

Sampling & Analysis Plan for the K&H and Frost Injection wells Investigation
Athens and Washington counties, Ohio

1.0 INTRODUCTION

This project will sample private water wells within a one-half mile radius of 11 oil and gas wells permitted under Chapter 1509 of the Ohio Revised Code (ORC). A total of 33 water wells have been identified through a record search to lie within the Areas of Review (AORs) of the 11 oil and gas wells. Each water well will be characterized by GPS location, photographs, samples, and the sample analysis conducted by an Ohio EPA or NELAP certified lab.

1.1 SAMPLING AREA

The sampling area encompasses Rome and Troy townships in Athens County and Belpre and Decatur townships in Washington County, Ohio. See Figure 1.

1.2 SAMPLING LOCATIONS

Each sampling location lies within a one-half mile radius (AOR) of the wells listed in Table 1. The contractor will locate and identify each individual sampling location (water well) within each AOR. Table 2 lists water well logs from ODNR online records for the known water wells within each AOR.

Table 1. Oilfield well locations at the center of each sampling area.				
Well Name	API #*	Latitude (NAD83)	Longitude (NAD83)	Identified Water Wells**
K&H Partners #1	34-009-2-3821-0000	39.22615°	-81.76125°	3
K&H Partners #2	34-009-2-3823-0000	39.23489°	-81.75702°	5
K&H Partners #3	34-009-2-3824-0000	39.23515°	-81.74816°	16
S. Moore #1	34-009-2-3537-0000	39.236115°	-81.73197°	3
M. Dunfee #1	34-009-2-3538-0000	39.24062°	-81.72883°	0
R. Dunfee Unit #1	34-167-2-9029-0000	39.24253°	-81.71954°	0
Frost M. #1	34-009-2-3761-0000	39.29157°	-81.83417°	3
Sillaman/Humphrey #1	34-009-2-3791-0000	39.29427°	-81.82091°	1
Cunningham #1	34-167-2-9681-0000	39.29673°	-81.79845°	1
S. Hutchinson #1	34-167-2-9675-0000	39.29815°	-81.80928°	1
Bailey D #1	34-167-2-9668-0000	39.30414°	-81.80979°	0
*American Petroleum Institute Number				
**Some well may be duplicates due to overlapping Areas of Review				

Table 2. Water well logs located within the Areas of Review.

Oilfield Well	Water Well Log #*	Address	Comments
K&H Partners #1	57315	Not listed on log	TD 80'
	322414	Not listed on log	TD 100'
	481531	Not listed on log	TD 140'
K&H Partners #2	57315	Not listed on log	TD 80'
	57319	Not listed on log	TD 66'
	465032	Not listed on log	TD 70'
	396966	Not listed on log	TD 60'
	933125	28570 Torch Rd., Coolville	TD 110'
K&H Partners #3	57319	Not listed on log	TD 66'
	66961	Not listed on log	TD 60'
	66962	Not listed on log	TD 75'
	66963	Not listed on log	TD 50'
	74561	Not listed on log	TD 110'
	74562	Not listed on log	TD 62'
	74564	Not listed on log	TD 73'
	74590	Not listed on log	TD 64'
	288144	Not listed on log	TD 125'
	322440	Not listed on log	TD 110'
	288118	Not listed on log	TD 80'
	351904	Not listed on log	TD 110'
	368824	Not listed on log	TD 135'
	465032	Not listed on log	TD 70'
	396966	Not listed on log	TD 60'
	933125	28570 Torch Rd., Coolville	TD 110'
S. Moore #1	66956	Not listed on log	TD 60'
	74563	Not listed on log	TD 40'
	288133	Not listed on log	TD 98'
M. Dunfee #1		No known wells	
R. Dunfee #1		No known wells	
Frost M. #1	84685	Not listed on log	TD 70'
	798354	Not listed on log	TD 37'

Table 2. Water well logs located within the Areas of Review.			
Oilfield Well	Water Well Log #*	Address	Comments
	2060940	7217 Frost Road, Coolville	TD 50'
Sillaman/Humphrey #1	66964	Not listed on log	TD 80'
Cunningham #1	66964	Not listed on log	TD 80'
S. Hutchinson #1	66964	Not listed on log	TD 80'
Bailey D #1		No known wells	
*Well logs in overlapping Areas of Review are listed once.			

1.3 RESPONSIBLE AGENCY

The Ohio Department of Natural Resources, Division of Oil & Gas Resources Management (Division) is the lead agency for this sampling event.

1.4 PROJECT ORGANIZATION

Table 3. Key ODNR Project Personnel Contact Information and Responsibilities			
Title	Name	Phone Number Email Address	Responsibilities
Natural Resources Administrator	Andrew Adgate	614-381-9402 Andrew.Adgate@dnr.ohio.gov	Contract management, Project scope
Incident Response Manager	Jason Blocker	330-813-3569 Jason.Blocker@dnr.ohio.gov	All technical/scientific aspects of the project

2.0 PROJECT BACKGROUND

Beginning in 2013, the K&H and Frost injection wells in Athens County have been utilized to inject brine into the Ohio Shale formation approximately 2000 feet below ground surface. After injection operations began, complaints of impacts to nearby production wells were received by the Ohio Department of Natural Resources, Division of Oil and Gas Resources Management (Division). In 2023, the Division suspended injection operations of the Frost and K&H injection wells after additional observations and information was collected regarding impacts to the nearby production wells. While the Division has received no reports of adverse effects to human health or safety associated with the implicated injection wells, the Division is preparing a Scope of Work for a third-party consultant to conduct a groundwater study to ensure no evidence of adverse impacts to ground water can be found.

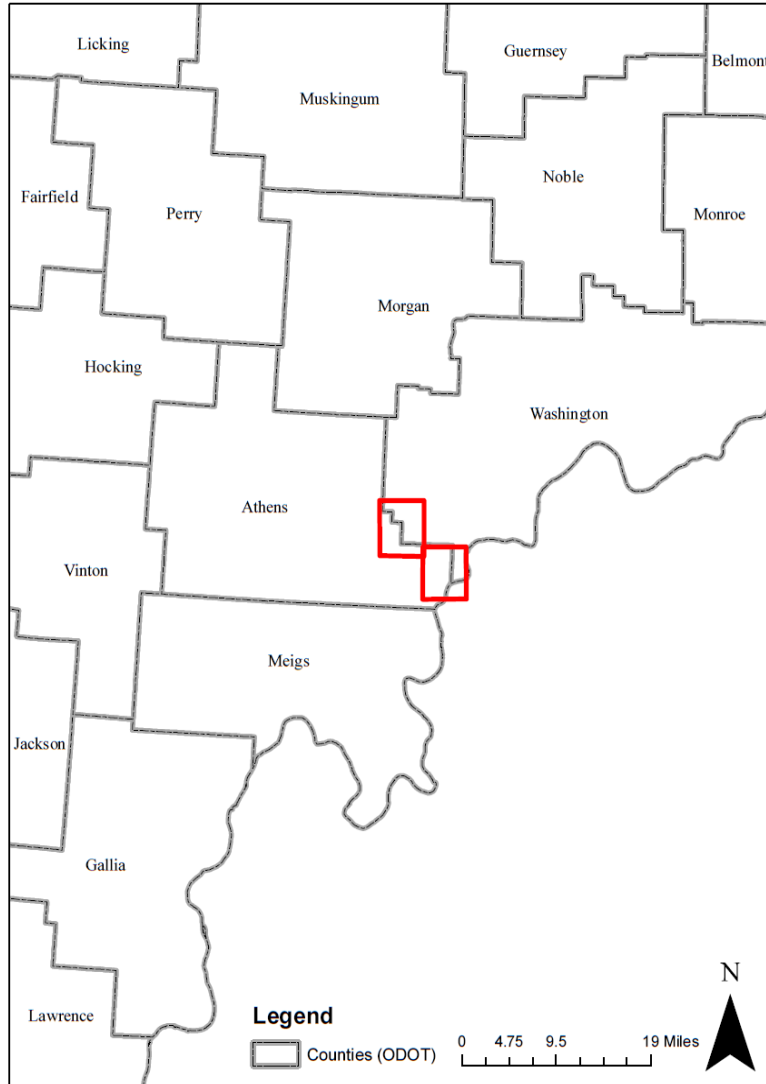


Figure 1. Project Area Map

2.1 SAMPLING AREA DESCRIPTION

Each AOR occupies approximately 500 acres of land in a rural area of eastern Athens County and southwest Washington County. See Figures 2 and 3.

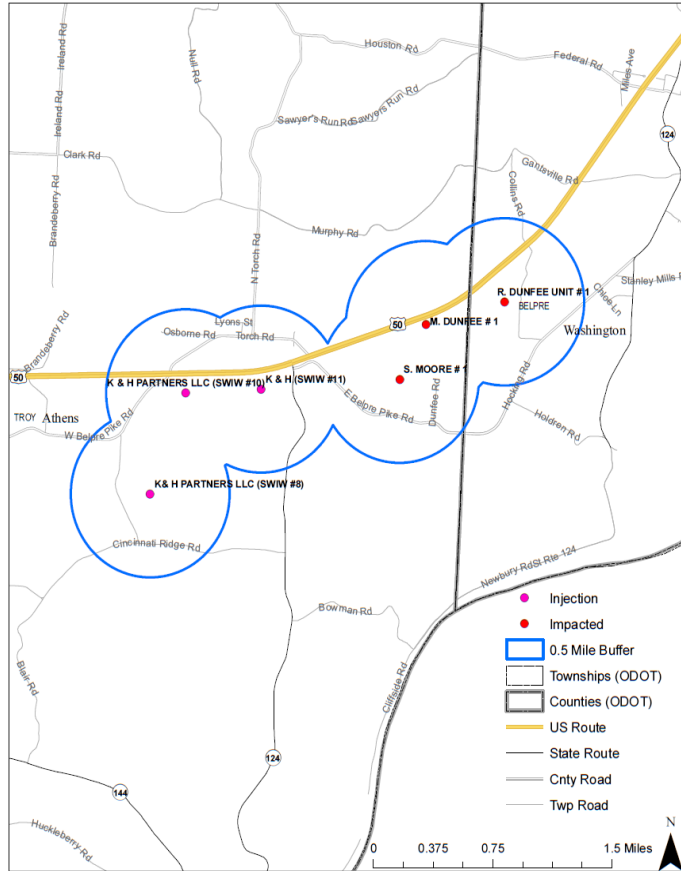


Figure 2. K&H Areas of Review Map

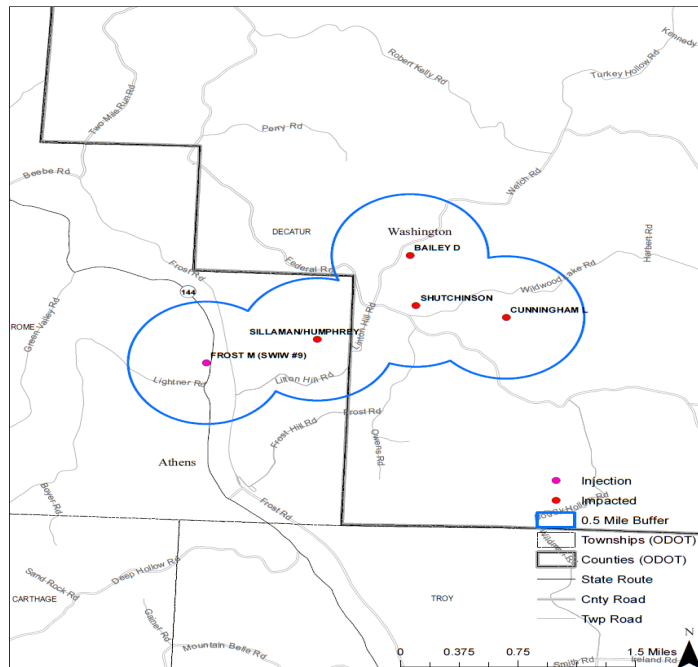


Figure 3. Frost Areas of Review Map

2.2 INJECTION WELLS OPERATIONAL SUMMARY

The earliest injection operations began at the Frost and K&H injection wells in 2013 into the Ohio Shale formation. At the Frost well, injection operations ceased in March 2021 after approximately 3.5 million barrels of brine were injected. At the K&H injection wells, injection ceased in June 2023 after more than 30 million barrels of brine were injected, but resumed after a stay of the suspension order was granted by the Ohio Oil and Gas Commission on October 3, 2023. In both instances, the affected production wells lie along an approximate N75E bearing from the injection wells.

2.3 GEOLOGY/HYDROGEOLOGY

The ODNR map entitled *Ground-Water Resources of Athens and Meigs Counties* (Schmidt, 1985) shows that the groundwater resources in southeast Athens County typically produce less than two gallons per minute with unconsolidated aquifers in river and stream valleys producing higher yields. The deepest known water well in the AORs is 140 feet deep. Because the exact location and elevation of these water wells is unknown, an elevation relative to mean sea level cannot be calculated. In general, there is approximately 1,850 feet between the base of the deepest aquifer and the top of the Ohio Shale which is approximately 1800 feet thick in the study area.

Bedrock in the study area consists of the Permian age Dunkard Group (shale, siltstone, mudstone, limestone) and the Pennsylvanian age Monongahela Formation (shale, siltstone, mudstone, limestone, minor coal and clay). The Monongahela is exposed in lower portions of the valleys where streams have incised through the Dunkard. The unconsolidated alluvium in the stream valleys is Quaternary in age. Groundwater flow in the unconfined bedrock aquifers generally mimics the surface water flow regime.

3.0 PROJECT DATA QUALITY OBJECTIVES

This study is being conducted to verify that brine from nearby injection wells has not intruded into shallower aquifers. Groundwater samples from the private water wells identified by the Division and by the vendor's field reconnaissance will be collected and analyzed for general chemistry, metal, and non-metal parameters listed in Table 5 below. The Division will review all the data, interpret it, and make the final determinations.

3.1 DATA QUALITY OBJECTIVES (DQO'S)

The principal objective is to identify if any water wells in the AORs have been impacted by analyzing if the wells have a chloride (Cl⁻) concentration above 250 mg/L along with measurable bromide (Br⁻). Those two parameters will be used to calculate a Cl:Br ratio for each sample. The chloride concentration of 250 mg/L is the US EPA secondary maximum contaminant level (SMCL) for chloride in drinking water and a Cl:Br ratio of 400:1 is the maximum theoretical limit for waters not influenced by an anthropogenic source of chloride. If a private water well has more than 250 mg/L Cl⁻ and a Cl:Br ratio less than 400:1, the Division will recommend additional testing.

3.2 FIELD DATA AND MANAGEMENT

Field data and notes must be recorded on a form provided or approved by the Division and submitted as part of the final data package including the laboratory analysis. At a minimum, the field data to be collected are listed in Table 4 below.

Table 4. Minimum field data for collection	
Data Item	Data Unit or Format
Water well latitude/longitude	D.D (NAD83)
Water well diameter	Inches or cm
Water well casing material	Steel/PVC/other
Water well accessibility	yes/no
Water well location	outdoors/indoors
Cistern present	yes/no
Sample number	Determined by sampler
Sample collection time	hh:mm
Water sample temperature*	°C
pH*	Standard units
Dissolved O ₂ *	ppm
Specific Conductivity*	µS/cm
Chloride*	mg/L or ppm
Sample collected before treatment	yes/no
Sample characteristics	clear/cloudy/turbid/sediment effervescent/sheen/other
Sample field filtered	yes/no
Well purge rate	gallons/min or liters/min
Water volume purged	gallons or liters
*Parameter that must be field screened and documented	

4.0 WATER WELL SAMPLING

Water well samples must be collected using the existing well pump through the household plumbing. Samples should be taken at the first available location prior to any treatment system or filter. If the homeowner/resident denies access to the interior of the home for sample collection, a sample may be collected from an outside spigot if the homeowner/resident confirms that the water from the spigot is untreated. This shall be recorded in the field notes.

All wells must be purged prior to sampling. Based on the ODNr groundwater resources map, wells producing less than two gpm are susceptible to being purged dry. The homeowner/resident must be asked if this has ever occurred. If a homeowner/resident answers that the well previously has been purged dry, the person obtaining the sample must use all caution necessary to avoid emptying the well. Purging 1.5 to 2 volumes of the pressure tank capacity is acceptable for this study. Private water supplies are generally used regularly therefore a high-volume purge is not necessary to remove stagnant water. If an uncommon situation arises in the field, contact the Division Incident Response Manager listed in Table 3.

After well purging and prior to collecting the sample, the turbidity of the groundwater extracted from each well must be measured using a portable turbidity meter. A small quantity of groundwater must be collected from the well, transferred to the meter, and a turbidity measurement performed. The results of the turbidity measurement must be recorded in the field notes. If the turbidity of the water is above 5 Nephelometric Turbidity Units (NTUs), the sample must be field filtered with a 0.45-micrometer (μm) filter. A clean, unused filter must be used for each filtered sample collected. Groundwater samples must be transferred from the filter directly into the appropriate sample containers with a preservative and processed for shipment to the laboratory. When transferring samples, care must be taken not to touch the filter to the sample container. An "F" will be placed on the sample container(s) and chain-of-custody form to signify a filtered sample.

4.1 CALIBRATION OF FIELD EQUIPMENT

All electronic field equipment must be calibrated at the beginning of each day prior to sampling according to the manufacturer's directions. Documentation must be made in the field notes or other appropriate form and submitted as part of the project data package.

4.2 FIELD SCREENING

Field screening of each sample must be completed for the designated parameters indicated in Table 5. The data shall be recorded on the appropriate field form noted in Part 3.3 in the required unit. If the vendor's standard operating procedure (SOP) requires their staff to collect additional data, the additional data must be recorded and submitted with the project data package.

4.3 SAMPLE HANDLING AND ANALYSIS

All water samples must be handled according to scientific/industry standard methods in terms of sample containers, sample volume, preservation, holding times, and storage. Coordination with the analytical

laboratory must occur to obtain the proper supplies and confirm holding times for the analytes listed in Table 5. Sample containers must be labeled prior to collection of the sample. After each sample is chemically preserved, when required, the sample must be placed immediately on ice at 4°C or colder. A sample is invalid and must be resampled if the sample is not analyzed within the required time, the temperature is above 4°C, or a preservation benchmark. There is an exception for pH as it is understood by common practice the general hold time is exceeded.

Sampling techniques from the United States Geological Survey (USGS) *National Field Manual for the Collection of Water-Quality Data (NFM)* available at www.usgs.gov or the Ohio EPA (OEPA) *Technical Guidance Manual for Ground Water Investigations, Chapter 10* available at www.epa.ohio.gov are acceptable. All sampling, decontamination, and field methodologies must be performed consistently and documented properly. The documentation must be maintained and submitted as part of the report package.

4.4 WATER SAMPLES

All water samples must be analyzed for the parameters listed in Table 5. Generally, each sample requires two clean, laboratory containers.

Table 5. Water Sample Analytical Parameters	
Parameter	Standard Method
Alkalinity (Total)	SM2320B
Aluminum (Total or Dissolved)	SM3120B
Acidity (Hot or Total)	SM2310B
Barium (Total or Dissolved)	SM3120B
Bromide (Total or Dissolved)	SM4110B
Calcium (Total or Dissolved)	SM3120B
Chloride	SM4500CID or SM4110B
Conductivity	SM2510B
Hardness (Total or Dissolved)	SM2340B
Iron (Total or Dissolved)	SM3120B
Magnesium (Total or Dissolved)	SM3120B
Manganese (Total or Dissolved)	SM3120B
pH	SM4500H+B
Potassium (Total or Dissolved)	SM3120B

Table 5. Water Sample Analytical Parameters	
Sodium (Total or Dissolved)	SM3120B
Strontium (Total or Dissolved)	SM3120B
Sulfate (Total or Dissolved)	SM4110B
Total Dissolved Solids	SM2540C
Total Suspended Solids	SM2540D

4.4.1 METALS

Each sample collected for metal analysis must be placed in a 250 mL polyethylene bottle unless otherwise specified by the laboratory. Each sample container must be preserved by adding nitric acid (HNO₃) in accordance with the Contractor’s Laboratory protocols. The samples will be placed in a cooler at 4°C immediately upon collection.

4.4.2 NON-METALS AND GENERAL CHEMISTRY

Each sample collected for non-metal and general chemistry analysis must be placed in 1-liter polyethylene bottles, typically a cubitainer, unless otherwise specified by the laboratory. The cubitainer shall be purged of air voids and placed in a cooler at 4°C immediately upon collection.

4.5 SAMPLE CHAIN of CUSTODY FORMS

All samples must be accompanied by a chain-of-custody (COC) record. The contractor may obtain blank COC from analytical laboratory. A COC form(s) must be completed and accompany each sample submitted to the laboratory. If multiple coolers are sent to a single laboratory on a single day, COC form(s) must be completed and accompany the samples in each cooler.

The COC form must identify the contents of each cooler and maintain the custodial integrity of the samples. Generally, a sample is considered to be in a person’s custody if it is either in the person’s physical possession, in a person’s view, locked up, or kept in a secured area by that person with restricted access to avoid breaking the COC. Until the samples are hand delivered or shipped, the custody of the samples will be the responsibility of contractor. The contractor’s sampling team leader or designee will sign the COC form in the “relinquished by” box and include the date and time that it was placed in the box.

4.6 ANALYTICAL LABORATORY

The samples must be analyzed by a laboratory that is certified by the Ohio EPA or the National Environmental Laboratory Accreditation Program (NELAP).

5.0 DECONTAMINATION PROCEDURES

Decontamination of sampling equipment must be conducted consistently to ensure the samples collected are not contaminated and to prevent contamination of private water systems. All non-disposable equipment that comes into contact with groundwater must be decontaminated. Disposable equipment shall not be reused and will be packaged for appropriate disposal. Decontamination will occur prior to and after each use of non-disposable equipment following the procedure to be carried out in the sequence below.

1. Wash with a non-phosphate detergent and tap water scrubbing with a brush if necessary.
2. Rinse using tap-water or distilled water.
3. Rinse two times using deionized water rinse.

6.0 PHOTO DOCUMENTATION

Photographs must be obtained of each water well in relation to the home and at the sampling location. The photographs verify information entered in the field form. For each photograph obtained, all of the following information must be recorded in the field notes or on a separate field photography log:

- Time, date, address, and weather conditions
- Description of the subject photographed
- Cardinal direction the photographer is facing
- Name of person taking the photograph

7.0 FIELD VARIANCES

Conditions in the field may vary and it may be necessary to implement modifications to sampling requirements of this plan. If the Contractor determines it is necessary to implement a modification to the sampling, the Contractor must contact the Division Incident Response Manager listed in Table 3 and obtain approval before implementing any changes. Modifications to the approved plan must be documented in the project report.

8.0 FIELD HEALTH AND SAFETY PROCEDURES:

The site Health and Safety Plan shall be consistent with and the Contractor must comply with all applicable Federal and State statues and rules, and county and township ordinances that apply.