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Thank you for the opportunity to testify this morning at the Joint Hearing on Natural Gas Drilling, Public Health and Environmental Impacts. Unconventional gas extraction in deep shale deposits presents considerable risks to public health and safety as well as to environmental resources, particularly water quality and aquatic organisms. My testimony today will cover three critical public health and environmental policy areas related to unconventional natural gas production.

First is the unregulated siting of natural gas wells in areas of high population density, and near schools and critical infrastructure. Unconventional gas extraction wells are highly industrialized operations that have public health preparedness risks of catastrophic blowout, explosion and fire. Any of these incidents can create an Immediately Dangerous to Life and Health (IDLH) condition for adults or children in close physical proximity. The unregulated siting of unconventional natural gas extraction wells and production facilities in residential neighborhoods and near critical infrastructure is unwise preparedness policy, especially in light of federal and state efforts to reduce risk from terror attacks on USA citizens and critical infrastructure.

Secondly, the higher rates and differential patterns of oil and gas act violations from Marcellus Shale gas extraction operations, as compared to conventional oil and gas wells, suggests a much greater impact to drinking water and aquatic resources. Marcellus Shale gas extraction wells have between 1.5 to 4 times more violations than their conventional well counterparts per offending well, including more serious violations and violations that have a direct impact on water quality and aquatic resources. Marcellus Shale gas extraction wells are more likely to have violations for:

- Failures to minimize accelerated erosion, implement erosion and sedimentation plans, and/or maintain erosion and sedimentation controls.
- Discharge of pollution to waters of the Commonwealth of Pennsylvania.
- General violations of the Clean Streams Law.
- Failure to properly store, transport, process or dispose of a residual waste and -
- Failures to adequately construct or maintain impoundments holding gas extraction flowback fluids containing toxic contaminants.

The third problem public health and environmental policy area to be addressed is the disposal of gas extraction flowback fluids, carrying a plethora of toxic elements and chemicals, in inefficient "brine" treatment facilities and Publicly Owned Treatment

Works (POTW's) [commonly called sewage treatment plants], which discharge effluent into surface water sources. Studies of the effluent from a commercial facility in Pennsylvania that treats fluids only from gas and oil operations shows discharge of 9 pollutants in excess of nationally recognized human and/or aquatic health standards into a nearby stream. The contaminants include:

- Barium, found in effluent over 8 times its minimum risk level (MRL) in drinking water to children and 27 times its EPA consumption concentrations for fish and "fish plus water".
- Stable Strontium, found in effluent 43.29, 51.68 and 97.90 times the drinking water MRL's for intermediate exposures for adult men, adult women, and children, respectively. Strontium levels found in effluent were 29,811 times the reporting limit in the plants NPDES permit.
- Bromide, which forms mixed chloro-bromo byproducts in water treatment facilities that have been linked to cancer and other health problems were found in effluent at 10,688 times the levels generally found acceptable as a background in surface water.
- Benzene, a known carcinogen, is present in effluent water at over 2 times its drinking water standard, over 6 times its EPA consumption criteria, and 1.5 times the drinking water MRL for chronic exposure for children.
- 2-butoxyethanol (2-BE), a glycol ether and used as an antifoaming and anti-corrosion agent in slick-water formulations for Marcellus Shale gas extraction was found in effluent water at 24.48, 29.21, and 55.14 times the drinking water MRL's for intermediate exposure to adult males, adult females, and children, respectively –based on hepatic health effects.
- Chlorides, the concentration of chlorides in the effluent was 138 and 511 times the EPA maximum and continuous concentration criteria set for the health of aquatic organisms, respectively.

Due to time constraints I will not cover impacts to air quality, although I wish to go on record that these impacts could be significant, due to release of hazardous air pollutants from 10's of thousands of projected natural gas wells, with the subsequent formation of ozone; areas of Maryland, Pennsylvania, Ohio, New York, and New Jersey are already in EPA nonattainment status for ozone exposure.

Potential "Immediately Dangerous to Life and Health" (IDLH) Conditions from Unregulated Siting of Unconventional Gas Extraction Wells

Unconventional gas extraction wells are highly industrialized operations that have attendant risks of catastrophic blowout, explosion and fire. The actualization of any of these incidents creates an IDLH condition for adults and children in close proximity to these wells from any blast or fires, the displacement of oxygen by methane, exposure to waterborne contaminants, and from inhalation of pyrolysis products of burning condensate, liners and/or production equipment. Over the past 2 years, within a 3 hour drive of Pittsburgh PA, there has been one catastrophic blowout, one explosion and fire due to ignition of methane from an underground coal mine, and two fires (one at a multi-

well site in production near Avella PA and one at a site being brought into production in Hopewell Township, PA).

If we use the figure of 1831 drilled wells in the State of Pennsylvania from 2007 to September of 2010, which is an overestimate of the wells drilled in a three hour drive of Pittsburgh PA and use this as the denominator, and use 4 incidents as the numerator we obtain an order of magnitude estimate of the probability for IDLH conditions at these wells of 0.002. Using this figure and based on estimates of the predicted number of wells to be drilled over the next 10 years of 25,000 wells- there could be as many as 50 wells that create IDLH conditions due to blowout, blast and/or fire. What is disturbing, in this era of spending billions of dollars to reduce risk from terror attacks on USA citizens and critical infrastructure, is that we are allowing these gas extraction wells to be sited in a largely unregulated fashion in close proximity to homes and critical infrastructure including schools, and in densely populated regions of Pennsylvania, Ohio, and West Virginia.

The well publicized and documented Marcellus Shale blowout in Clearfield County PA, due in part to failure of the operator to properly test the Blow-Out Preventers (BOPs) prior to use and to conduct the BOP test in a proper manner, resulted in the immediate evacuation of all residents within one mile of the drill site. Luckily the impacted area was largely state forest land with no population proximal to the drill site and very diffuse population density. CHEC has done projections to show impacts of such a blowout in a more densely populated area south of Pittsburgh PA- Peters Township, Washington County PA, where gas leases are currently being signed. If the blowout had occurred in the centroid of this township approximately 1,928 adults and children would need to be evacuated as well as up to 5 school complexes. Local emergency response personnel are not properly trained or adequately equipped to handle these type incidents nor is there a gas extraction specific planning mechanism for such large population displacements.

Patterns of Oil and Gas Violations from Marcellus Shale Gas Extraction Operations in Pennsylvania and General Threats to Water Resources

CHEC analyzed the number of Oil and Gas Act violations by well type in Pennsylvania over the period from January 1, 2007 to September 30, 2010 and found that Marcellus Shale gas extraction wells have between 1.5 to 4 times more violations than their conventional well counterparts per offending well (this is dependant on the denominator of total wells drilled which is difficult to ascertain for conventional oil and gas wells due to drilling for over 100 years). These include more serious violations and violations that potentially have a more direct impact on water quality and aquatic resources. Between January 1, 2007 and September 30, 2010, horizontal Marcellus wells had 3.75 violations per offending well, while vertical Marcellus wells had 2.99 violations per offending well, resulting in a rate of 3.51 violations per offending well for all Marcellus wells. Conventional non-Marcellus oil and gas wells had violations per offending well of 2.38.

In 2010, 451 distinct Marcellus Shale gas extraction wells in Pennsylvania were cited for violations of the Oil and Gas Act by the Pennsylvania Department of Environmental

Protection (DEP). There were 1544 total violations resulting in a mean violations rate per offending well of 3.42. Of these 1544 total Marcellus violations; 111 violations were for failure to minimize accelerated erosion, implement erosion and sedimentation plans, and/or maintain erosion and sedimentation controls and/or failure to stabilize the site until total site restoration under OGA Section 206(c)(d); 105 violations were for discharge of pollution to waters of the Commonwealth; 106 violations were general violations of the Clean Streams Law; 68 violations were for failure to properly store, transport, process or dispose of a residual waste; and 116 violations were issued for impoundment problems including failure to maintain a 2 foot freeboard, and impoundment not structurally sound or impermeable.

These patterns of violations of the Pennsylvania Oil and Gas Act by Marcellus Shale gas operators support my contention that development of natural gas from the Marcellus Shale has the potential to result in substantial adverse effects on water quality, the environment and public health. Ground-surface disturbances associated with well drilling, including site clearing, and the construction of access roads, drill pads and impoundments, can produce impacts associated with stormwater, erosion and sedimentation of surface waterways, which in turn may lead to higher levels of water turbidity, total dissolved solids, conductivity and salinity. In addition to the impacts associated with surface activities are those associated with deep well drilling. Wells drilled to depths of 5,000 to 8,000 feet to reach the Marcellus formation (and also the Utica Shale formation) create pathways for the migration of naturally-occurring contaminants into usable quality aquifers, and involve the disposition on the surface of drill cuttings and formation waters that also may contaminate ground and surface water. Contaminants associated with natural gas drilling in the Marcellus include toxic heavy metals and elements, organic compounds, radionuclides and acid producing sulfide minerals, and natural gases and sulfide producing gases, which can threaten surface and groundwater sources.

Disposal of Oil and Gas Flowback Fluids in Inefficient "Brine" Treatment Facilities and Publicly Owned Treatment Works (POTW's) that Discharge into Surface Water; Potentially Exposed Populations and Regional Significance

Hydraulic fracturing (HF) of shale gas deposits uses considerable masses of chemicals, for a variety of purposes to open and keep open pathways through which natural gas, oil and other production gases and liquids can flow to the wellhead. HF, also known as slick-water fracturing, introduces large volumes of amended water at high pressure into the gas bearing shale where it is in close contact with formation materials that are enriched in organic compounds, heavy metals and other elements, salts and radionuclides. Typically, about 1 million gallons and from 3 - 5 million gallons of amended water are needed to fracture a vertical well and horizontal well, respectively (Hayes, 2009). Fluids recovered from these wells can represent from 25% to 100% of the injected solution and are called "flowback" or "produced" water depending on the time period of their return. Flowback and produced water contain high levels of total dissolved solids, chloride, heavy metals and elements as well as enriched levels of organic chemicals, bromide and radionuclides – in addition to the frac chemicals used to make the water slick-water. Levels of shale

origin contaminants in flowback water generally increase with increasing time in contact with formation materials.

This oil and gas fluid waste is generally held in temporary open-air impoundment(s) near the well site or occasionally in large sealed containers. Additionally, oil and gas waste fluids accumulate in condenser tanks located on producing well pads, which must be drained regularly. Currently, flowback water is either taken for disposal to a POTW (sewage treatment plant), or a Brine Treatment Facility, both of which discharge effluent directly to surface water sources. The waste fluids may also be recycled for reuse (on-site or off-site at treatment facilities), or injected into Class II underground wells.

The relative volumes of flowback and condensate entering each end-point alternative described above are currently the subject of much heated debate, the unraveling of which is well beyond the scope of my testimony. It is sufficient to note that large volumes of oil and gas wastewater are disposed of in POTW's and brine treatment facilities that discharge effluent directly into surface water. The PA Brine Treatment, Josephine Facility received 15,728,242 gallons of Marcellus Shale gas extraction wastewater for treatment and effluent discharge into Blacklick Creek, Indiana County in the last half of 2010. The Clairton POTW received and disposed of 53,473 gallons of Marcellus Shale wastewater in the last half of 2010, which is ultimately discharged into the Monongahela River. CHEC has identified at least 10 facilities that discharged effluent into the Monongahela River drainage in 2010-2011 in Pennsylvania alone; if all these facilities are accepting flowback fluids at their permitted rate then 824,000 pounds of total dissolved solids and 15,000 pounds of barium could enter the watershed from these operations daily.

There is considerable scientific inquiry and even controversy regarding the potential of vertical or horizontal fracturing of shale gas reservoirs to contaminate shallow or confined groundwater aquifers, and thus expose municipal or private well water users to chemicals used in the hydrofracturing process and/or contaminants in the formation materials. However, when Marcellus Shale flowback and produced fluids are disposed of in POTW's or inefficient brine treatment facilities discharging into surface water, the fate and transport pathways to expose human and aquatic receptors are well described for most of the contaminants potentially in effluent discharge water and known to be in flowback and other oil and gas wastewater. Contaminants untreated by the facility and discharged into surface water will move in the water through advective and fickian processes downstream, be deposited and transferred into sediments and pore water, bioaccumulate in aquatic receptors and terrestrial animals that feed on them according to their species specific bioaccumulation factors, be transported to groundwater, and/or be volatilized to air dependent on their Henry's Law constants. Direct and complete human and ecological exposure pathways via ingestion, dermal absorption and inhalation (gill transfer in fish) can be demonstrated for different classes of elements, and compounds in the wastewater, constituting a potential exposure threat to recreationalists, private well water users and municipal drinking water users.

Case Example; Concentrations of Contaminants in Effluent Water from Pennsylvania Brine Treatment Facility, Josephine Facility (PBT-JF)

The Center for Healthy Environments and Communities (CHEC) of the Graduate School of Public Health, University of Pittsburgh, conducted sampling of wastewater as it was discharged into Blacklick Creek, Indiana County, Pennsylvania from the PBT-JF on December 10, 2010. Samples were taken at 3-hour intervals over the course of one 24-hour period. The concentrations of analyzed contaminants in this effluent of primary environmental public health importance, which may also stress aquatic life, include: barium (Ba) [mean, 27.3 ppm; maximum, 37.0 ppm]; bromides (Br) [mean, 1068.8 ppm; maximum, 1100.0 ppm; strontium (Sr) [mean, 2983.1 ppm, maximum 3120.0 ppm]; benzene [mean 0.012 ppm; maximum 0.013 ppm] and 2-butoxyethanol (2-BE) [mean 59ppm; maximum 66 ppm]. Contaminant concentrations of ecological and secondary drinking water importance include: chlorides (Cl) [mean 117,625 ppm, maximum 125,000 ppm]; magnesium (Mg) [mean 1247.5 ppm; maximum 1300.0 ppm]; total dissolved solids (TDS) [mean 186,625 ppm; maximum 190,000 ppm]; sulfate (SO4) [mean 560 ppm; maximum 585 ppm], and pH [mean 9.58 units; maximum 10 units].

Levels of contaminants in effluent from the PBT-JF were interpreted according to comparisons with applicable federal and state standards and recommended guidelines for both human and aquatic health. Barium had a mean concentration in effluent of 27.3 ppm (maximum of 37 ppm); this is approximately 14 times the United States Environmental Protection Agency (EPA) maximum concentration limit (MCL) of Ba in drinking water of 2 ppm. The EPA consumption concentrations ‘water and organism’ and ‘organism alone’ for barium are both 1 ppm. The levels of barium in the effluent are over 27 times these consumption concentrations. The U.S. EPA criteria maximum concentration (CMC) and the EPA criteria continuous concentration (CCC), both for protection of aquatic health, are 21 ppm and 4.1 ppm, respectively; the mean level of barium in effluent exceeds these criteria by 1.3 and 6.7 times, respectively. The mean concentration of barium in PBT-JF effluent water (27.3 ppm) is 3.96, 4.73, and 8.98 times the ATSDR derived drinking water minimum risk level (MRL) for intermediate and chronic exposures for adult men, and women, and children, respectively.

The EPA (ATSDR ascribed) recommends that drinking water levels of stable strontium should not be more than 4 milligrams per liter of water (4 mg/L), Sr levels in PBT-JF effluent are 746 times this recommended level. The strontium ATSDR MRL for oral route, intermediate exposure is 2 mg/kg of body mass/day, for musculoskeletal endpoints. The derived minimum risk levels for strontium in drinking water for intermediate exposure for adult men, adult women, and children are 68.87 mg/L/day, 57.67 mg/L/day, and 30.45 mg/L/day, respectively. The mean concentration of strontium in PBT-Josephine effluent water (2,981.1 ppm) is 43.29, 51.68 and 97.90 times the derived strontium drinking water MRL’s for intermediate exposures for adult men, adult women, and children, respectively. Strontium is not listed on the PBT-JF, NPDES permit but the facility is required to notify the PA DEP if they routinely discharge 100 ppb of a toxic pollutant or nonroutinely discharge 500 ppb of a toxic pollutant. The mean concentration of Sr in effluent water of 2,981.1 ppm is 29,811 and 5,962 times the lower and upper

notification levels required by the PA DEP NPDES permit, respectively. . Searches of the PA DEP file for December, 2010, shows no such notification to the DEP.

Bromide in water is of concern because of its ability to form brominated analogs of drinking water disinfection by-products (DBP). Specifically, bromide can be involved in reactions between chlorine and naturally occurring organic matter in drinking-water, forming brominated and mixed chloro-bromo byproducts, such as trihalomethanes or halogenated acetic acids. Several DBPs have been linked to cancer in laboratory animals, and as a result the U.S. EPA has regulated some DBP's. There is general agreement that bromide levels in freshwater sources be kept below about 100 ppb (.1 ppm) so that formation of brominated DBP's are minimized, therefore regulatory authorities and water treatment plant operators become concerned when there are sources of bromides in a surface system adding to this level. The PBT-JF discharged effluent into Blacklick Creek with a measured mean concentration of bromide of 1,068.8 ppm, which is 1,068,800 ppb. This is 10,688 times the 100 ppb level at which authorities become concerned. Bromide is not listed on the PBT-JF NPDES permit, but the facility is required to notify the PA DEP if they routinely discharge 100 ppb of a toxic pollutant or nonroutinely discharge 500 ppb of a toxic pollutant. The mean concentration of Br in effluent water 1,068.8 ppm is 10,688 and 2,138 times the lower and upper notification levels required by the PA DEP NPDES permit, respectively. Searches of the PA DEP file for December, 2010, shows no such notification to the DEP.

The mean level of benzene, a known carcinogen, in outfall effluent from PBT-JF was 0.012 ppm or 12 ppb. The drinking water MCL for benzene is 5 ppb, thus effluent levels were above twice the drinking water MCL. The EPA consumption, water and organism risk level for benzene is 2.2 ppb in water, the mean level of benzene in PBT-Josephine effluent water is almost 6X this criteria; the organism only risk level for benzene is 50 ppb in water, the mean level of benzene in effluent water is 24% of this guideline. The benzene ATSDR MRL for oral route, chronic exposure is 0.0005 mg/kg of body mass/day, for immunological endpoints. The derived minimum risk levels for benzene in drinking water for chronic exposure for adult men, adult women, and children are 0.017 mg/L/day, 0.014 mg/L/day, and 0.008 mg/L/day, respectively. The mean concentration of benzene in PBT-Josephine effluent water (0.012 ppm) is 70% of, 86% of, and 1.5 times the derived chronic drinking water MRL for benzene for adult men, adult women, and children, respectively.

2-butoxyethanol (2-BE) is a glycol ether and is used as an antifoaming and anti-corrosion agent, as well as an emulsifier in slick-water formulations for Marcellus Shale gas extraction. The mean and maximum levels of 2-BE found in the PBT – JF effluent were 59 ppm and 66 ppm, respectively. The 2-BE ATSDR MRL for oral route, acute exposures is 0.4mg/kg/day based on hematological effects, with an uncertainty factor of 90; the 2B-E MRL for oral route, intermediate exposure is 0.07 mg/kg/day and it is based on hepatic health endpoints with an uncertainty factor of 1000. The derived minimum risk levels for 2-BE in drinking water for acute exposure for adult men, adult women, and children are 13.77 mg/L/day, 11.53 mg/L/day, and 6.09 mg/L/day, respectively; the derived MRL's for 2-BE in drinking water for intermediate exposure for adult men, adult

women, and children are 2.41 mg/L/day, 2.02 mg/L/day, and 1.07 mg/L/day, respectively. The mean concentration of 2-BE in PBT-JF effluent water (59 ppm) is; 4.28, 5.12, and 9.69 times the derived 2-BE drinking water MRL's for acute exposure to adult males, adult females, and children, respectively; and 24.48, 29.21, and 55.14 times the derived 2-BE drinking water MRL's for intermediate exposure to adult males, adult females, and children, respectively. 2-BE is not listed on the PBT-JF NPDES permit, but the facility is required to notify the PA DEP if they routinely discharge 100 ppb of a toxic pollutant or nonroutinely discharge 500 ppb of a toxic pollutant. The mean concentration of 2-BE in effluent water is 590 and 118 times the lower and upper notification levels, required by the PA DEP NPDES permit, respectively. Searches of the PA DEP file for December, 2010 show no such notification to the DEP.

Contaminants with secondary MCL's (SMCL) and aquatic receptor effects that were measured in the PBT-JF effluent include magnesium, manganese, chlorides, sulfates, and total dissolved solids (TDS). Magnesium was found in the effluent with a mean concentration of 1,247.5 mg/L, which is 24,950 times the EPA Mg SMCL of .05 mg/L. The mean concentration of Manganese in the effluent was .08 mg/L, and the SMCL for Manganese concentration in drinking water is .05 mg/L, which is 62.5% lower than the concentration in the effluent. The mean concentration of chlorides in the sample analysis was 117,625 mg/L, which is 470.5 times the SMCL for chlorides in drinking water of 250 mg/L. To protect aquatic communities, the criteria maximum concentration (CMC) for chlorides in surface water is 860 mg/L, and the criteria continuous concentration (CCC) for chlorides in surface water is 230 mg/L. The mean concentration of chlorides measured in samples was 138 times the CMC and 511 times the CCC. The mean concentration of sulfates in the sample analysis was 560 mg/L, 2.2 times the SMCL for sulfates in drinking water (250 mg/L). The SMCL for total dissolved solids (TDS) in drinking water is 500 mg/L, and the mean concentration of TDS measured in samples was 186,625 mg/L, 373 times the SMCL.

Masses of Contaminants Entering Blacklick Creek

CHEC has information from the Pennsylvania, Department of Environmental Protection (DEP) that the PBT – JF treated 15,728,241 gallons of oil and gas wastewater in the 6 month period from July 1, 2010 to December 31, 2010. Using this figure as the amount of effluent wastewater exiting the Josephine outfall and using the mean level of each contaminant found in the effluent over the sampling period of the study, the masses of contaminants with important human and ecological consequences discharged from the PBT-JF into Blacklick Creek in the last 6 months of 2010 are projected to be: barium-1627 kg (3588 pounds); strontium -177,712 kg (391,856 pounds; 196 tons); bromides-63,708 kg (140,476 pounds; 70.2 tons); chloride – 7,011,631 kg (15,460,646 pounds; 7,730 tons); sulfate – 33,382 kg (73,607 pounds; 36.8 tons); 2 BE– 3517 kg (7,755 pounds; 3.88 tons); and total dissolved solids – 11,124,733 kg (24,530,036 pounds; 12,265 tons).

Potentially Exposed Populations

Recreationalists are at risk of being exposed to outfall contaminants through ingestion, inhalation and through dermal exposure. The outfall of the BBT-JF is easily accessible to users of nearby rails-to-trails pathways, and there are indications that anglers frequent the area. Additionally, children wade and swim in the creek during warmer weather, and regional watershed websites indicate that paddlers use the creek for canoeing and kayaking. 2 BE released into Blacklick Creek may be ingested by swimmers in the creek. This pollutant can become airborne and present an inhalation hazard to anglers, swimmers and boaters. It is also taken in to the body via dermal absorption. Anglers catching and eating fish from upstream or downstream of the effluent outfall are at risk for exposure to multiple contaminants that were sampled in this study. CHEC has developed maps showing numerous private water wells in the immediate vicinity of Blacklick Creek downstream from the effluent discharge. Private well water users are at risk of exposure to contaminants in effluent being released into Blacklick Creek because these private wells may capture water from the creek when the well pump rate is sufficiently high. High pump rates can occur especially during peak usage by residents. The first identified municipal drinking water intake downstream of this discharge is at Freeport, Pennsylvania on the Allegheny River. Populations served by the Freeport authority and water authorities downstream of Freeport are at potential risk for exposure to contaminants identified in effluent, as well as other contaminants in Marcellus Shale flowback water that were not sampled for in this study.

Implications of Effluent Discharge from the PBT – Josephine Facility Discharge For Exposures to Other Contaminants Known to be Present in Marcellus Shale Flowback Fluids and a Regional Appreciation of These Results

Of particular environmental public health significance is that Marcellus Shale flowback water contains other contaminants, in addition to those analyzed for in this study, which have health consequences if ingested, inhaled, and/or absorbed through the skin. While we make no statements regarding the presence of other contaminants in this effluent water being discharged into Blacklick Creek, it is imperative that additional testing be conducted immediately by federal and state health and enforcement agencies to determine if other contaminants of public health significance are entering this watershed. Additionally, oil and gas wastewater and Marcellus shale flowback fluids are being disposed of in “brine treatment” facilities and at POTW’s throughout the Commonwealth of Pennsylvania and in Ohio, Maryland, West Virginia, and New York. The ramifications of disposal of large quantities of oil and gas wastewater through ineffectual brine treatment plants and POTW’s needs further evaluation throughout the region to determine its impact on stream and river systems and public drinking water supplies, as well as to recreationalists and private well water users.

Local and Regional Public Health and Environmental Recommendations Based on PBT-JF Results

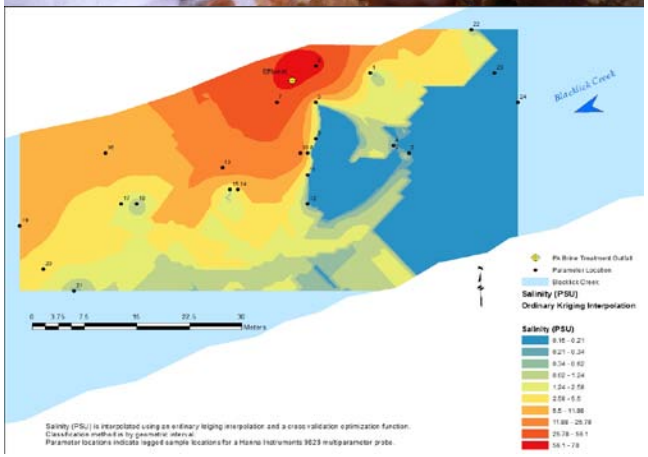
- The Pennsylvania Brine Treatment – Josephine Facility is discharging up to 60 ppm of 2-BE into Blacklick Creek, which is not listed in its discharge permit. Operations at this plant should be halted until all contaminants in accepted oil and

gas fluids are known and it can be determined if the treatment processes used at the plant effectively remove these contaminants from the fluids being treated, so that effluent discharge concentrations of contaminants are consistent with human and aquatic health standards, guidelines and criteria. This recommendation should extended to other treatment plants and POTW's accepting Marcellus Shale flowback fluids in this drainage.

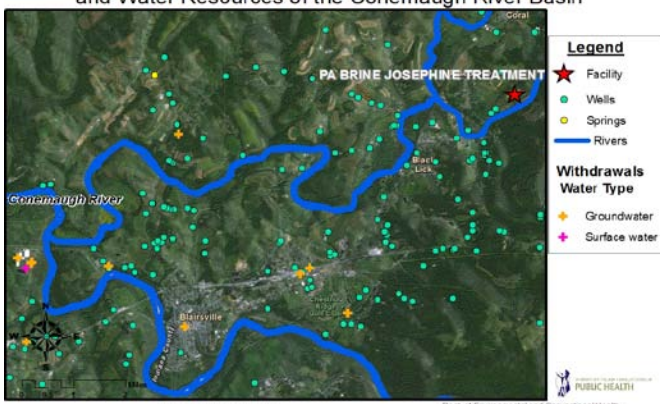
- All approaches to the effluent discharge area and a reasonable distance downstream (at least 100 meters) from stream-side and land-side should be posted with warning signs. These signs should discourage any use of and/or contact with stream water.
- An advisory should be issued to all anglers that fish taken from this stream, both up and down stream, may be contaminated and discouraging fish take and of course consumption.
- Studies to determine the levels of all potential Marcellus Shale flowback fluid contaminants in downstream water, sediments and pore water should be undertaken immediately. These should include sampling upstream of the effluent discharge point and at short, intermediate and longer distances downstream from the effluent discharge point. The number of samples taken (n) of surface water, sediments and pore water upstream and at the various distances downstream should be sufficient so that statistically significant differences of contaminant concentrations can be inferred. CHEC took additional samples of effluent and performed both up and downstream transect sampling on April 1st and 2nd, 2011- these samples are now being analyzed for an expanded list of chemicals including antimony, radium radionuclides, phenols and derivatives, polynuclear aromatic hydrocarbons (PAH's), phthalates, and total petroleum hydrocarbons
- Residential and other private well water users downstream of the effluent outfall of the PBT-Josephine Facility should be advised that there may be contaminants in their well water and discouraged from using it for drinking, cooking or bathing. Well water from wells in close proximity to Blacklick Creek should be tested to assure that contaminants in Marcellus Shale flowback fluids and other oil and gas waste fluids are not present in concentrations that may affect human health.
- Municipal water authorities downstream of this outfall should be notified of the contaminants found in effluent from the PBT- Josephine Facility, of other possible contaminants in Marcellus Shale flowback fluids and oil and gas wastewater, and that there are other treatment facilities and POTW's in the Blacklick, Conemaugh, and Kiskikiminetas drainages that accept and discharge oil and gas waste fluids into surface water. They should also be notified that landfill facilities in the drainage accept solid wastes produced from these treatment facilities. Downstream municipal water authorities should test raw unfinished intake water and finished drinking water for identified contaminants in effluent from the PBT- Josephine Facility, and other contaminants known to be present in Marcellus Shale flowback fluids and oil and gas wastewater.
- All municipal water authorities at reasonable distances downstream of "brine treatment" and POTW's accepting Marcellus Shale flowback fluids and other oil and gas wastewater in the region extending eastward across Ohio, Pennsylvania and West Virginia and New York should be notified of these results. It is

important that they initiate sampling of raw, unfinished inflow water and finished drinking water immediately to insure that their systems are capable of handling all potential contaminants, without breakthrough above specific drinking water MCL's.

- The PA DEP and other states and federal regulatory authorities, including the Susquehanna River Basin Commission (SRBC) and the Delaware River Basin Commission (DRBC) should immediately review all surface water discharge permits granted to brine treatment facilities and POTW's that accept Marcellus Shale flowback fluids and oil and gas wastewater, to insure that 2-BE concentrations being discharged are below all applicable standard, guidelines and criteria. This review should be informed by results of this report but should be extended to all known contaminants in flowback and other oil and gas wastewater.



Hart Resources PA Brine Josephine Treatment Facility and Water Resources of the Conemaugh River Basin



Data obtained from the PADEP at https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/DataExports/ExportWasteData.aspx?PERIOD_ID=20102, www.PASDA.PSU.EDU

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Senate Committee on Environment and Public Works and its Subcommittee on Water and Wildlife

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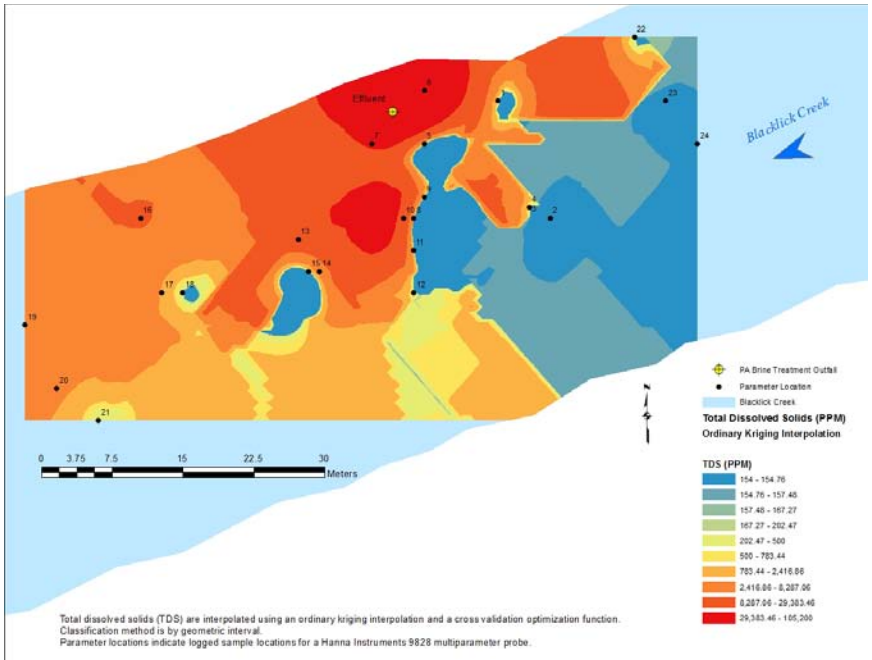
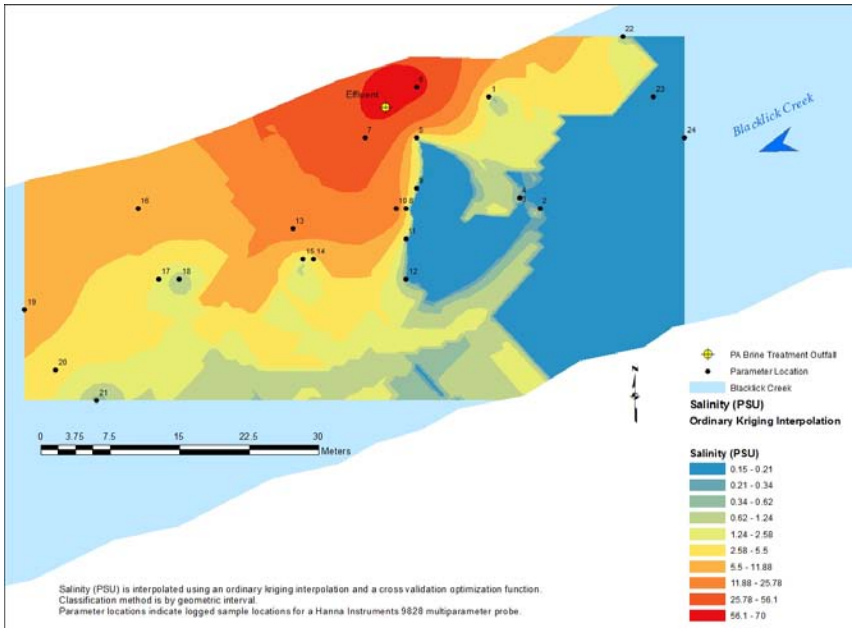
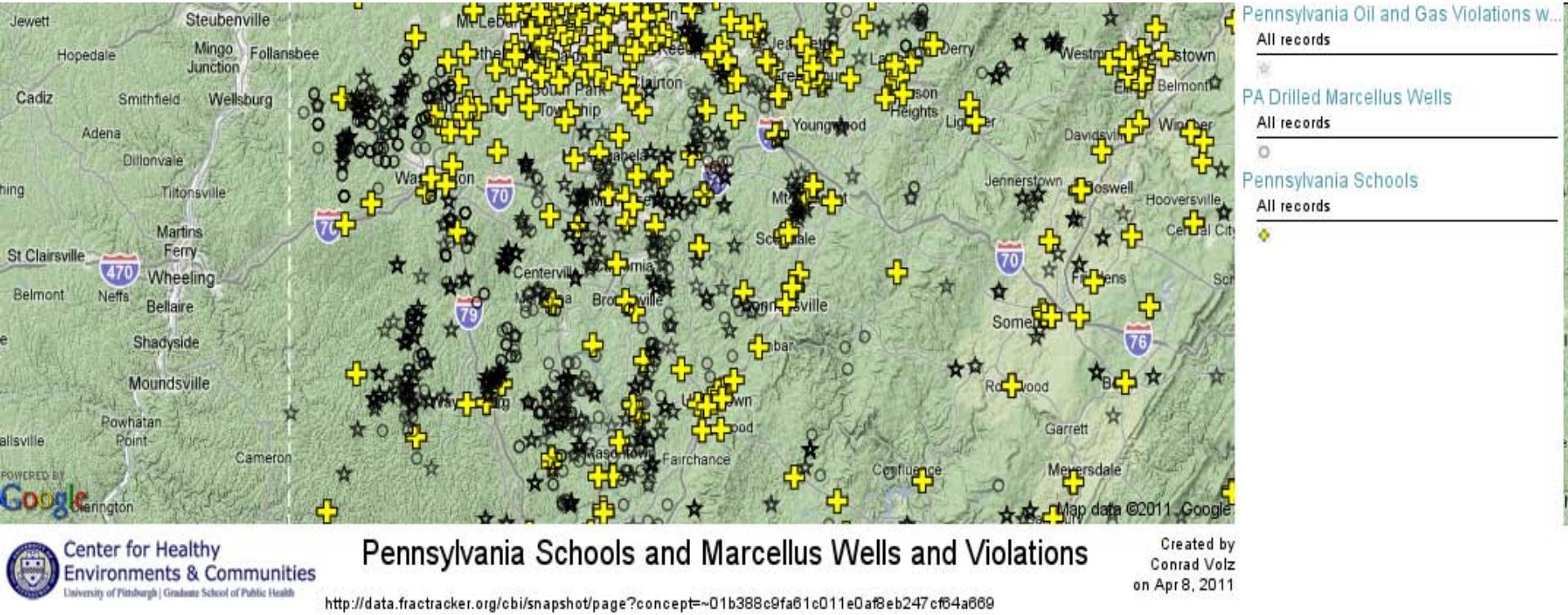
PBT-Josephine Facility Outfall on Blacklick Creek and Kriging Interpolation of Instream Total Dissolved Solids and Salinity





View South of Pittsburgh, PA

Proximity of Schools to Marcellus Wells and Marcellus Violations



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2010 Oil and Gas Act Citations by Well Type Issued by the PA DEP

Violation Description	Non Marcellus	Marcellus	Unknown Formation	Grand Total
Failure to minimize accelerated erosion, implement E&S plan, maintain E&S controls. Failure to stabilize site until total site restoration under OGA Sec 206(c)(d)	88	111	97	296
Failure to plug a well upon abandonment	85	8	161	254
Discharge of pollultional material to waters of Commonwealth.	58	105	85	248
O&G Act 223-General. Used only when a specific O&G Act code cannot be used	20	138	13	171
Failure to install, in a permanent manner, the permit number on a completed well	25	29	76	130
Clean Streams Law-General. Used only when a specific CLS code cannot be used	8	106	12	126
Failure to properly store, transport, process or dispose of a residual waste.	15	68	43	126
Failure to maintain 2' freeboard in an impoundment	33	58	11	102
Failure to submit well record within 30 days of completion of drilling	83	2	14	99
Impoundment not structurally sound, impermeable, 3rd party protected, greater than 20" of seasonal high ground water table	12	58	9	79

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Hart Resources
PA Brine Josephine Facility

Legend

- Facility

Data obtained from the PADEP at:
https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/DataExports/ExportWasteData.aspx?PERIOD_ID=2010-2

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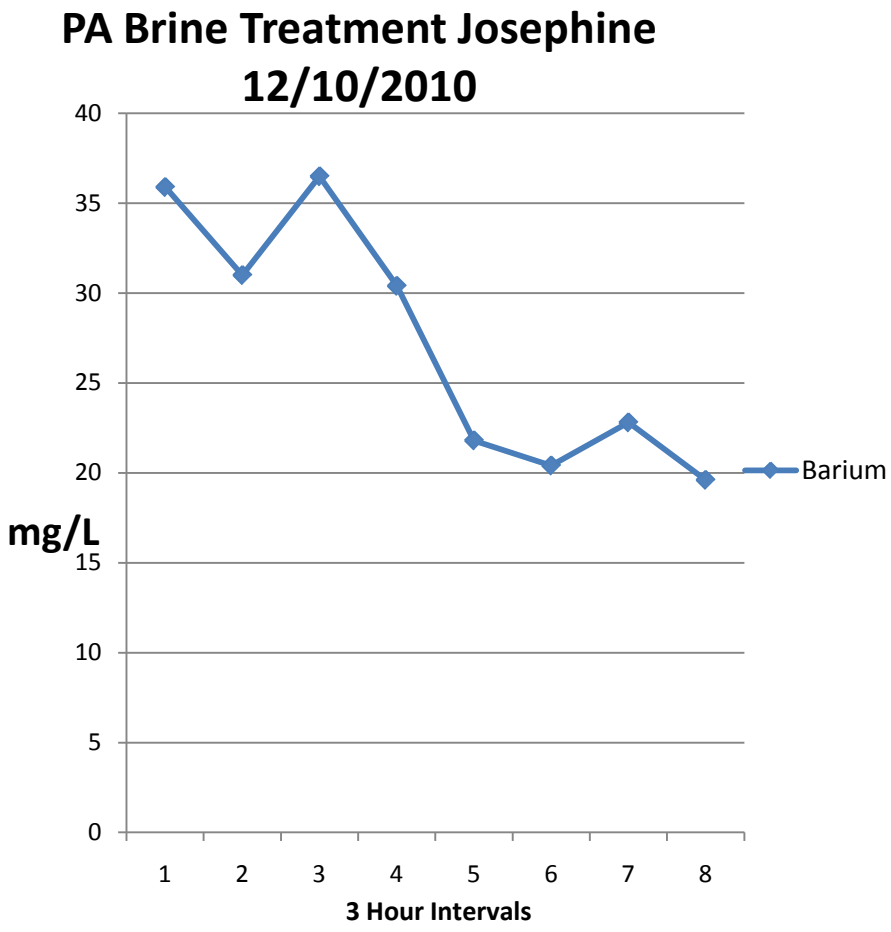
Barium in PBT-Josephine Effluent

[Mean] = 27.30 mg/L; [Max.] = 37 mg/L

•[Mean Ba] ≈14 x (MCL) of Ba in drinking water of 2 ppm.
• The Ba ATSDR MRL's oral intermediate/chronic exposure are .2 mg/kg/day. Derived MRLs for barium in drinking are 6.89, 5.77, and 3.04 (mg/L/day) for adult men, adult women, and children, respectively (renal).
•[Mean Ba] is 3.96, 4.73, and 8.98 X the derived drinking water MRL's for intermediate and chronic exposures for adult men, women, and children, respectively.
•EPA Ba CMC of 21 ppm exceeded; EPACCC for barium in water is 4.1 ppm, 6.66X [Mean Ba].



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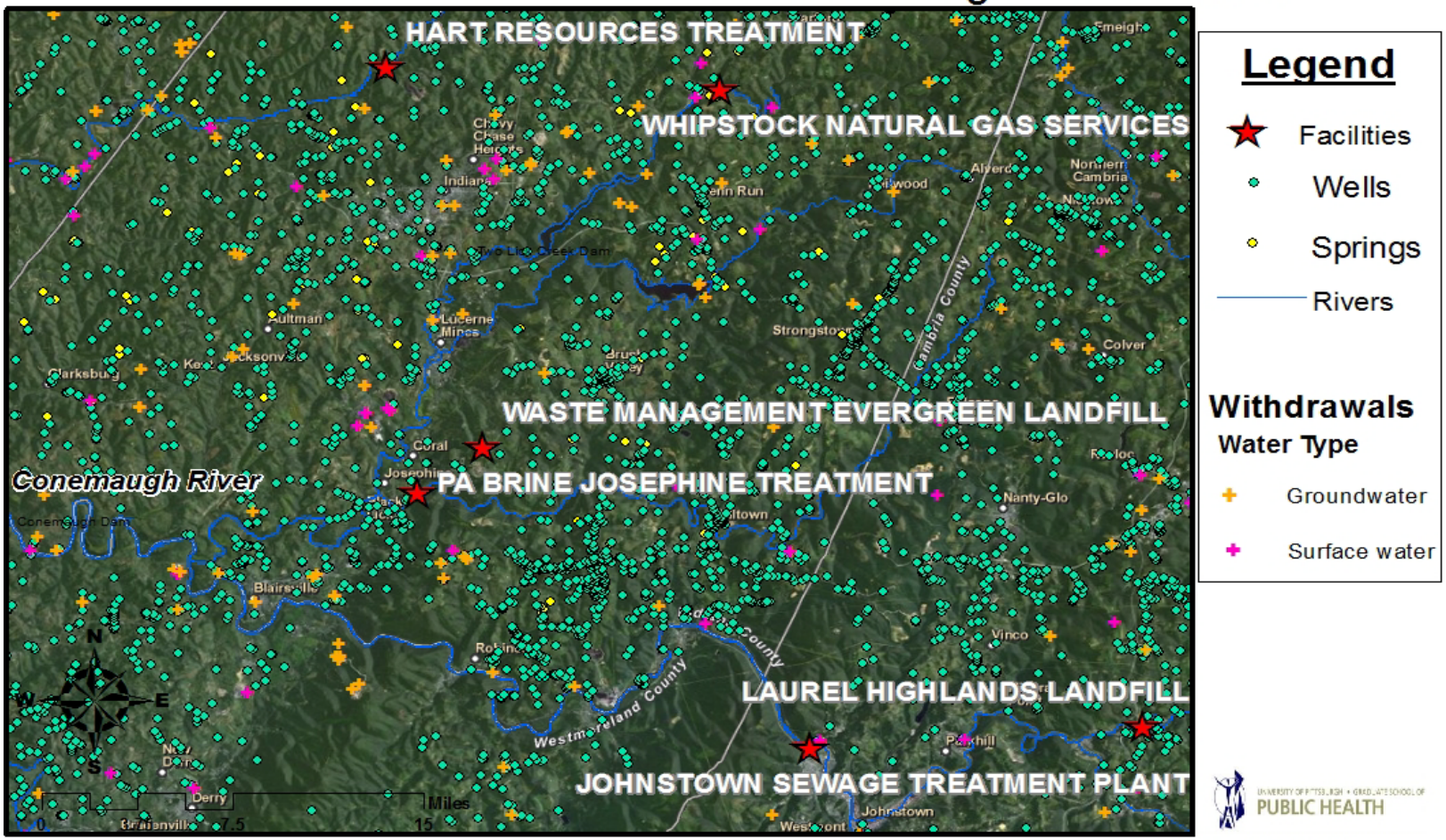
Facilities Accepting Natural Gas Solid Wastes and Waste Water and Water Resources of the Conemaugh River Basin



Data obtained from the PADEP at:
https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/DataExports/ExportWasteData.aspx?PERIOD_ID=2010-2

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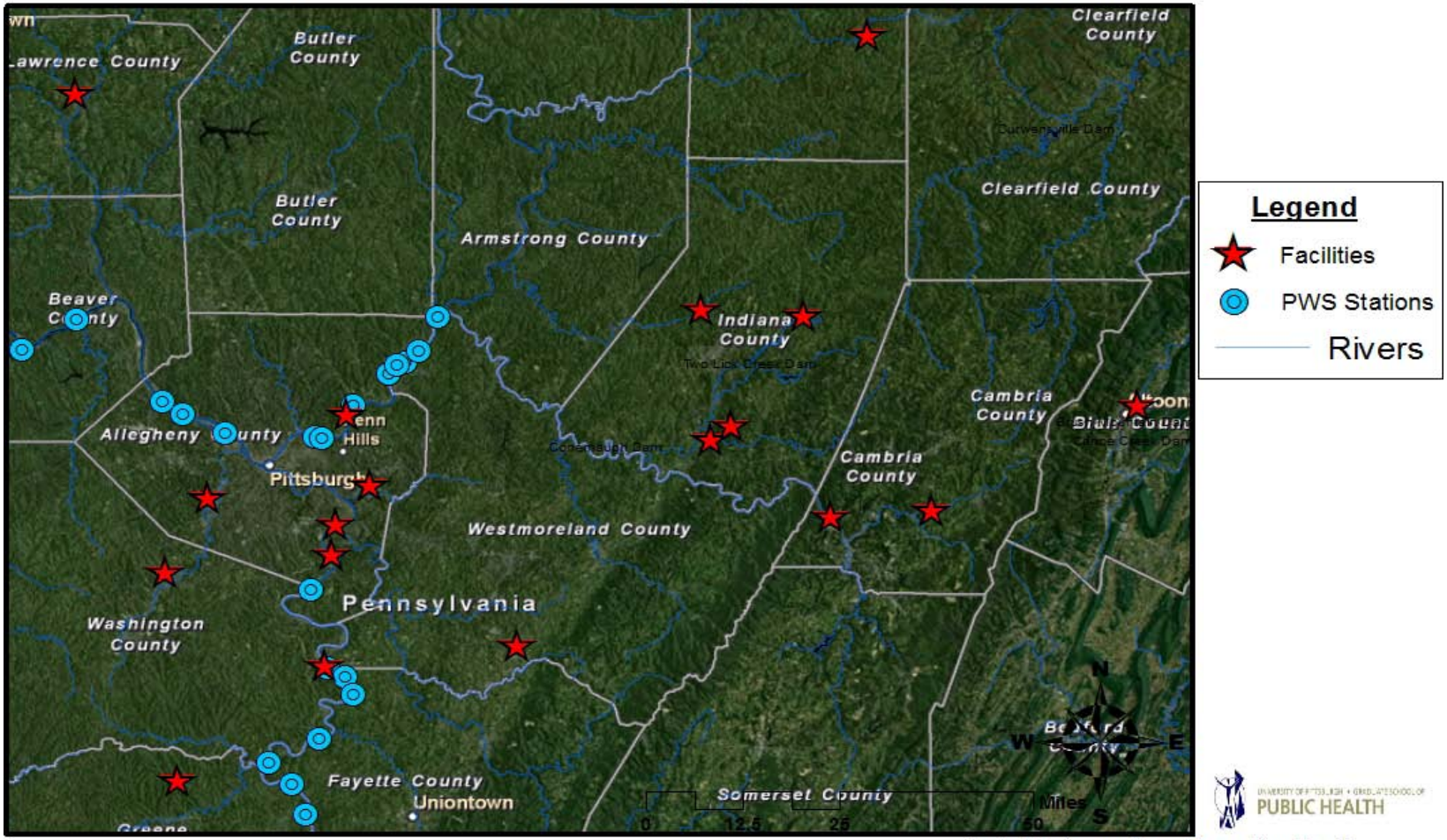
Facilities Accepting Natural Gas Solid Wastes and Wastewater and Public Water Supply Withdrawal Stations



Data obtained from the PADEP at:
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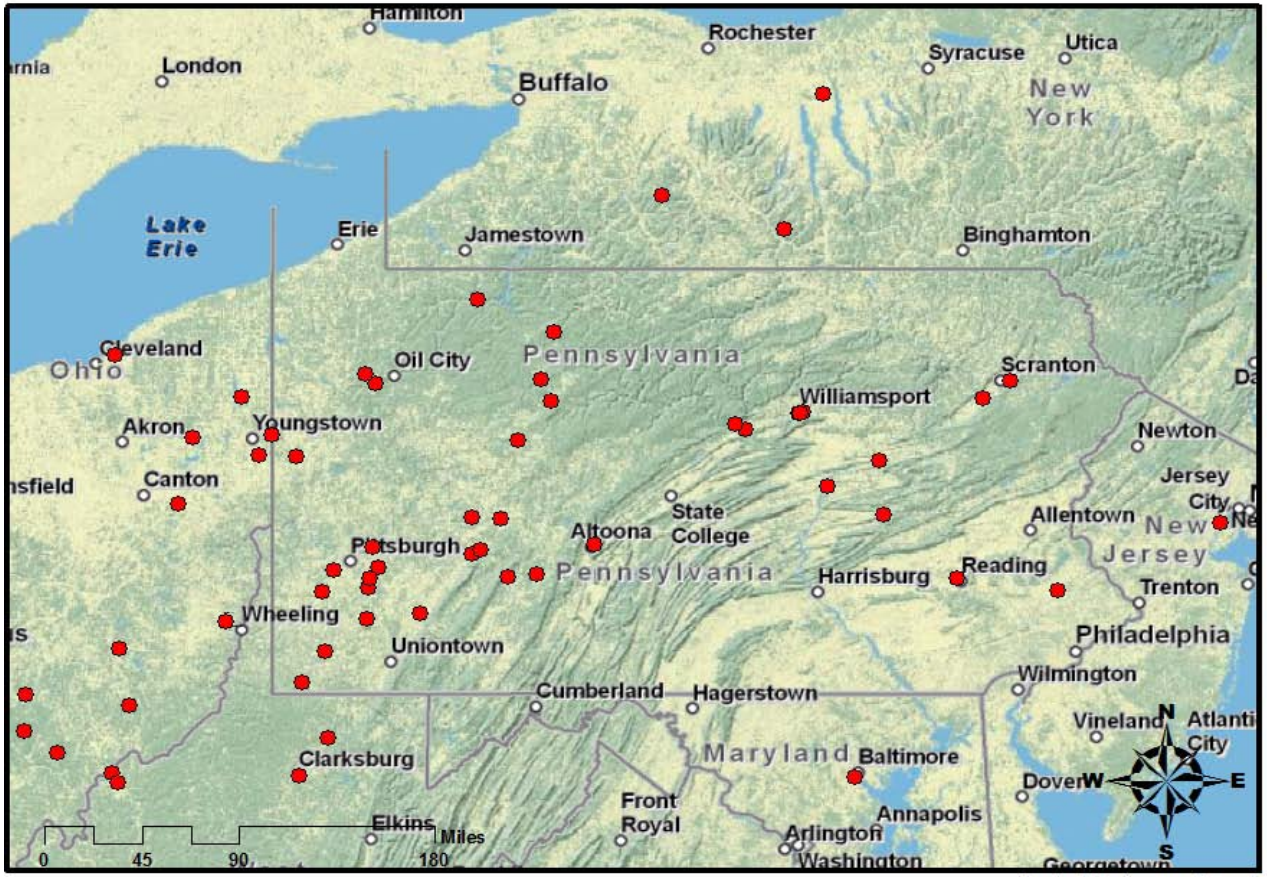
Facilities Accepting Natural Gas Wastewater
MD, NY, NJ, OH, WV & PA



Legend

- Facilities

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