UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

STATEMENT OF BASIS

U.S. EPA UNDERGROUND INJECTION CONTROL (UIC)
DRAFT CLASS II-D PERMIT REISSUANCE VAS2D907BDIC

FOR

ENERVEST OPERATING, LLC
809 HAPPY VALLEY DRIVE
CLINTWOOD, VA 24228

FOR

A project consisting of one Class II-D injection well used for the disposal of produced fluids (brine) associated with coal bed methane and conventional gas production located at:

P-143 Injection Well
Nora Field, Lick Creek watershed
Dickenson County, Virginia

On May18, 2020, EnerVest Operating, LLC ("EnerVest" or "the Permittee") submitted a UIC permit renewal application to the U.S. Environmental Protection Agency ("EPA" or the "Agency"), Region 3, for the reissuance of a permit that would allow for the continued operation of a Class II-D brine disposal injection well, P-143 ("Injection Well" or the "Facility"), located in the Nora Field, near Lick Creek, Ervinton District of Dickenson County, Virginia. The coordinates for the Injection Well are: Latitude 37º 04' 9.99" Longitude -82º 15' 50.76". EPA Region 3 staff reviewed this permit renewal application and deemed it complete on June 22, 2020. However, during EPA's technical review, the Agency found EnerVest's permit application to be deficient and issued a Notice of Deficiency ("NOD") to EnerVest on July 6, 2020. In response to the NOD, EnerVest submitted additional information to EPA on July 7, 2020. The Permittee's May 18, 2020 and July 7, 2020 submittals are collectively referred to in this Statement of Basis as the "Permit Application."

Equitable Production Company of Pittsburgh, PA ("Equitable Production") held the previous permit for the construction and operation of Injection Well, effective on May 7, 1990. In 2014, Equitable Production transferred that permit to Range Resources of Abingdon, VA ("Range Resources"). Range Resources subsequently transferred the Injection Well permit to EnerVest on January 14, 2016. The current permit to operate Injection Well expires on October 22, 2020.

Pursuant to the federal Safe Drinking Water Act, 42 U.S.C. §§ 300f *et. seq.*, and its implementing regulations, 40 C.F.R. §§ 144 -146, and 40 C.F.R. § 147.2350-2352, the EPA has developed a federal UIC Program and, through the issuance of permits, is responsible for regulating the construction, operation, monitoring and closure of injection wells that place fluids underground for disposal or enhanced recovery in oil and gas production. Today's draft permit specifies conditions for Injection Well construction, operation, monitoring, reporting, and plugging and abandonment which are designed to protect and prevent the movement of fluids into Underground Sources of Drinking Water (USDW). The Permittee's UIC project and the draft permit conditions specific to the project are described below:

Area of Review: Pursuant to the applicable regulations, 40 C.F.R. §§ 144.3 and 146.6(b), the "Area of Review" is an area surrounding the Injection Well for which the applicant must first research, and then develop, a program for corrective action to address any wells that penetrate the injection zone and which may provide conduits for fluid migration during the injection operation at the Facility. EnerVest proposed a fixed radius Area of Review of one-quarter mile, which EPA has determined to be acceptable. In determining the fixed radius, EPA has considered the following information provided by the Permittee: chemistry of injected and formation fluids; hydrogeology, population and ground-water use and dependence; and historical practices in the area. EnerVest has provided documentation on the fluid to be injected, the ground-water use in the area, and on the well population within the one-quarter mile Area of Review. The injectate is compatible with the hydrogeological formation as evidenced by successful use of the Weir formation by this Injection Well since the early-1990s. There are no drinking water wells within a half mile radius of the Injection Well. The Permittee did indicate that there are two coal-bed methane wells within the Area of Review; however, these wells do not penetrate the injection zone. There are no plugged wells, and no known unplugged/abandoned wells, within the Area of Review. If any unplugged/abandoned wells that penetrate the injection zone are found within the Area of Review at a later date, the draft permit requires the Permittee to perform corrective action.

Underground Sources of Drinking Water (USDW): An USDW is defined by the UIC regulations as an aquifer or its portion which, among other things, contains a sufficient quantity of ground water to supply a public water system and which also contains fewer than 10,000 mg/L (milligrams per liter) Total Dissolved Solids, and which is also not an exempted aquifer. The Permittee reported that USDWs within the Area of Review for the Injection Well are generally located within the unconsolidated alluvium/colluvium deposits and the associated Norton Formation along local stream elevation. Furthermore, groundwater is typically found at depths between 0 to 500 feet below ground surface. Therefore, EPA has determined the lowermost USDW to be located at 500 feet below ground surface. The construction of the Injection Well requires installation of surface casing from the surface to a depth of at least 50 feet below the base of the lowermost USDW and cementing that entire length of casing back to the surface. EnerVest has set the surface casing for the Injection Well at an approximate depth of 2,234 feet below ground surface and cemented the casing back to the surface to protect groundwater.

Injection and Confining Zones: The draft permit limits injection of fluids for disposal to the Lower Mississippian Weir Sand formation in the approximate subsurface interval between 4,690 and 5,184 feet below ground surface. The lowermost USDW is separated from the injection zone by approximately 4,190 feet. The Mississippian Big Lime formation, a dense carbonate (limestone) and shale formation that is approximately 518 feet thick, is located immediately above the Weir formation injection zone.

Injection Fluid: The draft permit limits injection to treated fluids produced from EnerVest's conventional and coalbed methane well operations into the Injection Well. The draft permit also

establishes a maximum daily injection volume of 35,000 barrels per month of these disposal fluids into the Injection Well. One barrel of fluid is equal to 42 gallons.

The Permit Application includes analyses of the injection fluid that corresponds to the requirements stated in Paragraph II.C.3. in the draft permit. The parameters chosen for sampling reflect not only some of the typical constituents found in the injection fluid, but also in shallow ground water. Should a ground water contamination event occur during the operation of the Injection Well, EPA will be able to compare samples collected from groundwater with the injection fluid analysis to help determine whether operation of the Injection Well may be the cause of the contamination.

Maximum Injection Pressure: The maximum allowable surface injection pressure for the permitted operation of the Injection Well will be 990 pounds/squire inch (psi). The maximum pressure was developed using the injection pressure limitation calculation; a formula that considers the depth to the Weir Sandstone injection zone, the specific gravity of fluid encountered in EnerVest's Virginia Nora Field operations (1.10) and a fracture gradient developed by using the instantaneous shut-in pressure. The maximum allowable surface pressure has not changed from what was previously permitted for this Injection Well.

Potential for Seismicity: The SDWA regulations for Class II wells do not require consideration of the seismicity of the region, unlike the SDWA regulations for Class I wells for the injection of hazardous wastes. See regulations for Class I hazardous injection wells at 40 C.F.R. §§ 146.62(b)(1), 146.68(f). Nonetheless, because of public concerns about injection-induced seismicity, EPA evaluated factors relevant to seismic activity as discussed below and addressed more fully in *"Region 3 framework for evaluating seismic potential associated with UIC Class II permits"*. https://yosemite.epa.gov/oa/eab_web_docket.nsf/Attachments%20By%20ParentFilingId/0EA8C0D9BA82F48B85257CD9006624C2/$FILE/Tab%20I%20seismicity%20framework9-26-13.pdf

The permit provides that the Permittee shall only inject produced fluids through the Injection Well and into a formation which is overlain by a confining zone free of known open faults or fractures within the Area of Review, as required pursuant to 40 C.F.R. § 146.22. The Permittee submitted geologic information indicating an absence of faults or fractures within a one-mile radius of the Injection Well. The entire Appalachian Plateau, on which the Facility will be located, is considered geologically stable with no active faults. Additionally, the region in which the Facility is located consists of an extensive, thick, sedimentary sequence with numerous confining strata between the surface and the proposed injection zone.

The available geophysical and seismic information researched by the Permittee, and EPA's review of published information of seismicity in Virginia, reveal no evidence of faults that reach the land surface from basement rock. More information on seismicity can be found on a website about Earthquakes from the Virginia Department of Mines, Minerals, and Energy, Division of Geology and Minerals (http://www.dmme.virginia.gov/dgmr/earthquakes.shtml). The available geologic information does identify the presence of the Russell Fork Fault, which is a right-lateral fault located nearly 4.7 miles southwest of the Injection Well. This fault is transcurrent and is believed to have a lateral displacement of up to six miles. Movement along this fault occurred several million years ago and was due to regional compression (sediment deposition). Geophysical well logs from wells which penetrate the injection zone located on either side of the suspected surficial fault document minimal relative displacement or movement of the deeper injection and confining zones across the fault area.

Available geological information shows that the Appalachian Basin, including southwestern Virginia, which lies on the passive continental margin, is not seismically active because insufficient pressure exists to cause movement along ancient faults and fractures. These faults and fractures are closed and non-transmissive due, in large measure, to the tremendous downward pressure exerted by thousands of feet of overlying sediment deposited since their creation.

The United States Geologic Survey (USGS) has not recorded any seismic activity that originated in Dickenson County, Virginia from 1900 through present day (USGS: "Information by Region-Virginia-All Earthquakes 1900-Present": http://earthquake.usgs.gov/earthquakes/byregion/virginia.php). Virginia is located near the center of the North American Plate and experiences a much lower rate of seismicity than an area like California, which is located closer to a plate boundary and experiences shallower, more energetic seismic events due in part to less coherency in the basement rock. Additionally, California earthquakes often break the ground surface, whereas earthquakes in Virginia usually occur on faults at depths from three to fifteen miles below the ground surface. The rare earthquakes felt in Virginia today generally have no relationship with faults or fractures seen at ground surface. Residual stresses from the formation of the Appalachian Range and the Piedmont Province hundreds of millions of years ago appear to be the mechanism for Virginia's earthquakes. Earthquake activity in Virginia has been associated with basement rock, either form basement faulting or faulting at a shallower depth, caused by tectonic stresses that originated from the basement rock.

The final permit will include an injection pressure limit to prevent the initiation or propagation of fractures that could create conduits for the injected fluid to flow to any existing faults. The maximum allowable injection pressure for this permit was calculated by the instantaneous shut-in pressure (ISIP). The ISIP is the minimum pressure necessary to begin to reopen any fractures created during the fracture stimulation process and is significantly lower than the pressure required to fracture the rock. The surface injection pressure is less than both the ISIP and the fracture pressure to prevent the initiation of new, or the propagation of existing, fractures.

Finally, a number of factors help to prevent injection wells from failing in a seismic event and contributing to the contamination of a USDW. Most Class I or Class II injection wells, including this Injection Well, are constructed to withstand significant amounts of pressure. The EnerVest Injection Well is constructed with multiple steel rings of casing that are cemented in place. Furthermore, both the existing permit and the draft permit require EnerVest to mechanically test the Injection Well to ensure integrity before operations begin and to continuously monitor the Injection Well during operations in order to identify any potential mechanical integrity concerns. The Injection Well is also designed to automatically shut-in and cease operation in the event that the mechanical integrity of the well is compromised, including by a seismic event.

Testing, Monitoring and Reporting Requirements: The Permittee is required to conduct a mechanical integrity test ("MIT") after construction of the Injection Well. The MIT consists of a pressure test and a fluid movement test. The pressure test will be conducted in order to ensure that the casing, tubing and packer in the Injection Well do not leak. The fluid movement test, which includes case cement record and cement bond log or temperature log reviews, will be conducted to ensure that fluid movement does not occur outside of the injection zone. In addition to the testing described above, additional pressure testing of the casing, tubing and packer will occur every five (5) years and whenever a rework on the Injection Well requires the tubing and packer to be released and reset.

The Permittee will be responsible for continuously monitoring the Injection Well for surface injection pressure, annular pressure, flow rate and cumulative volume from the date on which the Injection Well commences operation and until such date that the Injection Well is plugged and abandoned. The Permittee must submit an Annual Report to the EPA summarizing the results of the monitoring and testing activities required by the permit, including monthly monitoring records of the injection fluid, the results of any mechanical integrity testing and information identifying any major changes in the characteristics of the injected fluid. The Annual Report must be submitted to EPA by January 31 of each calendar year.

Plugging and Abandonment: The Permittee has submitted a Plugging and Abandonment Plan that will result in an environmentally protective Injection Well closure at the time of cessation of operations. The Permittee has secured a Performance Surety Bond along with a Standby Trust Agreement to ensure proper plugging of the Injection Well. The amount of the Performance Surety Bond shall cover the estimated cost to close, plug and abandon the Injection Well and shall be in the amount of at least Ninety Thousand Dollars ($90,000). The amount of the Performance Surety Bond, which is based upon an independent, third-party professional's estimate of the costs associated with the plugging and abandonment of the Injection Well, must also be sufficient to preclude the possibility of abandonment without proper closure.

Expiration Date: When issued, a permit will be in effect for ten (10) years from the date of that final permit's effective date. EPA will conduct an annual review of the Permittee's Injection Well operation. The final permit will contain the same conditions as in this draft permit unless EPA receives information supporting and warranting alternative final permit conditions or actions on this Permit Application.

Additional Information: The Administrative Record for the draft permit is available for public inspection. All information submitted by the Permittee in support of the draft permit, unless deemed confidential, is included in the Administrative Record for the draft permit and is available to the public for review. Copies of the Permit Application, the draft permit, the Statement of Basis, and the Administrative Record index are available for review and inspection on EPA's website at https://www.epa.gov/va/epa-public-notices-virginia. Please direct any questions, comments and requests for additional information to the contact listed below. **The Administrative Record for this action will remain open for public comment until October 23, 2020**.

Request for Public Hearing: Requests to hold this public hearing must be received via email or telephone by EPA by October 23, 2020. When requesting a public hearing, please state the nature of the issues you propose to raise. EPA expressly reserves the right to not hold a hearing unless a significant degree of public interest is evidenced by October 23, 2020.

Submit comments or requests for a hearing or for additional information to:

Kevin Rowsey
Source Water & UIC Section
Drinking Water & Source Water Protection Branch
U.S. Environmental Protection Agency
215-814-5463
Rowsey.kevin@epa.gov