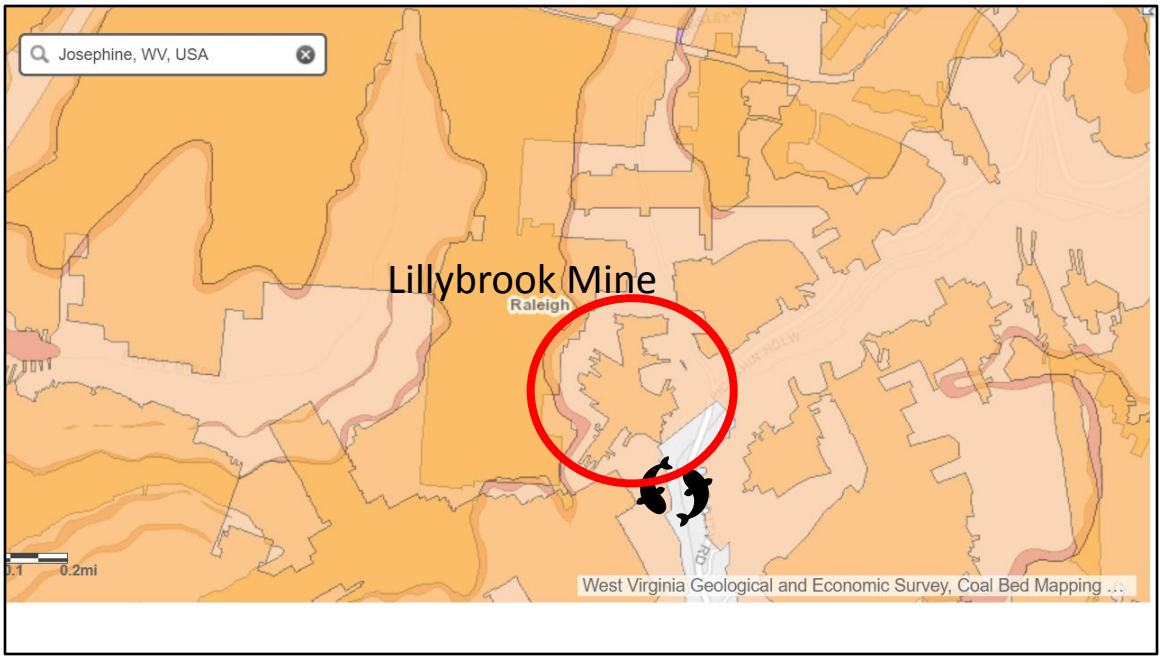
It enters the raceways supplemented with liquid oxygen at the Low Head Oxygenation Chambers

This team has averaged 350,000 pounds of trout per year distributed **wholesale** from Massachusetts to Michigan to Missouri (and to Texas). Substantial clients are commercial packers in NC. Shown is co-owner Tony Matherly. His partner is Mr. Kevin Bartley.

It is a successful sustainable industry aided by the WV Jobs Investment Trust which has helped with the financing.



The deep mine is but one of many in southern WV.



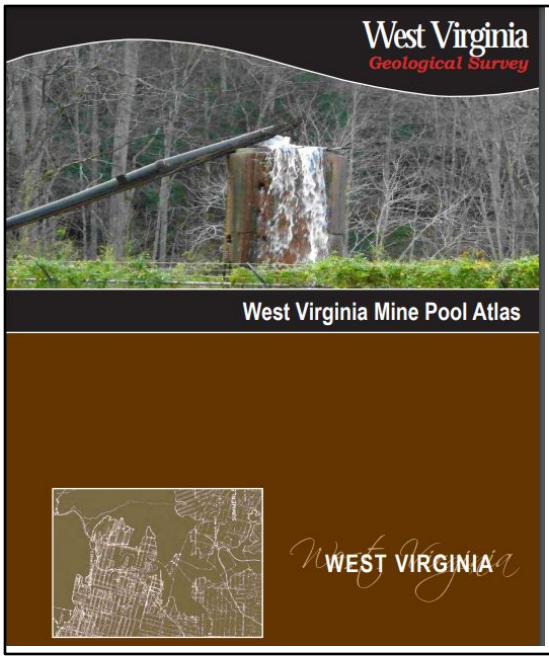
All indexed by the WV Geological Survey

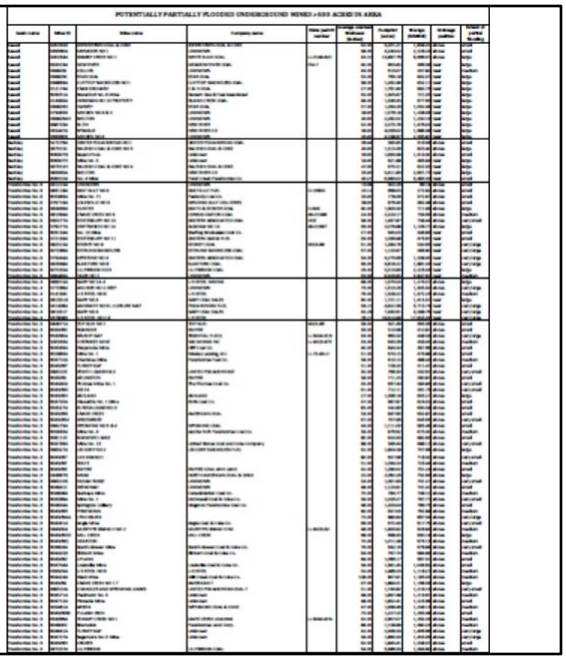
POTENTIALLY TOTALLY FLOODED UNDERGROUND MINES >500 ACRES IN AREA

Seam name	Mine ID	Mine name	Company name	State permit number	Average coal bed thickness (inches)	Footprint (acres)	Storage (MMGal)	Drainage position
Sewell	336829AC	CRANBERRY	NEW RIVER CO		43.00	4,271.55	2,494.79	below
Sewell	334858A	OAKWOOD	NEW RIVER CO		45.00	4,587.45	2,817.88	below
Beckley	376885A	HANSFORD SMOKELESS NO 4	HANSFORD SMOKELESS COLLIERIES		49.00	1,589.31	1,076.81	below
Beckley	907761A	BAYBECK MINE NO. 1	TEDDY COAL CO., INC.	U-19-84F-B	67.00	1,238.17	1,135.94	below
Beckley	953405A	BECKLEY	PICKANDS MATHER & CO		69.00	3,202.99	3,043.20	below
Beckley	953436A	ECCLES N0 5	WESTMORELAND COAL		70.75	3,640.92	3,497.34	below
Beckley	953169A	MAPLE MEADOW	MAPLE MEADOW MINING	8252	66.67	4,133.41	3,741.66	below
Pocahontas No. 6	322759B	LILLYBROOK COAL	LILLYBROOK COAL		31.00	2,186.21	938.83	below

Lillybrook Mine
Pocahontas #6 Seam
34”seam
3386 acres with 1,564 MMGal Storage
Above drainage

Sure enough, this PROVEN resource is indexed in the WVGS Mine Pool Atlas





The Mine Pool mapping project of 2012 by WVGS lists potential mine pools based on deep mine mapping. It focuses on likely flooded or partially flooded mine pools to evaluate abandoned coal mines as potential groundwater sources.
It and the Coal Bed Mapping Project are available online and the mapping is interactive and searchable.

It is indexed by coal seam, and based on available water quality, the Beckley and Sewell coal seams in the New River formation and Pocahontas seams of the Pocahontas formation are very interesting

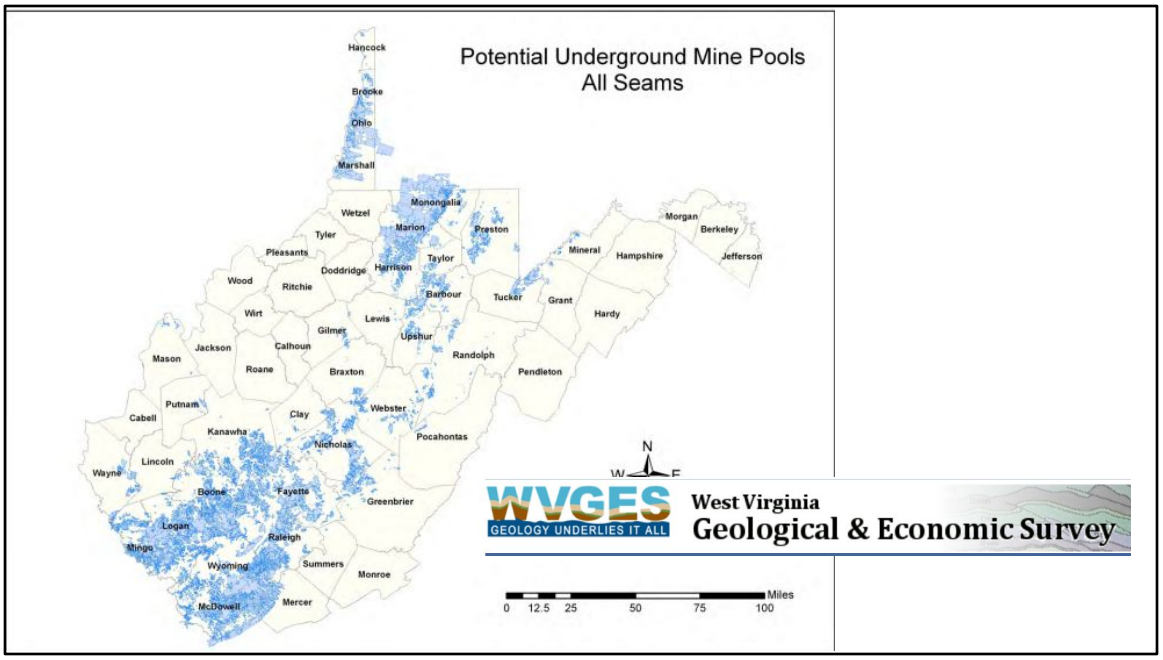
The WVGS MinePoolAtlas concluded there were ~100 mines > 500 acre generally below drainage potentially **totally** flooded

- Pittsburgh coal in Ohio, Marshall, Monongalia, Marion, and Harrison counties
- Upper Freeport coal in Preston County
- Middle Kittanning coal in Preston and Barbour counties
- Coalburg coal in Wayne and Lincoln counties
- Peerless coal in Kanawha, Nicholas, and Mingo counties
- Number 2 Gas coal in Logan, Mingo, Boone, and Kanawha counties
- Powellton coal in Boone, Logan, and Mingo counties
- Lower Powellton coal in Mingo County
- Eagle coal in Nicholas, Fayette, Kanawha, Boone, Logan, and Mingo counties
- Sewell coal in Nicholas, Fayette, Raleigh, and Wyoming counties
- Beckley coal in Fayette, Raleigh, and Wyoming counties
- Pocahontas No. 6 coal in Raleigh County
- Pocahontas No. 4 coal in McDowell County
- Pocahontas No. 3 coal in Wyoming, McDowell, and Raleigh counties

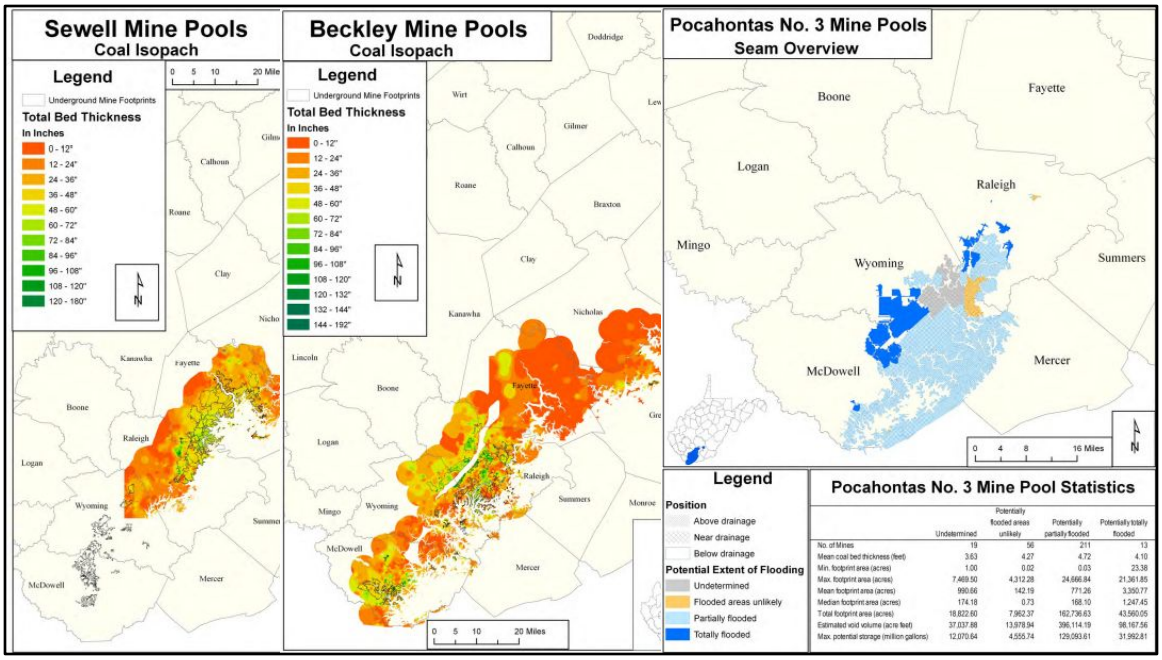
The WVGS MinePoolAtlas concluded there were ~100 mines > 500 acre generally below drainage potentially totally flooded

They are organized by oldest to youngest seams and that roughly corresponds to North to South

There are 532 mines > 500 acres potentially **partially** flooded.



Here are the potential mine pools in all seams from WVGS



There are good quality mine pools in the Sewell and Beckley seams and in the Pocahontas seam southwest of Beckley.

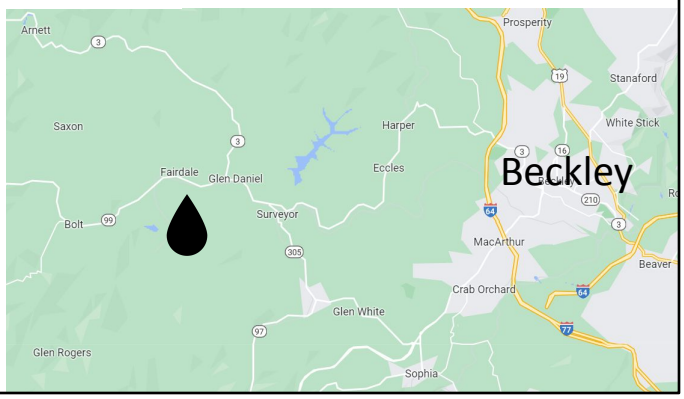
Pocahontas No. 3 Mine Pool Statistics

	Undetermined	Potentially flooded areas unlikely	Potentially partially flooded	Potentially totally flooded
No. of Mines	19	56	211	13
Mean coal bed thickness (feet)	3.63	4.27	4.72	4.10
Min. footprint				23.38
Max. footprint				21,361.85
Mean footprint				3,350.77
Median footprint area (acres)	174.18	0.73	168.10	1,247.45
Total footprint area (acres)	18,822.60	7,962.37	162,736.63	43,560.05
Estimated void volume (acre feet)	37,037.88	13,978.94	396,114.19	98,167.56
Max. potential storage (million gallons)	12,070.64	4,555.74	129,093.61	31,992.81

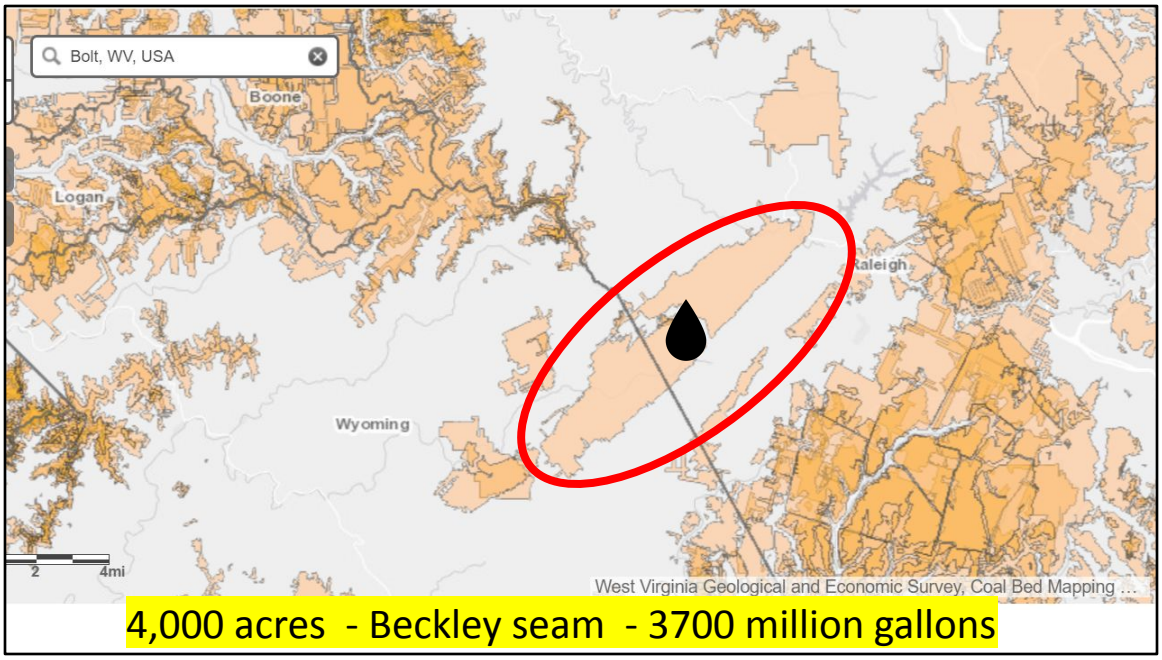
129 Billion Gallons of storage!

Just in the Pocahontas #3 seam, WVGS sees 211 mines of interest as potentially partially flooded covering over 160,000 acres with over 100 billion gallons of storage.

APPALACHIAN SALMON



The Maple Meadow Mine is about 13 miles due west of Beckley. It is in development as Appalachian Salmon by former WVDEP cabinet secretary Austin Caperton.



It covers over 4,000 acres in the Beckley seam which is 67” high and completely flooded, storing over 3700 million gallons of water.

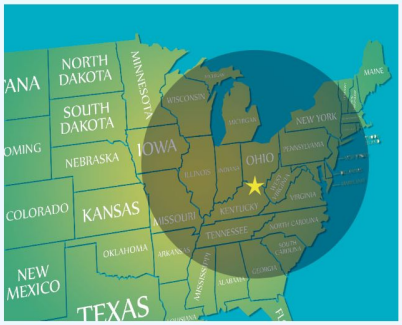
RESOURCES THAT CAN ONLY BE FOUND IN SOUTHERN WEST VIRGINIA

At the site of our facility, we draw from unique underground pools of fresh, pure groundwater which are currently without access or use. These pools, located in the spaces left behind by mine excavation, are filled with naturally cooled, clear groundwater filtered over long periods of time by the earth, and are ideal for raising salmon.

The pool at our initial access site is estimated to contain approximately 4 billion gallons of fresh, pristine water which will replenish itself at a steady rate as we withdraw.

It is a unique resource

A Shorter Journey to Your Plate



Most of the salmon we eat is grown and shipped from countries outside of the United States, creating a hefty carbon footprint through increased emissions.

We are located within a day's drive of 60% of North American consumers, enabling us to produce fresh, nutritious salmon while shortening the journey from producer to your dinner table.

Representing a great market niche since it is located within a day's drive of 60% of North American consumers. Getting FRESH fish to market has always been the challenge.

Our facility is located in the heart of Appalachia, with access to abundant pools of groundwater, and a highly skilled workforce. Our focus isn't just on delivering a sustainable product; our aim is to create a sustainable industry to support generations to come.

Respecting our Environment

Our US location is within a day's drive of 60% of the North American market, enabling us to eliminate the excess carbon impact of imported salmon.

Innovative Technology

Our advanced Recirculating Aquaculture System enables us to efficiently use resources to grow healthy, nutritious fish.

Premium Salmon

Our commitment to raising a premium product means using non-GMO stock, quality feed, and providing a stress-free environment for our fish.

A Sustainable Industry

We're not just delivering a sustainable product; we're building a sustainable industry to provide jobs for generations to come.

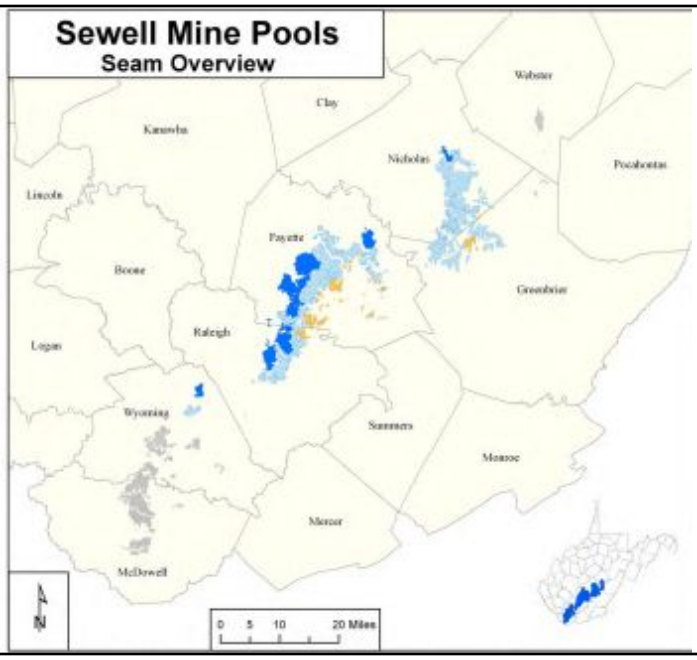
He envisions growing a premium non-GMO salmon that will build a sustainable industry to provide jobs for generations to come.

Recirculating Aquaculture Systems (RAS), are indoor, land-based facilities that recirculate and reuse water, cleaning it through numerous filtration technologies, providing an optimized growing environment for our salmon.

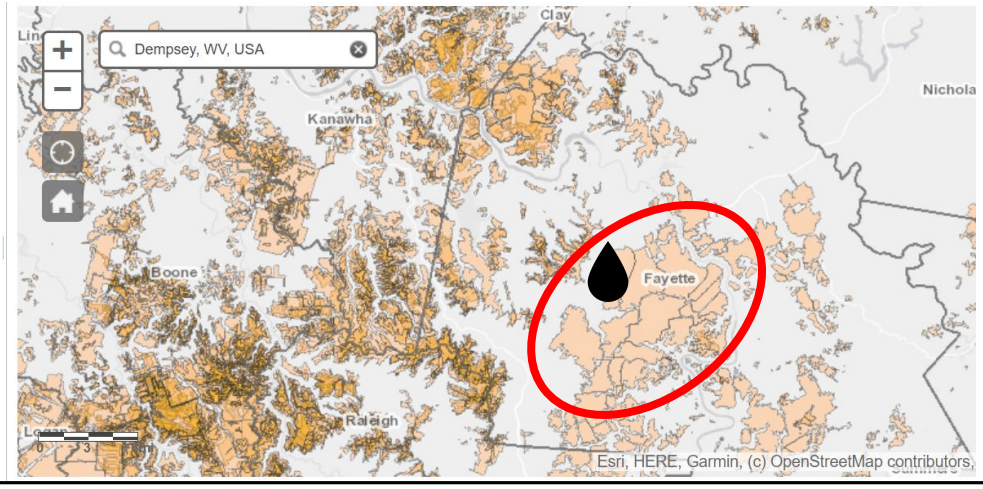
RAS has numerous advantages, including minimal environmental impact, maximum control of water chemistry, minimized water consumption, and protection for the fish from exposure to parasites, disease, or pollution.

*PHOTO JOHN HOLDER DESIGN

He will use a Recirculating Aquaculture System that will draw water from the mine pool, taking advantage of the optimum temperature of the groundwater for fish growth and capitalizing on the steady supply of clean, dependable mine water that is free of most of the water quality issues associated with surface water.



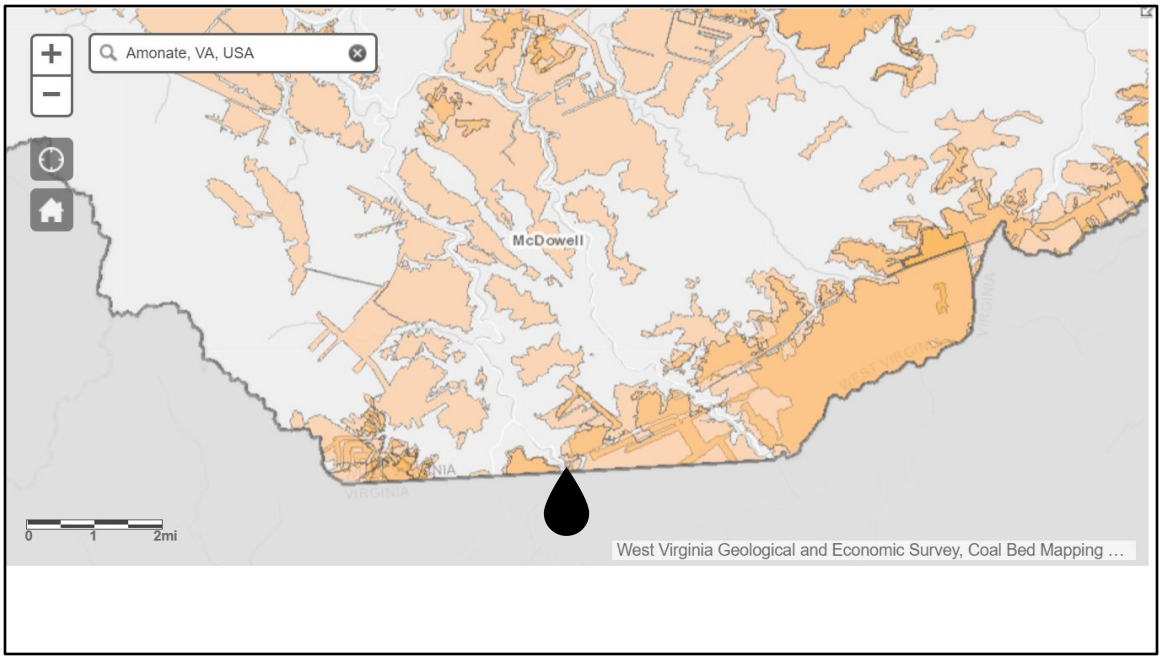
Another ideal water source for development is available now that Fayetteville no longer draws from the mine pool that artesian flows at Dempsey, WV.



POTENTIALLY TOTALLY FLOODED UNDERGROUND MINES >500 ACRES IN AREA

Seam name	Mine ID	Mine name	Company name	State permit number	Average coal bed thickness (inches)	Footprint (acres)	Storage (MMGal)	Drainage position
Sewell	336829A	SUMMERLEE	UNKNOWN		37.00	3,794.41	1,928.35	below

The Summerlee Mine in the Sewell seam is completely flooded to produce artesian flow from 3800 acres and stores about 2 billion gallons of water. It is hydraulically connected to the Lochgelly Mine which more than doubles this storage.



Finally, I invite your attention to the very southern part of WV - right on the VA line. This WVGS map of McDowell county shows the extent of the Pocahontas coal seams that have been deep mined.

There is another mine portal we have measured that exhibits over 4,000 gpm gravity flow even during very dry conditions. It exceeds 10,000 gpm during most of the year. The 18 mile tunnel was constructed in 1936 to drain the vast Pocahontas coal reserve

4 Section V Sunday, September 29, 2013 Bluefield Daily Telegraph

Great underground river: 20th century man-made marvel

By BILL ARCHER
Bluefield Daily Telegraph

BOISSEVAIN, Va. — In the fall of 1936, a group of about 200 coal miners received an unusual award from Pocahontas Fuel, Inc. Each of the miners received a medal in recognition of their efforts in the completion of one of the most challenging engineering feats ever tackled in North America.

Because they worked in darkness hundreds of feet beneath the earth's surface, few people except for the coal miners, their families and close friends know anything about their accomplishment. However, what they did during the height of the Great Depression had a direct impact on the course of world history through the balance of the 20th Century.

This story is all about water. While water represents an essential life-giving force on earth, its presence in underground coal mines can represent an expensive obstacle in the mining process. Most underground mines are always damp, but mines beneath drainage can have a significantly adverse impact on the mining process.

Not all of the rain that falls on earth gets channeled into streams for transportation to the seas of the world. A great deal of water finds its way underground where it weaves its way through layers of rock strata, collecting in pools, or joining with steams that often flow in limestone deposits to form great underground rivers. For centuries, rural homeowners have drilled wells hundreds of feet underground to tap into pools of constantly replenished and purified water.

Underground coal mining almost always takes place below drainage. While a cool, moist environment is a constant, mines driven against the natural flow of water underground can present special problems to coal miners and mine operators. Since water is not a commercial product of coal mining, it is considered an expense just like rock and other materials cleaned from coal in the preparation plant.

Commercially viable large-scale underground coal mining came into its own in southern West Virginia in the late 19th and early 20th century. Prior to that time, technological limits including ventilation and water control were prohibitive in terms of sinking deep shafts, and thus, sustaining mine workings on any given heading. The distance of transportation either underground or above ground, is a key factor in measuring expense in coal mining.

By the end of the first decade of the 20th Century, mine engineers were well on the way to solving ventilation problems that had plagued the industry since its inception, bringing great loss of life to coal miners everywhere. However, moving increasingly large volumes of water proved an even greater challenge due to limitations on pumps as well as collection systems at the time.

Several smaller companies merged into the Pocahontas Fuel Company in 1907, and at the time, operated 11 underground coal mines on 22,000 acres of property located in McDowell, Wyoming and Mercer counties in West Virginia and Tazewell County, Virginia. The oldest of the company's mines was located in Pocahontas, Virginia, and was opened in 1882. During the coming decades, Poca Fuel opened other operations in coal camps with strange sounding names like Anawalt, Jenkinjones, Amonate, Ilmann, Sagamore, Lick Branch and Boissevain.

By 1920, mine mechanization was revolutionizing the industry with the advent of machines like the Jones Coaloader developed circa 1915 by Pocahontas Fuel vice president James Elwood Jones and the O'Toole Mining Machine, developed circa 1919 by Colonel Edward O'Toole general superintendent of the U.S. Steel mines in Gary Hollow, McDowell County. Still, coal operators couldn't reap the full benefit of their increased productivity with coal miners standing knee-deep in water all the time.

Pocahontas Fuel had struggled with its drainage problem since 1907, and about a decade later, the company gathered some of the industry's top mine engineers together to examine the problem. The cost associated with pumping water at the Boissevain Mine was almost equal to the cost of extracting coal. In 1915, the company

Marvel, 14

Mine Engineer Tells Of Building Giant Tunnel

W. A. Bishop Describes Undertaking Of Pocahontas Fuel Company Which Provides Gravity Drainage For Five Large Mines Through

The newspapers that year heralded the accomplishment as the “World’s Longest Coal Drainway” and a “Great Underground River”.

There's good water out there, let's use it.

Thanks to
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Dr. Emily Sarver, Associate Professor, Mining & Minerals Engineering, Virginia Tech

With thanks to our contributors.

Questions?

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