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Re: Section 7 Consultation for the Atlantic Coast Pipeline…Pipeline Pollutant Leaks

December 13, 2019

Mr. Simon, Ms. Toschik, and Ms. Schulz:

I wrote to you on October 27, 2019 regarding the current Section 7 Consultation for the Atlantic Coast Pipeline (ACP). Since then I have conducted research into the rate of leakage from natural gas transmission pipelines, and the environmental and health impacts from the pollutants that leak from those pipelines. I have found that this leakage is very significant, and the leaking pollutants pose a substantial risk to endangered species, especially in underground habitat in the 71 linear miles of karst along the current proposed route of the ACP.

Based on this information, and in addition to information that I previously sent to you, I believe that the U.S. Fish and Wildlife Service (FWS) should require that the ACP be moved away from all karst areas in order to comply with the Endangered Species Act (ESA). FWS should also conduct research to further determine the threat to all endangered species from pipeline pollutant leakage along the entire proposed route of the ACP. FWS should also quantify and assess the impact to endangered species from greenhouse gas emissions from the pipeline, pipeline and compressor station blowdowns, and the exploration, extraction, treatment, storage, and combustion of natural gas that would be facilitated by this project.

Pipeline Leakage

The Pipeline and Hazardous Materials Safety Administration (PHMSA) regulations allow what they term non hazardous leaks from natural gas transmission lines to continue to leak, unabated, and even unreported.[1] PHMSA has advised me that they are unaware of the amount of leakage from gas transmission pipelines.

In 2016 the Obama Administration enacted voluntary guidelines to reduce methane emissions from the natural gas industry[2]. The Trump Administration rolled them back earlier this year[3].

I have researched leaks from gas transmission lines, and found that they are extensive.

Alvarez et al, in an article in Science Magazine in 2018[4] found that natural gas transmission lines, like the ACP, lose 0.35% of their product during transmission. EPA's 2017 National Inventory of Greenhouse Gases and Sinks[5] found that 10% of those losses were from intentional releases, including blowdowns for pipe repair and maintenance, and routine compressor station blowdown releases. Therefore, 90% of

those transmission pipeline losses, or 0.315% of total pipeline volume is lost by leakage.

Given the very large volume of gas transmitted through these large transmission lines, this is a very large amount of pipeline pollutants that are being released into our environment.

The ACP has been approved by the Federal Energy Regulatory Commission (FERC) to transport 1.5 billion cubic feet of natural gas per day (1.5 bcf/d), with an allowable increase to 2.0 bcf/d, if requested.[6] At an average leak rate of 0.315%, the ACP would leak 4,725,000 cubic feet of pollutants per day, when carrying 1.5 bcf/d, and 6,300,000 cubic feet of pollutants per day, when carrying 2.0 bcf/d.

For the 605 mile ACP, this amounts to 7,810 cubic feet of pollutant leakage per day, and 10,413 cubic feet of pollutant leakage per day for every mile of pipeline, or about 1.5 cubic feet of pollutant leakage per day, and 2.0 cubic feet of pollutant leakage per day for every foot of pipeline.

The ACP is proposed to travel through 71 miles of karst terrain in the current route. Therefore, expected ACP losses to karst terrain along the ACP would be 554,510 cubic feet of pollutant leakage per day and 739,323 cubic feet of pollutant leakage per day.

Please note that leak locations may not be uniform over the entire pipeline. They may be higher in some areas, and lower in other areas. The above figures represent an average of losses over the entire transmission line. The amount and composition of the pollutant leakage from the ACP is reasonably expected to be similar to the gas transmission pipeline leakage research findings.

Nevertheless, leakage from the ACP to karst may actually be higher than the average gas transmission pipeline leakage, due to the following factors:

- The ACP would be constructed on extreme and unstable slopes with geohazards like land movement that would stress the pipe, and particularly the pipe welds, which are a source of leakage. PHMSA recently sent out a safety warning to pipeline operators regarding pipe stability concerns from soil movement in steep terrain[7]. This warning was prompted by a large number of recent pipeline explosions and ruptures in steep terrain, similar to the area that would be traversed by the ACP.

- Karst terrain is unstable as well, with underground voids that are prone to dynamic change as limestone dissolves in underground aquifers. Pipeline construction itself is likely to accelerate these changes through redirection of surface stormwater (which is known to create new sinkholes in karst) and altered underground flow routes. This inherent instability would also stress the pipe and welds, leading to increased leakage.

- Since the ACP would be constructed primarily in sparsely populated areas, PHMSA safety requirements are reduced.[8] This includes substantially thinner pipe walls, less weld inspections, reduced hydrostatic testing requirements, and less inspections once the pipe is in operation. This would also increase the likelihood of leaks.

Pollutant leakage from the ACP to our environment, and to karst would be very substantial.

Pollutants in Pipeline Stream

The largest constituent carried in natural gas pipelines is methane. There are other constituents as well, including liquids that can precipitate out of the gas stream. All of these can cause environmental damage when released, and all can be detrimental to human and wildlife health. The percent of constituents

carried in natural gas pipelines can vary considerably according to where the natural gas is obtained. Virtually all of these constituents can be considered pollutants.

Methane amounts in natural gas pipelines are generally between 90% and 95%, but can be as low as 60%. Other pollutants include ethane, propane, butane, pentane, hexane, heptane, octane, hydrogen sulfide, and aromatic chemicals, including benzene, toluene, benzoic acid, and naphthaline.

Enbridge Gas, Inc. lists the following typical analysis of their natural gas, sourced from the United States and Canada.[9]

Component	Typical Analysis (%)	Range (%)
Methane	93.9	87.0 - 97.0
Ethane	4.2	1.5 - 9.0
Propane	0.3	0.1 - 1.5
Iso - Butane	0.03	0.01 - 0.3
Normal - Butane	0.03	0.01 - 0.3
Iso - Pentane	0.01	trace - 0.04
Normal Pentane	0.01	trace - 0.04
Hexanes Plus	0.01	trace - 0.06
Nitrogen	1.0	0.2 - 5.5
Carbon Dioxide	0.5	0.05 - 1.0
Oxygen	0.01	trace - 0.1
Hydrogen	trace	trace - 0.02

Croft Production Systems lists the following components of natural gas and their range of percentages in the gas stream.[10] This indicates the variability in natural gas constituents based on where the gas is sourced.

Component	Range (%)
Methane	60-90
Ethane	0 - 20
Propane	0 - 20
Butane	0 - 20
Carbon Dioxide	0 - 8
Oxygen	0 - 0.2
Nitrogen	0 - 5
Hydrogen Sulfide	0 - 5
Rare Gases	0 -2

Negative Impacts of Pipeline Pollutants

Virtually all of the pollutants carried in gas pipelines mentioned here have negative health and environmental impacts.
The pollutants have carcinogenic, mutagenic, and toxic properties. They negatively impact respiration, and the central nervous system, cause cardiac arrhythmia, displace Oxygen, and cause toxicity to aquatic life, with long lasting impacts. There are other negative impacts, as shown below.

The following information was obtained from the National Institutes of Health PubChem sites.[11]

<u>Benzene - C6H6</u>

Heavier than air
Less dense than water and slightly soluble in water, floats on water
Flammable
Environmental contaminant
Toxic, carcinogenic, mutagenic
Coma and death possible
May be fatal if swallowed and enters airways
Damages bone marrow and central nervous system
Chronic exposure linked to oxidative stress and leukemia
OSHA permissible limits 1 PPM for 8 hours and 5 PPM for 15 minutes
NIOSH permissible limit 0.1 PPM for 10 hours

Benzoic Acid - $C_6H_5CO_2H$

Anti-fungal agent of relatively low concern

Butane - C_4H_{10}

Heavier than air
Extremely flammable
Immediately dangerous to life and health
Sudden death when inhaled at high concentrations
Central nervous system impacts
10 minute exposure at 1% causes drowsiness
May cause cancer and genetic defects
OSHA permissible limit 800 PPM for 8 hours
NIOSH permissible limit 800 PPM for 10 hours

Ethane - C_2H_6

Asphyxiant that can cause death when it displaces air
Heavier than air and may displace Oxygen in low places
Very high mobility in soil
Extremely Flammable
When mixed with Chlorine Dioxide it always explodes spontaneously

Heptane - C_7H_{16}

Heavier than air
May explode in enclosed area
Inhalation irritant to respiratory tract causing coughing and difficulty breathing
May cause impacts to central nervous system
If swallowed, enters airways, and could result in aspiration pneumonitis
Defats the skin, which may cause dryness and cracking
OSHA permissible limit 500 PPM for 8 hours
NIOSH permissible limits 85 PPM for 10 hours, and 750 PPM is immediately dangerous to life or health

Hexane - C_6H_{14}

Heavier than air
Highly flammable and explosive
Causes peripheral polyneuropathy and testicular atrophy
Irritates eyes, nose, and respiratory tract
Inhalation causes respiratory tract irritation, cough, mild depression, and cardiac arrhythmias
Aspiration causes severe lung irritation, coughing, pulmonary edema, and excitement followed by

depression
Ingestion causes nausea, vomiting, swelling of the abdomen, headache, depression
Associated diseases and disorders - Crohn's Disease and ulcerative colitis
OSHA permissible limit 500 PPM for 8 hours
NIOSH permissible limit 50 PPM for 10 hours

Hydrogen Sulfide - H2S

Highly flammable
Heavier than air
Very toxic by inhalation
Deadens smell, victims unaware of presence until it is too late
Death or permanent injury can occur after short exposure to small quantities
Toxic by all routes including inhalation, ingestion, and absorption
Inhalation may cause lung edema and long term chronic bronchitis
Causes ulceration of the skin, conjunctivitis, inflammation of nasal mucosa, shortness of breath, and trachiobronchitis
May cause effects on central nervous system
OSHA permissible limit 10 PPM for 10 minutes
NIOSH permissible limit 10 PPM for 10 minutes
100 PPM is immediately dangerous to life and health

Methane - CH4

Asphyxiant that can cause death when it displaces air
Lighter than air
Extremely flammable
Greenhouse gas

Naphthaline - C10H8

Carcinogenic agent
May be associated with an increased risk in developing laryngeal and colorectal cancer.
Environmental contaminant
Skin exposure must be avoided
Vapors may be toxic
Exposure associated with hemolytic anemia, liver damage, neurological system damage, retinal hemorrhage, and cataracts.
Denser than water and insoluble in water
Lethal dose 5 - 15 grams for adults, and 2 grams within 2 days for a 6 year old child.
OSHA permissible limit 10 PPM for 8 hours
NIOSH permissible limit 10 PPM for 10 hours, or 15 PPM for15 minutes

Octane - C8H18

Heavier than air
Less dense and insoluble in water, floats on water
Highly flammable
Very toxic to aquatic life with long lasting effects - acute hazard
Produces irritating vapor
Inhalation of concentrated vapor may cause irritation of respiratory tract, depression, and pulmonary edema
May be fatal if swallowed and enters airways
Harmful in contact with skin, causing skin irritation

Serious eye irritation
Aspiration causes severe lung irritation, rapidly developing pulmonary edema, and central nervous system excitement, followed by depression
OSHA permissible limit 500 PPM for 8 hours
NIOSH permissible limit 75 PPM for 10 hours

Pentane - C5H12

Heavier than air
Highly flammable and explosive
Asphyxiant
Toxic to aquatic life with long lasting effects
Inhalation causes drowsiness and dizziness
Very high concentrations produce narcosis and depression of the central nervous system
Aspiration into lungs can produce chemical pneumonitis and/or pulmonary edema
Causes irritation of the eyes, skin, nose, dermatitis, nausea, and unconsciousness
Lowest published human inhalation lethal concentration 130 mg/cubic meter
Lethal concentration mouse inhalation 325 mg/cubic meter
OSHA permissible limit 1000 PPM for 8 hours
NIOSH permissible limit 120 PPM for 10 hours

Propane - C3H8

Asphyxiant that can cause death when it displaces air
Heavier than air and may displace Oxygen in low places
Extremely flammable
Concentrations of greater than 10% can cause dizziness in a few minutes
Concentrations of 1% can cause dizziness in 10 minutes
OSHA permissible limit 1,000 PPM for 8 hours
NIOSH permissible limit 1,000 PPM for 10 hours
Lowest published lethal concentration inhalation by dog - 180,000 PPM for 5 minutes, death from cardiac arrhythmias

Toluene - C6H6CH3

Heavier than air
Less dense than water and insoluble in water, floats on water
Substance of very high concern
Vapors irritate eyes and upper respiratory tract, and cause dizziness, headache, anesthesia, and respiratory arrest
Liquid irritates eyes, and causes drying of the skin
Aspiration causes coughing, gagging, distress, and rapidly developing pulmonary edema
Ingestion causes vomiting, griping, diarrhea, and depressed respiration
OSHA permissible limit 200 PPM for 8 hours
NIOSH permissible limit 100 PPM for 10 hours, and 150 PPM for 15 minutes

All of these polluting chemicals are likely to enter confined karst underground environments, and groundwater, and surface water along, and near the current proposed route of ACP. Each of them has specific negative impacts to the environment, and to living organisms, including endangered species. In combination, these pollutants pose an even more significant threat.

Pathways of Natural Gas Pollutants from Pipeline to Karst

The ACP is a 42 inch diameter pipeline that would be buried underground. On average, the top of the pipe would be around 6 feet under the surface of the ground, and the bottom of the pipe would be 9 to 10 feet under the surface. Compacted soil would cover the pipe to that depth.

Gas in the pipeline would be under 1,440 pounds per square inch pressure.[12] This is about 100 times more pressure than atmospheric pressure. Due to the very large difference in pressure inside and outside of the pipe, leaks in the pipe would be constantly forced out of the pipe under high pressure.

As I stated previously in my letter to you of October 27, 2019, renowned karst expert and hydrogeologist Christopher Groves points out that caves and karst areas are interconnected to a greater extent than previously thought, and pollutants can travel rapidly through them. He also points out that pollutants can enter karst aquifers not only through sinkholes and sinking streams, but through diffuse infiltration, or diffuse autogenic recharge, through highly permeable bedrock covering large areas, with little filtering.[13]

Since the pipe will be covered with 6 to 10 feet of compacted soil, the pressurized leaks will flow along the path of least resistance, and in many cases enter karst voids and caves, rather than discharge to the atmosphere. There are three possible pipeline pollutant pathways to the karst voids and caves.

1 - Through interconnected karst passages, no matter how small, in the immediate area of the pipe leak.
2 - By following the outside of the pipe along voids around the pipe created by subsurface water flow and inherent difficulty in completely compacting soils immediately adjacent to a large 42 inch diameter pipe, and then entering karst voids and caves through an interconnected karst passage.
3 - By diffuse infiltration, either at the leak location, or along the voids in the ground along the pipe.

Once the pollutants reach the karst voids and caves, they will accumulate and concentrate within these confined spaces, rather than mix and dilute into our atmosphere, as above ground blowdowns from pipe repair and maintenance, and blowdowns from compressor stations do.

FERC ACP Environmental Impact Statement (EIS) Inaccuracies Regarding Impacts of Pipe Pollutant Leaks to Karst

FERC's EIS[14] is severely deficient regarding pipeline leaks to karst.

Section 4.1.2.3 of FERC's Environmental Impact Statement (EIS) for the ACP states:

"Because methane is lighter than air, it would generally dissipate rapidly in the event of a pipeline leak, thereby causing little to no impact on karst or groundwater resources. However, concern was raised regarding the potential impacts of natural gas being drawn into a cave due to barometric changes, and methane dissolution into groundwater in the event of a leak. Because the pipeline would be installed either in soil or weathered bedrock, it is highly unlikely that any methane gas would be drawn into cave systems due to changes in atmospheric pressure.

Moreover, the Karst Mitigation Plan specifically requires inspection of the trench during construction for any openings into the subsurface, and if openings are found, they would be sealed and/or mitigated to prevent migration and transport of contaminants, including gas- phase hydrocarbons. Methane has a solubility limit of 3.5 ml/100 ml of H2O at 17 degrees Celsius, and is highly evaporative and readily degasses from aqueous solution and is considered non-toxic when dissolved in water. If methane was to partition into the groundwater, the impacts would be local and temporary.

However, concentrations of methane in water exceeding 10 mg/L may have explosive potential if the

methane degasses and migrates into enclosed spaces such as water well casings. Given that the pipeline would be monitored during operation and the likelihood of a gas release is low, we conclude that the probability for methane to impact karst features and associated groundwater to be low."

Page 4-564 of the EIS for the ACP states that methane is not toxic, but it is an asphyxiate that displaces Oxygen. "When released into the atmosphere (as opposed to a confined space) sufficient air mixing would occur to negate this hazard."

These FERC statements do not accurately assess the negative impacts of ACP pipe leaks to subterranean karst areas. The following is a summary of how the FERC's EIS is not accurate in this regard:

- The EIS only addresses Methane, and none of the other numerous chemical pollutants that would be leaked from the pipe.

- Even though methane is lighter than air, it would be discharged from leaks in the pipe 6 to 10 feet underground. It would not dissipate into the air. The compacted earth above the pipe would prevent the methane from reaching the atmosphere. Instead, the methane would be more likely to follow the path of least resistance, and be drawn into the many nearby interconnected karst passages and voids, or enter the karst passages and voids by diffuse infiltration through permeable material.

- Barometric pressure differences would have little or no impact on methane being drawn into karst, because the leaks are effectively blocked from the atmosphere by the 6 to 10 feet of fill over the pipe. Regardless of the barometric pressure, Methane, and other gas stream pollutants are likely to be drawn into underground voids in the karst.

- Inspections of the trench for openings to karst as described in the karst mitigation plan will not adequately insure that all pathways from the trench to karst voids are found and sealed due to the following factors:

- Openings to karst may be too small to be located and sealed during this massive construction project, which is planned on slopes exceeding 60% under very adverse conditions, and with much loose material in the trench, making observation of openings extremely difficult. The ACP has previously publicly stated that they plan to continue construction throughout the winter, and in snow depths of up to 11 inches. Construction workers, or even karst specialists, will not be able to find all openings to karst, or even a reasonable number of them, under these adverse conditions. Nor will they be able to locate and somehow seal permeable material in the base of the trench that would allow leaked pollutants to enter the karst voids. These pathways to karst will remain after the pipe is in the ground and carrying very large amounts of gas. Leaks of pollutants in the gas stream will surely enter the subterranean karst environment.

- The ACP has failed to conduct satisfactory inspections in just the first few miles of construction in West Virginia regarding pipe placement into the trench. PHMSA has cited the ACP for probable violations for placing pipe in rock lined trenches which could damage the pipe.[15] The ACP has also had to remove pipe from the ground due to pipe coating anomalies that should have been found during mandatory inspections of the pipe required by PHMSA regulations before placing the pipe in the trench, and placing backfill over the pipe.[16, 17] These anomalies were only found by an electrical test after the pipe had already been placed into the ground. The project has also created numerous areas of land slippage in just the first few miles of construction.[18] All of these issues could lead to increased pipe pollutant discharges.

- The EIS mentions explosive methane degassing and possibly entering well casings when aqueous concentrations exceed 10mg/Liter, but does not mention negative impacts to karst terrain if this should happen.

- The EIS incorrectly states that the likelihood of a gas release is low. All evidence, as indicated by EPA, the Alvarez study, and others, shows that these very large cumulative releases are routine, pervasive, ongoing, and inevitable.

- The EIS states that the pipeline will be monitored, but PHMSA regulations only require patrols and leak detection inspections once every 15 months.[19] Regardless, the chances of a patrol or leak detection inspection finding an underground leak to karst is extremely rare.

The EIS is correct in one sense regarding pipeline leaks. It states that methane is an asphyxiate that displaces oxygen and is hazardous in confined spaces (like caves and voids in karst).

Endangered Species That Would Be Impacted By ACP Leaks to Karst

Madison Cave Isopod - Direct contact with pipeline pollutants leaked to karst could displace oxygen in the subterranean habitat, and result in death. Other pollutants with negative health impacts that are leaked to karst could result in death.

Indiana Bat - Methane and other pipeline pollutants could enter caves where bats are hibernating, resulting in physical distress, or death.

Rusty Patched Bumble Bee - Methane and other pipeline pollutants could enter underground nests, resulting in physical stress, or death.

Clubshell Mussel - Pentane and Octane leaks are toxic to aquatic life with long lasting impacts. These, and other pipeline pollutants could result in physical stress, or death.

Roanoke Logperch - Pentane and Octane leaks are toxic to aquatic life with long lasting impacts. These, and other pipeline pollutants could result in physical distress, or death.

Candy Darter - Pentane and Octane are toxic to aquatic life with long lasting impacts. These, and other pipeline pollutants could result in physical stress, or death.

Other endangered species along the current route of the ACP would face similar negative impacts from pipeline pollutant leakage.

Total Gas Production Loss Impacts To Climate Change

Alvarez, et al also found total losses from United States natural gas production at 2.3%.[20] This includes losses from exploration, extraction, storage, transport, and combustion. They state that because Methane is such a potent greenhouse gas, a 2.3% loss is the greenhouse gas equivalent of all Carbon Dioxide emissions from all United States natural gas combustion. They also state that these methane losses are the greenhouse gas equivalent of all Carbon Dioxide emissions from all United States coal fired power plants in 2015.

While the ACP itself would not lose 2.3%, it would facilitate and encourage the exploration, extraction,

storage, and combustion that all contribute to that 2.3% total loss.

These are stunningly high numbers, with extremely grave consequences regarding climate change, and devastating climate change impacts to endangered species.

As I stated in my October 27th letter to you, of all the stressors to survival and restoration of endangered species, climate change ranks at the top in overall impacts, and the ACP would significantly harm endangered species through climate change.

Summary and Recommendations

Pervasive pollutant leaks from the ACP will very likely enter, and pollute underground karst voids and caves, and stress, injure, or kill endangered species in those habitats.

The pollutant leaks will very likely also enter surface waters and groundwater all along the current route of the ACP, and stress, injure, or kill endangered species.

In order to comply with the Endangered Species Act, and in addition to my recommendations in my letter of October 27th, FWS should:

- Require that the ACP be routed away from karst areas.

- Further research the impacts of expected pollutant leaks to endangered species along the entire current route of the ACP.

- Further research all climate change impacts expected from methane losses to our atmosphere from ACP pipeline blowdowns, and from natural gas extraction, processing, storage, and combustion losses facilitated by the ACP.

Thank you for your public service.

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Footnotes
1 49 CFR 192.711
2 2016 New Source Performance Standards 40 CFR Part RIN2060 - AS30 and Bureau of Land Management Waste Prevention, Production Subject to Royalties and Resource Conservation 82FR83008
3 Oil and Gas Natural Gas Sector Emission Standards for New, Reconstructed, and Modified Sources Review RIN EPA 40 CFR Part 60- AT90 and Department of the Interior 43 CFR Parts 3160 and 3170
4 Alvarez, et al Science Magazine July 13, 2018

5 EPA 2017 National Inventory of Greenhouse Gas Emissions and Sinks
6 Atlantic Coast Pipeline and Supply Header Project Final Environmental Impact Statement, July 2017
7 Federal Register May 2, 2019 Pipeline Safety: Potential for Damage to Pipeline Facilities Caused By Earth Movement and Other Geological Hazards Document 2019 - 08984
8 49 CFR 192.5
9 Chemical Composition of Natural Gas, Enbridge Gas, Inc. Website
10 Croft Production Systems Oil and Gas Blog Jessica Lee October 7, 2015
11 NIH PubChem Sites for each listed pollutant
12 Atlantic Coast Pipeline and Supply Header Project Final Environmental Impact Statement, July 2017
13 Dr. Christopher Groves Karst Landscapes and Aquifers of the Central Appalachian Mountains, and Implications for the Proposed Mountain Valley Pipeline FERC Accession No. 20161223-5058 Mountain Valley Pipeline Docket
14 Atlantic Coast Pipeline and Supply Header Project Final Environmental Impact Statement July, 2017
15 Robert Burrough, PHMSA, July 25, 2019 letter to Brian Sheppard, Dominion Energy Transmission, Inc.
16 FERC Environmental Compliance Monitoring Program Weekly Summary Reports for the Atlantic Coast Pipeline 4/1/19 - 4/7/19, 4/8/19 - 4/14/19, 4/15/19 - 4/21/19.
17 49 CFR 192.461
18 ABRA Pipeline CSI Program
19 49 CFR 192.705, 49 CFR 192.706
20 Alvarez, et al Science Magazine July 13, 2018