

2019 AML PROJECT SUMMARY

January 2020

Exploratory Drilling AML Project

Project One: Abandoned Underground Mine Exploration

Drilling and Coring

Location

Parcels near Williams County Road 9, Williston

Contractor

Agapito Associates, Inc. of Grand Junction, CO

Total Project Cost: \$517,475

Williams County Road 9 Phase 7 and Noonan AML Project

Project Two: Abandoned Underground Mine Reclamation

Pressurized remote backfilling with cementitious grout and drilling

Locations

Parcels near Williams County Road 9, Williston
Harris M. Baukol WMA, Noonan

Contractors

B & C Concrete Pumping, Inc. of Williston
(S & S Drilling, Williston-subcontractor)
Material Testing Services, LLC of Minot

Total Project Cost: \$1,100,313

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2019 AML Project Combined Statistics

Project Dates	May 13-August 15, 2019
Project Length (consecutive days)	96
Total Work Days	72
Total Days of Pumping Grout	22
Holes Drilled	1,092
Holes Cased	292
Feet Drilled	69,503
Feet Cased	13,213
Grout Pumped (cu. yd.)	2,945
Grout Pumped (cu. yd.) per Grout Day	134
Holes Pumped	29
Holes Filled by Pumping Adjacent Holes	64
Average Grout Take (cu. yd.) per Hole Pumped	102
Average Grout Take (cu. yd.) per Hole Filled	31
Remaining Void Holes	135



ND PSC Inspector, Chris Brown (left), speaking with the material tester on site.

North Dakota Public Service Commission and the Abandoned Mine Lands Division

North Dakota has records for about 1,700 abandoned coal mines in the western half of the state. The Surface Mining Control and Reclamation Act of 1977 (SMCRA) provides for the reclamation of abandoned coal mine lands with fees collected on actively mined coal. In 1981, the North Dakota Legislature approved an Abandoned Mine Lands (AML) Program to be administered by the Public Service Commission (PSC) on behalf of the State of North Dakota.

ND PSC AML Mission

The AML Program is charged with eliminating existing and potential public hazards resulting from abandoned surface and underground coal mines. The AML Program is a service (not regulatory) program aimed at protecting North Dakotans by reclaiming hazardous abandoned mines. Mines eligible for reclamation may be in our abandoned mine inventory or reported to us by other agencies or the public. The PSC's selection of reclamation projects is based on prioritization of abandoned mine related hazards. It also requires federal approval. Emergency projects are conducted when AML problems are an immediate and serious danger to the public, such as a sinkhole in a highway ditch.

Program Funding

Reclamation costs are provided by a federal fee on actively mined coal. The current rate for lignite coal is 8¢ per ton. The federal government, through the Office of Surface Mining Reclamation and Enforcement (OSMRE), reallocates the money to each state or tribe with an AML program through a grant program. North Dakota's allocation is about \$3 million per year. Federal fee collection is scheduled to end in September 2021 unless reauthorized by the United States Congress.

Drilling and Grouting

Reclamation by drilling and grouting involves drilling through the overburden into the coal to locate areas where the coal was removed. When these openings (voids) are found, a cement-like grout mixture is pumped into the void to fill the space left when the coal was removed. The goal is to stabilize the mine and reduce the likelihood of the mine collapsing. This will reduce the chances of sinkholes forming at the surface. Drilling and grouting projects are expensive and are reserved for use around public roads or residential and commercial areas.

Glossary of Terms

Backfill— Material used to fill an opening, void or depression. Material placed in the mine void to support the mine roof.

Casing—A tubular structure installed in a drill hole to prevent the wall of the hole from caving and to provide a conduit for grout.

Core—A cylindrical sample taken from a formation for analysis. Usually a core barrel is substituted for the drilling bit and it procures a sample as it penetrates the formation.

Cribbing— Timbers laid at right angles to each other, sometimes filled with earth, as a roof support or as a support for machinery.

Drift mine— An underground coal mine that enters a coal seam horizontally usually from a coal outcrop.

Haul Tunnel— Any underground entry or passageway designed for transport of coal, other material, personnel, or equipment.

Highwall— The unexcavated face of exposed overburden and coal in a surface mine.

Mine Workings— The entire system of openings in a mine.

Overburden— Layers of soil and rock covering a coal seam.

Pillar—The part of coal left between individual rooms and entries to support the overlying strata.

Rob— To mine or remove coal pillars left for support.

Roof —The stratum of rock or other material above a coal seam; the overhead surface of a coal working place.

Roof Fall— A coal mine cave-in.

Room and Pillar Mining— A method of underground mining in which a portion of the coal is left in place to support the roof of the active mining area. Large "pillars" are left while "rooms" of coal are extracted.

Rubble— Debris encountered when drilling into mine workings that may indicate mine collapse or roof fall.

Seam— A stratum or bed of coal.

Shaft— A vertical opening from the mine to the surface that may be used for ventilation, drainage or transportation.

Slope— An inclined connection to the surface from underground workings used for transportation, drainage and ventilation.

Slump—In material testing it is a measure of consistency of concrete or grout on a scale from 0-12 inches. The higher the number the more liquid or flowable the mixture.

Void— A general term for openings in rock. In mine reclamation it is the open space remaining after coal was extracted by underground mining.

Source: OSMRE



A laser level monitors ground movement near the Shift Services building during grout pumping. Inspector, James Thornburg, is on the right.



The grout runs through the meter to monitor the pressure. It then goes into the cased hole right next to a building.



This drill rig ready to begin drilling a new hole. Piles of cuttings show the locations of recently drilled holes.

Exploratory Drilling: Williams County Road 9

The project site for the 2019 Exploratory Drilling Project is undermined by the Williston Coal & Ice Company mine. The mine operated between 1913 and 1936. In the mid-1920s, two coal seams were mined to produce an average of over 20,000 tons of coal annually. The lower seam is about 140 feet below the surface and does not appear to extend under the 2019 project site. The upper seam is 65-75 feet below the surface.

In the spring of 2017, the Public Service Commission investigated a sinkhole reported at 5140 134th Avenue NW (Shift Services Property). That investigation led to the area's inclusion in the 2017 Exploratory Drilling Project and then to the 2018 drilling and grouting project at the Sand Draw Property (5132 134th Avenue NW). Through those projects, 396 holes were drilled, over 135 holes were cased and nearly 4,500 cubic yards of grout were pumped into the mine workings at the Sand Draw Property. This exceeded the estimated 3,500 cubic yards of grout for the Sand Draw Property, the Shift Services Property and the Pruitt Property (5146 134th Avenue NW) combined.

To get a better idea of the condition of the mine, a 2019 Exploratory Drilling Project was conducted at the Shift Services, Pruitt Properties and near the Drivelines Property (1314 28th Avenue E) prior to the 2019 drilling and grouting project. Drilling at the Shift Services and Pruitt Properties is shown on the map on page 5. Drilling was done in a grid pattern. Rows are 20 feet apart and holes within a row are 10 feet apart. At each red dot drilling encountered the mine workings. These holes were cased with PVC pipe to be used for pumping grout into the mine. Confirmation drilling done at the Sand Draw Property revealed additional grout is

2019 Exploratory Drilling Statistics

Project Dates	May 13– July 31, 2019
Project Cost	\$517,475
Holes Drilled	763
Holes Cased	229
Feet Drilled	54,464
Feet Cased	11,868

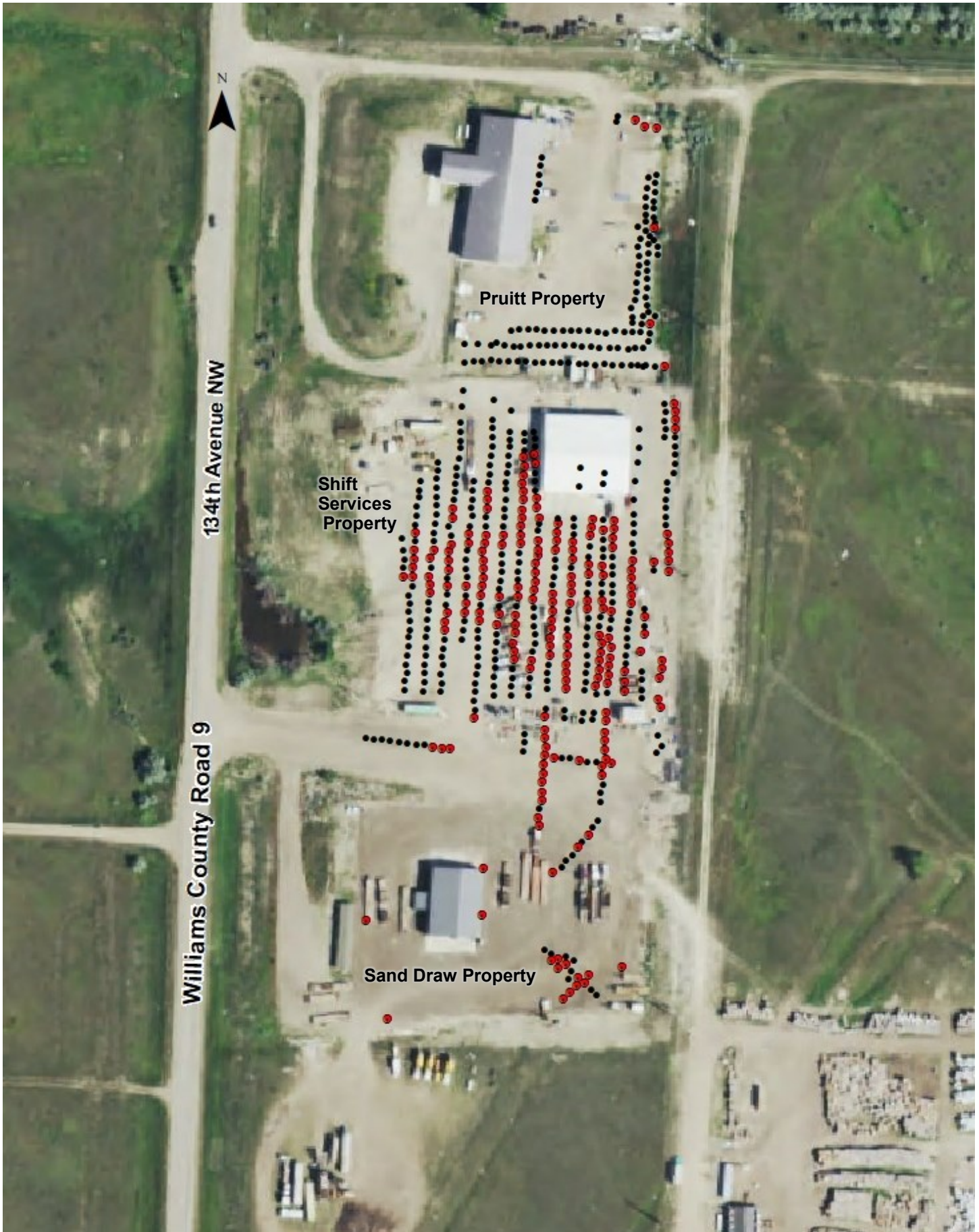
needed there as well. Work done in 2017 and 2018 at Sand Draw is not shown on the map.

Drilling near the Drivelines Property is shown on the map below. One mine entrance may be to the southwest of the red-roofed building. Two holes drilled near the southern corners of the building encountered coal only. Previous drilling around the building also encountered solid coal. Drilling along the two access roads to the property did encounter the mine workings.

In the 2019 Exploratory Drilling Project 763 holes were drilled. Of those, 229 holes were cased. Information on the 2019 drilling and grouting project can be found on pages 6 and 7.



Williams County Road 9, also called 134th Avenue NW, runs north and south. Drilling encountered solid coal at **black dots** and no coal at **black triangles**. **Red dots** are void holes that need grout.



Williams County Road 9, also called 134th Avenue NW, runs north and south. Drilling encountered solid coal at **black** dots. **Red dots** are void holes that need grout.

Grouting: Williams County Road 9 Phase 7

The 2019 drilling and grouting project immediately followed the 2019 Exploratory Drilling Project at the Williston site. The map on page 7 shows all of the holes drilled in the Exploratory Drilling Project like the map on page 5. The difference is the map on page 7 shows holes that were pumped and filled with grout. The blue dots are holes where grout was pumped. The orange holes are holes that were filled with grout while pumping on a nearby hole.

Pumping on 29 holes filled an additional 65 holes and took 2,945 cubic yards of grout. The exploratory drilling and grouting work took coordination with Shift Services who had to move their equipment to allow space for drilling rigs and grout pumping equipment. Exploratory drilling began in the southeast corner of the Shift Services property and continued north and west. Since the Shift Services lot was empty on the western edge at the end of the drilling, grouting started on that side of the property and worked north and east. We tried to limit the amount of moving that Shift Services had to do.

Over 135 holes remain to be pumped at Shift Services, Sand Draw, Pruitt and Drivelines (map on page 5). A drilling and grouting project is planned for the site in 2020.



Left: Contracting crew locating cased holes for pumping grout in Williston.

Right: Drilling rig set up in front of the Shift Services Building in Williston.

2019 Williston Grouting Statistics

Project Dates	
Project Cost	\$760,096
Grout Pumped (cu. yd.)	2,945
Holes Pumped	29
Holes Filled by Pumping Adjacent Holes	65
Average Grout Take (cu. yd.) per Hole Pumped	102
Average Grout Take (cu. yd.) per Hole Filled	31
Remaining Void Holes	135



What is Grout?

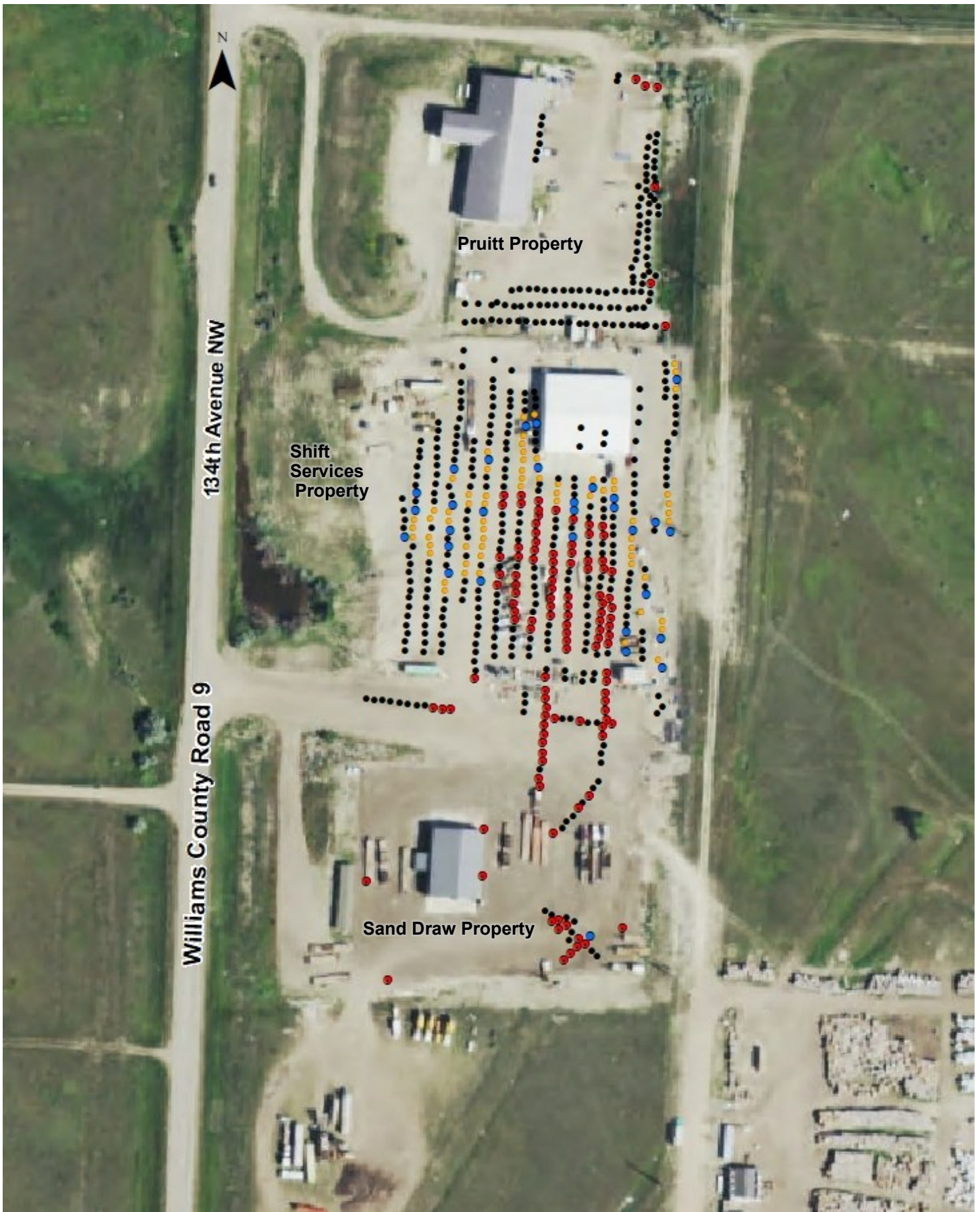
Grout, concrete and mortar have similar components. Each contain cement, water and aggregate. Generally, the difference between grout and concrete or mortar is the water to cement ratio, in other words its flowability. Concrete is very stiff and not very flowable. It stays where it is put. Mortar is less stiff and grout is the most flowable.

Grout is a commonly used flowable fill in reclamation of abandoned underground coal mines. The North Dakota AML Division uses cementitious grout exclusively to remotely fill mine workings in reclamation projects.

Our grout mix contains Portland cement, water and flyash. The flyash has a determination of a “beneficial use” by the ND Department of Environmental Quality. Our mix also contains un-washed aggregate (size less

than 3/8 inch). We have found that this “dirty” sand adds to the flowability of the grout.

Flowability in grout is essential for our projects. The grout is pumped into the void spaces in the mine. These spaces can be very large or very small. In either case, the grout must be flowable enough to fill all the void spaces left when the coal was removed. Our grout formula is designed to mimic the strength of the coal it is replacing.



Williams County Road 9, also called 134th Avenue NW, runs north and south. Drilling encountered solid coal at **black dots**. Grout was pumped into holes at **Blue dots**. The **orange dots** are holes filled by pumping grout into a different hole. **Red dots** are void holes that still need grout.

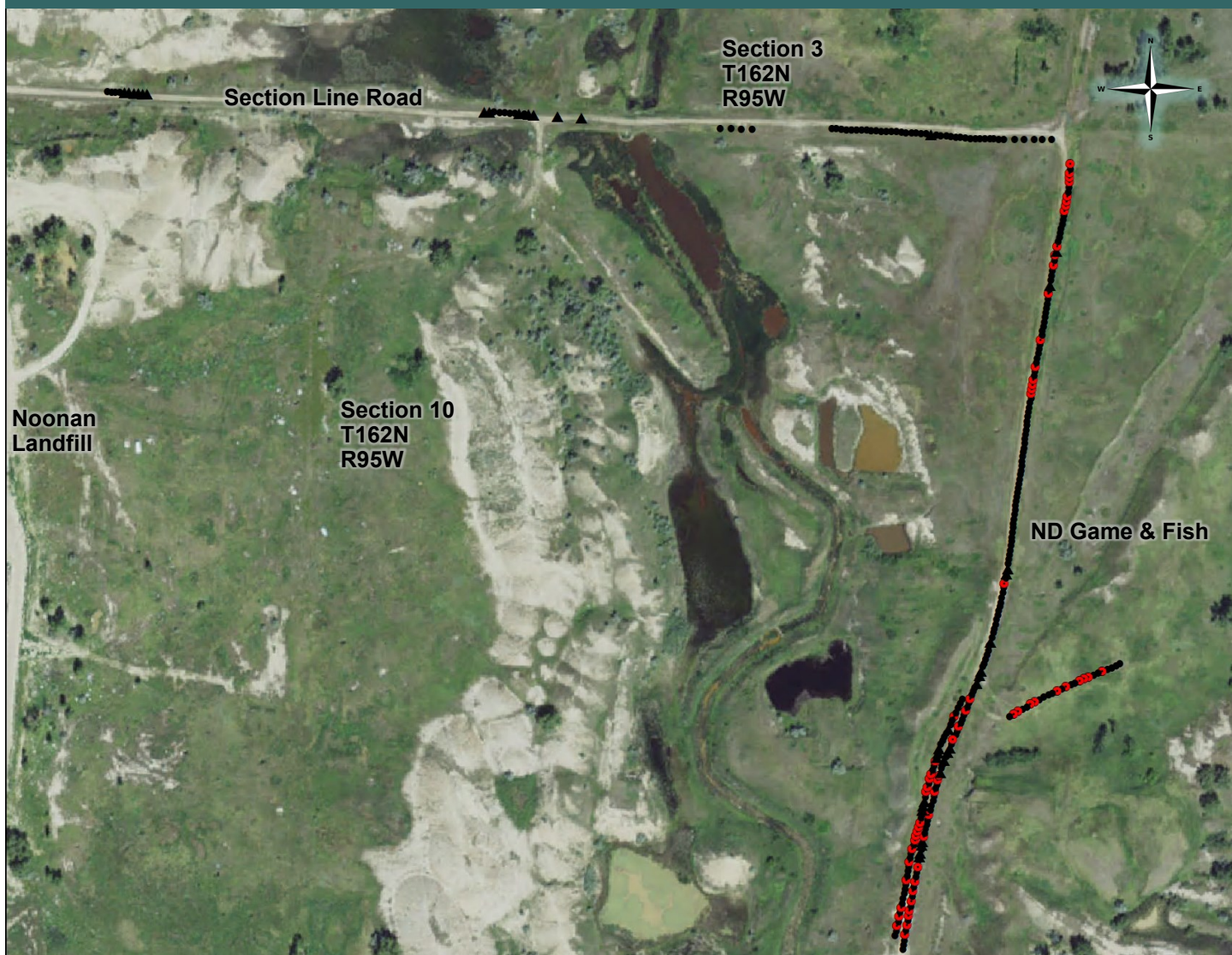
Drilling: Noonan

The Noonan portion of the 2019 drilling and grouting project was designed to try a new method of filling underground mine voids using foamed sand. Our current grout mix contains cement, flyash, water, a water-reducing superplasticizer and sand to achieve a specified slump. Initially, flyash was considered a waste product and relatively inexpensive to obtain. Recently the oil boom in the Bakken produced an increased demand for grout components. At times both cement and flyash have been difficult to obtain to complete our drilling and grouting projects. With the high cost of grout components, we concentrate our drilling and grouting projects on high use areas such as roadways and around residential structures. With the availability of a less expensive alternative, we may be able to extend our drilling and grouting projects to areas that would otherwise have not been considered.

A foamed sand (think shaving cream consistency added to sand) has been successfully pumped into dry and open abandoned underground mines in other states. However, many of the underground mines in Western North Dakota are in various stages of collapse. For the foamed sand method to be effective in these mines, the foamed sand must be able to flow into and provide support in the collapsed areas. Also, the abandoned underground mines commonly contain water so the foam would have to work in a wet environment as well.

The Harris M. Baukol Wildlife Management Area (North Dakota Game and Fish property) was chosen for the ND PSC's first attempt at using a foamed sand because the mine is dry and mostly collapsed. Plus, Noonan is a small town where the cost of cementitious grout would be higher than if the site were near a larger populated area.

The drilling portion of the project started on the east-west section line road on July 3, 2019 (shown on the map below). Drilling in this area revealed that the coal had been removed



Noonan Drilling: Drilling encountered solid coal at **black dots** and no coal at **black triangles** . **Red dots** show holes where foamed sand will be pumped in 2020.

(black triangles) by surface mining and replaced with spoil material to create the section line road.

At the ND Game & Fish's request drilling on the Harris M. Baukol WMA (north-south drill holes) did not begin until July 15 in consideration of nesting birds. The two-track roads on the property were roads used during strip mining operations. In the past, the two-track has been used by hunters. The Harris M. Baukol WMA is currently closed to vehicles.

Between July 3 and July 31, 2019, more than 325 holes were drilled. All 63 holes that encountered the

underground coal mine workings are on the Harris M. Baukol WMA. These holes were cased and are shown as red dots on the map on page 8. Drilling confirmed that the mine is collapsed and dry.

The Game and Fish also asked that the project be completed by August 31 so that it would not interfere with hunting season. After the completion of the Williston portion of the 2019 drilling and grouting project only two weeks remained for mobilization to Noonan and pumping of foamed sand at the site. Since this was a new method and time was short, it was decided to post-pone the foamed sand portion to 2020.

2019 Noonan Project Statistics

Project Dates	July 3 – August 15
Project Cost	\$340,217
Holes Drilled	328
Holes Cased	63
Feet Drilled	15,039
Feet Cased	1.345

1. Baukol-Noonan Mine spoil piles as seen from the drilling site.
2. A line of cased holes on the Harris M. Baukol WMA near Noonan.
3. Casing to be installed at Noonan.



The Mine Map

Shown on the right is a portion of the Williston Coal and Ice Company mine map over an aerial image of the ground surface. Around 1919, the State of North Dakota began collecting information from coal companies of the underground mines, including mine maps.

While the ND PSC has mine maps for many of the mines in our inventory, the maps only provide a snap shot of the mine itself. Often mining continued for years after the last mine map was produced. Sometimes the surveyors mapped the tunnels, but not the rooms. Portions of a mine may have collapsed during mining. Some maps were drawn without being surveyed. Other errors can be introduced when the maps are projected onto imagery.

Even with these limitations, the mine maps can be a very useful tool in understanding the extent and conditions of the mines. Maps give us a good idea of where to start drilling. It also serves as an initial guide for estimating how much grout will be needed.

If you have a piece of property that is undermined and would like more information on it, please let us know. We may have a mine map that we can share.



Material Testing

Material testing is an important part of our drilling and grouting projects. The grout must meet certain flowability and strength requirements. The material testing firm is on site during grouting and collects samples for every 50 cubic yards of grout pumped.

For our grout projects, flowability is measured with a slump test. The higher the slump the more flowable the mixture. When we want the grout to flow a long distance or into the rubble of a collapsed portion of the mine, we use a grout with slump between 10 - 11 inches.

If we have an open void or don't want the grout to travel as far, we use a lower slump grout between 6 and 8 inches. Just for comparison, most poured concrete has a 1-3 inch slump-very stiff.

Material testers also measure grout temperature, calculate grout yield and cast grout cylinders. The cylinders are broken by a special machine that measures the strength of the grout. Our goal is for the grout to be at least as strong as the coal it is replacing.

Material testers also inspect the grout raw materials and the batch operation.



The material tester is doing a slump test on grout at Williston.



1. A composite photo of the Truax Tipple (Top) and the underground Mine (Bottom) at Noonan in the early 1900s. Images are from the ND State Historical Society.
2. A line of drilled holes at Shift Services near Williston.
3. Drillers are carefully drilling through the concrete floor inside the Shift Services building in Williston. Four holes were drilled inside the building. The good news—each hole hit solid coal.
4. A drill hole that has been cased. The cased holes are counter sunk and marked with pink top stake chasers until it is time to pump grout into them.
5. The drilling contractor, Agapito, removing a core barrel from the drill hole. We do confirmation drilling and coring to see where the grout flowed.
6. A 3.75 foot core of grout. The grout in this core was pumped in 2018.
7. The drillers used a piece of plywood to catch drill cuttings. This helps keep the drilling area clean.
8. Agapito's drill rig set up inside the Shift Services building.

PLACE
STAMP
HERE

North Dakota Public Service Commission
Abandoned Mine Lands Division
600 East Boulevard Avenue, Department 408
Bismarck, ND 58505-0480

Subsidence near Wilton

Underground coal mining was common in Western North Dakota in the early part of the twentieth century. After WWII surface mining became more economical, and many underground mines ceased operation and became abandoned. One legacy of underground mining is the continuing potential for surface collapse.

If you live or work near an abandoned underground coal mine, please use caution. The ground can give way without warning. In this photo, the sinkhole is 25 feet in diameter and over 20 feet deep. It was also close to a country road. According to the rancher, one day it was a depression filled with water. The next day the water was gone and a very large hole was left.



Contact Us

To report a sinkhole or request more information about our program

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Abandoned Mine Lands Division
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