SANBORN HEAD

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Mr. Allan G. Palmer
GSP Merrimack LLC
431 River Rd
Bow, NH 03304

October 15, 2018
File No. 2025.07

Re: Assessment of Unstable Areas
Merrimack Station Ash Landfill
Bow, New Hampshire

Dear Allan:

Sanborn, Head & Associates, Inc. (Sanborn Head) prepared this Assessment of Unstable Areas (Assessment) for the Merrimack Station Coal Ash Landfill (landfill) located in Bow, New Hampshire. This Assessment was prepared in accordance with the Coal Combustion Residual (CCR) Rules (40 CFR Part 257).

REGULATORY REQUIREMENTS

As stipulated in 40 CFR Part 257.64(a), existing CCR landfills "*must not be located in an unstable area unless the owner or operator demonstrates that recognized and generally accepted good engineering practices[1] have been incorporated into the design of the landfill to ensure that the integrity of the structural components of the landfill will not be disrupted.*"

As defined in 40 CFR Part 257.63, an unstable area is *"a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity, including structural components of some or all of the CCR unit that are responsible for preventing releases from such unit. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and karst terrains."*

As required by 40 CFR Part 257.64(b), the following factors were considered in this Assessment to demonstrate that the existing landfill is not located in an unstable area:

1. On-site or local soil conditions that could result in significant differential settling;
2. Onsite or local geologic or geomorphologic features; and
3. On-site or local human-made features or events (both surface or subsurface).

[1] As defined in 40 CFR Part 257.53, recognized and generally accepted good engineering practices means engineering maintenance or operation activities based on established codes, widely accepted standards, published technical reports, or a practice widely recommended throughout the industry. Such practices generally detail approved ways to perform specific engineering, inspection, or mechanical integrity activities.

SITE BACKGROUND

The landfill, which began operating in 1978, was constructed in an abandoned sand and gravel quarry on a property adjacent to the Merrimack Station electric power generation facility in Bow, New Hampshire. The original clay-lined landfill was approved for disposal of fly ash and other wastes (e.g., dewatered wastewater treatment facility sludge, slag, and ash pond dredging material) resulting from electric power generation at coal-fired power plants in New Hampshire.

In 1981, environmental concerns prompted a series of hydrogeologic studies of the facility. The studies concluded that site operations were impacting groundwater quality in the immediate vicinity of the landfill. As a result, 2,000 cubic yards of previously disposed ash sludge were removed from the landfill, and future site use was restricted to the disposal of dry coal fly ash from Merrimack Station. In addition, the New Hampshire Water Supply and Pollution Control Commission mandated extensive groundwater quality monitoring pursuant to a facility groundwater permit, which was first issued in 1985. A number of facility upgrades/improvements were also implemented by 1986, including:

- Excavating all pre-existing ash materials and relocating the materials into disposal cells lined with a 36-mil thick chlorosulfonated polyethylene synthetic rubber liner (i.e., Hypalon);
- Installing a leachate collection system within the Hypalon-lined cells, including perforated collection pipe, non-perforated drainage pipe and a sump; and
- Constructing a final cover system over the portions of the landfill brought to final grade.

We understand that the landfill operations have not materially changed since 1986. The construction of additional lined cells, installation of the final cover in select areas, and groundwater monitoring activities have been ongoing. The landfill has been permitted and operates under a New Hampshire Department of Environmental Services (NHDES) Solid Waste permit (DPHS-SW-85-012) and adheres to state regulations for design and operation of the landfill.

SOIL AND GEOLOGIC CONDITIONS

Sanborn Head reviewed publically-available physical setting resources, as well as historical site studies. A summary of soil and geologic information obtained from these sources is provided below.

Statewide geographic information system (GIS) resources[2] classify overburden soils in the vicinity of the site as Windsor loamy fine sand, with a sandy outwash parent material derived mainly from granite, gneiss, and schist. Bedrock in the site vicinity is mapped as the lower part of Rangeley Formation, which is described as variably metamorphosed sedimentary and volcanic rocks of greenschist to granulite facies.[3] Previous studies

[2] New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT): http://granitviewii.unh.edu/, as accessed on November 10, 2015.

[3] U.S. Geologic Survey Mineral Resources On-line Spatial Data by State: https://mrdata.usgs.gov/geology/state/map.html, as accessed on November 11, 2015.

provided a more detailed overview of regional geology,[4] reporting that the site is located within a kame delta (glacial deposit) characterized by 10 to 15 feet of sand and gravel underlain by successive layers of sand and gravel below which is silt and fine sand. Locally, ice contact structures interrupt the otherwise relatively uniform deltaic structure forming a valley fill. The ground surface is marked by numerous kettle holes (a shallow, sediment-filled body of water formed by retreating glaciers) with one kettle hole located northeast of the landfill. Also, the topography was dissected by post glacial erosion by the Merrimack River and its tributaries, and by gravel excavation/mining.

The regional geologic characterization is generally consistent with observations documented in previous site studies. The subsurface explorations performed at the site classified the soil encountered as medium dense to dense sand and/or sand and gravel.[5] A relatively thin layer of dense till-like material was reported below the sandy deposit at a few locations. Bedrock was encountered at varying depths, suggesting an overburden thickness ranging from about 35 to 100 feet. The variation in overburden thickness is attributed in part to variations in surface topography associated with gravel excavation, and in part to variation in the bedrock surface elevation.

Although depths to groundwater range from less than 10 feet to greater than 60 feet below the ground surface at the landfill, the historical elevation data indicate the groundwater table is relatively flat (i.e., hydraulic gradients on the order of 0.001 feet per foot [ft/ft]). The direction of overburden groundwater flow is to the northeast, consistent with surface water hydrology, and indicates that the regional groundwater flow is toward the Merrimack River, located less than a mile to the north and east of the landfill.

Karst is a topography formed from the dissolution of soluble rocks (i.e., limestone, dolomite, and gypsum) and is characterized by underground drainage systems with caves and sinkholes. A review of the United States Geologic Survey (USGS) maps of karst and potential karst areas in soluble rocks in the contiguous United States indicted that there are no areas of karst anticipated in Bow, New Hampshire.[6]

SEISMIC IMPACT ZONES

New CCR landfills, existing and new CCR surface impoundments, and lateral expansions of CCR units are not to be located in seismic impact zones, as specified in 40 CFR Part 257.63(a). While this landfill is an existing landfill and is not required to adhere to this standard, unstable areas are defined as areas susceptible to mass movements. Therefore, the seismic impact zone, defined as an area having a 2 percent or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitational pull, will exceed 10 percent of gravity in 50 years, was assessed for the landfill location.

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4 *Phase II – Hydrogeological Investigation and Phase III - Water Quality Analysis, Merrimack Station Landfill Site for Public Service Company of New Hampshire*, DuBois & King, Inc., April 1982.

5 *Ibid.*

6 *Karst in the United States: A Digital Map Compilation and Database,* USGS, David J. Weary and Daniel H. Doctor, 2014, https://pubs.usgs.gov/of/2014/1156/pdf/of2014-1156.pdf

As indicated by ground-motion maps prepared by the USGS, Bow, New Hampshire has an expected seismic-induced or earthquake-caused maximum horizontal acceleration in rock of 7.5 percent of gravity, which is less than the 10 percent gravity specified above.[7] In other words, there is a 90 percent probability that the maximum horizontal acceleration of 7.5 percent will not be exceeded in the time period of 50 years. Therefore, the landfill is not located in a seismic impact zone, as defined by 40 CFR Part 257.

CONCLUSIONS

The landfill has been located and operated at the same location since 1978 and is a NHDES-approved solid waste facility that has had continued oversight by NHDES for 40 years. The landfill is designed to meet NHDES standards and is approved as such to meet the recognized and generally accepted good engineering practices that are included in NHDES regulations. As described above, the landfill is located within an old sand and gravel quarry that contains intact side slopes that can still be seen today. The soils beneath the landfill are generally medium dense to dense sand and/or sand and gravel that appear to be acceptable foundation conditions as no significant differential settlement has been observed or reported to the NHDES over the past 40 years.

Based upon the depth to groundwater and the density of the soil observed in the landfill vicinity, soil liquefaction is not anticipated to be an issue. Soil liquefaction occurs when saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress, like shaking during an earthquake. This is most often observed in saturated and loose sandy soils.

Based on the available information reviewed by Sanborn Head and summarized above, the landfill is not located in an unstable area, as defined in 40 CFR Part 257.63.

LIMITATIONS

- In preparing this letter, Sanborn Head relied on information available from state resources and other parties referenced herein. Although there may be some degree of overlap in the information obtained from these various sources, we did not attempt to independently verify the accuracy or completeness of all information reviewed or received as part of this assessment.

- The conclusions contained in this report are based in part upon various types of environmental data, as well as historical and hydrogeologic information developed by previous site studies. While Sanborn Head reviewed that data and information as stated in this report, Sanborn Head's interpretations, conclusions, and recommendations that rely on that information is contingent on its validity. Should additional environmental data, historical information, or hydrogeologic information become available in the future, such information should be brought to Sanborn Head's attention. We will

7 *USGS Map A-Horizontal Acceleration (90 percent probability) of not being exceeded in 50 years, Probabilistic Earthquake Acceleration and Velocity Maps for the United States and Puerto Rico,* USGS, S.T. Algermissen, D.M. Perkins, P.C. Thenhaus, S.L. Hanson, and B.L. Bender, 1990, https://pubs.er.usgs.gov/publication/mf2120

evaluate the information and, on the based on our evaluation, may modify the conclusions stated herein.

- This letter was prepared for the exclusive use of GSP Merrimack LLC for specific application to the Merrimack Station Coal Ash Landfill in Bow, New Hampshire, in accordance with generally accepted engineering practices. No other warranty, express or implied, is made.

Sincerely,
SANBORN, HEAD & ASSOCIATES, INC.

Lisa L. Damiano, P.E.
Project Manager

Eric S. Steinhauser, P.E., CPESC, CPSWQ
Principal

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