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Subject: Comments to the *Response to Comments, Draft Methane Recovery Design Plan*, 321 Landfill, Lexington County, SC; Work Assignment 0-164

The *Response to Comments, Draft Methane Recovery Design Plan* (G.N. Richardson & Associates [GNRA], September 22, 2000) is GNRA's reply to the U.S. Environmental Protection Agency (U.S. EPA) Region IV (Region IV) written comments to the *Draft Methane Recovery Plan* that addressed both the *Draft Methane Recovery Plan* and the *Revised Final Extraction Test Report* (GNRA, July 2000). The U.S. EPA Environmental Response Team Center (ERTC), supported by the Response Engineering and Analytical Contract (REAC), was asked to assist in the reviewing and commenting on GNRA's *Response to Comments*.

A copy of GNRA's *Response to Comments* is included in Appendix A.

The numbers below represent the sequential ERTC/REAC comments to the numbered *Response to Comments,* which in turn correspond to the numbering in the Region IV's written comments to the *Draft Methane Recovery Plan*. Therefore, the ERTC/REAC comments correspond to the Region IV's comments and the subsequent GNRA's response to Region IV's comments.

1. Comment: Region IV commented that the methane generation rate should have been based on the assumptions, equations, and procedures in the *Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills* (the Landfill Rule). GNRA replied that they received approval from the South Carolina Department of Health and Environmental Conservation (SCDHEC) Bureau of Air Quality (the Bureau) for the GNRA's methane generation rate data gathering methodology and calculations after Region IV comments. Although GNRA's receipt of approval from the Bureau could certainly imply to GNRA that they did perform the data gathering and calculations according to approved procedures and regulations, GNRA must address the issue of data collection and calculations according to the Landfill Rule. GNRA should be cognizant that the Landfill Rule is a federal regulation. GNRA should be clearly aware of addressing Applicable or Relevant and Appropriate Regulations (ARARs), and certainly including federal regulations. Therefore, the Landfill Rule requirements must also be addressed by GNRA irrespective of approval from the Bureau. Furthermore, GNRA and its client(s) must meet the requirements of the Landfill Rule as they apply to the landfills.
Recommendation: Region IV/ERTC/REAC should explore the applicability of the Landfill Rule. Then the

requirements of the Landfill Rule should be identified and addressed by the landfill's owner and their consultant(s) and contractor(s). Additionally, a timeline, with milestones, for the completion of the various requirements should be created, in concert with all stakeholders, the U.S. EPA, the State, the owner of the landfills, and the consultant(s) and contractor(s), to insure that the specific requirements of the Landfill Rule are completed in an organized and timely manner.

The first step in the Landfill Rule process should be reviewed to determine if its standards are applicable to all three landfills: the 321 Landfill and the two adjacent landfills, the Old Cayce Dump and the Bray Park Dump. Each landfill may effectively be considered as just a cell within one large landfill. In summary, the first step is the determination whether the three adjacent landfills, 321 Landfill, the Old Cayce Dump and the Bray Park Dump, are actually one combined landfill under the provisions of the Landfill Rule.

2. Comment: Region IV states that a site conceptual model is needed to determine the fate and transport of landfill gas (LFG) incorporating all archival data. GNRA does not address the Region IV comment; however the GNRA reply consists of various statements about the collected data. GNRA mainly addresses the individual data sets. A site conceptual model is an integration of relevant data to predict, qualitatively or quantitatively, certain current and future characteristics of a site. The only mention of what may be considered an integration of data is the statement, "Based on this data, we believe the methane has migrated onto adjacent properties over a long period of time (up to 30 years or more). ..."

Recommendation: A site conceptual model should be constructed for several reasons: a) GNRA, or its client, may not want to quantitatively address the issue of a site conceptual model, b) GNRA may not have the resources to address a site conceptual model, and c) there is an assurance that the modeling will be accomplished accurately.

Additional Comment: GNRA states that there is a diurnal pattern of barometric pressure versus methane pressure. From the GNRA data titled *Methane Evaluation, Blanchard Property*, dated November 19,1999, the ERTC/REAC agree that barometric pressure (BP) does exhibit a diurnal pattern, with the maximum pressure between 0600 and 1200, and a minimum pressure around 1400 to 1900. This could be the result of a local microclimate that induces localized pressure maxima and minima due to the an interaction between the topography and the diurnal wind patterns. For example, absolute pressure varied from one day to the next, but the relative diurnal variation followed the same pattern each day.

GNRA believes that the relationship between BP and methane levels is "that when BP is above 29.9 in. mercury, the methane level will be below the lower explosive level (LEL) of 5% methane." It has been shown that for a landfill generating gas at approximately steady state, a rise in the BP temporarily halts LFG emissions. The rising BP acts as a temporary pressure cap and opposes the escaping LFG. But if the BP remains constant, eventually, the internal LFG pressure rises to equal then exceed the atmospheric pressure, and LFG begins emitting. Oppositely, a decrease in BP accelerates the rate of LFG emissions. This phenomena is evident in the graph titled, Gas Migration Data js.xls 10-25 (*Methane Evaluation, Blanchard Property*, November 19,1999). In summary, it is when the LFG pressure exceeds the BP that the LFG emission rate begins and increases.

3. Region IV commented that the capability of the soils to transport LFG off site should be ascertained. GNRA replied that the soil permeability was evaluated during the Remedial Investigation (RI).

ERTC/REAC has not reviewed or validated the remedial investigation (RI) data.

As for the GNRA data on soil permeability, the permeability of site soil was based on a test using water. ERTC/REAC has seen no information regarding the test protocols, other than the results. More important is the fact that for a situation where there is gas migration in soil, tests of air permeability using air is much preferred over tests for permeability using water and then calculate a conversion from water to air. For a gas collection system, a gas

permeability test should be performed

Recommendation: Perform tests for air permeability of site soil using air.

Region IV/ERTC/REAC should validate the RI data and perform additional data gathering that meets two objectives: 1) replicate selected RI data and 2) provide additional information for a particular conceptual site model. Additional data should include the C&D waste disposal area.

4. Region IV commented that the depth to groundwater needs to be evaluated during the pre-design process. GNRA states the groundwater depth "has historically been approximately 80 feet deep."

Recommendation: Evaluate the groundwater data as part of the proposed data validation in recommendation #3.

5. Region IV commented that man-made features need to be examined and evaluated to determine their role in off-site migration of LFG. GNRA addressed the man-made features by stating that the features "need to be examined and evaluated at the landfill to ascertain their role in the off-site migration of gas" are the C&D waste disposal area and the drain pipe area from the Drake property.

GNRA's response addresses the facts, which ERTC/REAC brought out during the September 8, 2000 meeting in Columbia, SC, that high LFG flow rates were measured at wells in these two areas. GNRA's comment agrees with the observation and analysis of ERTC/REAC.

Recommendation: Analyze LFG migration in the C&D waste disposal area and adjacent to the Drake property pipe.

6. Region IV commented that gas migration should be monitored both laterally and vertically and that monitoring events should take into account probe spacing and depth and sampling frequency. GNRA replied by mentioning the nested probes they installed and that the details of these probes are in their response to comment #4. At this time, ERTC/REAC has been provided no details of the construction design of and the resulting data from many of the site's probes and wells; data from many of the site's borings has not been provided.

An important point on the installation of the probes and wells concerns the fact that GNRA did not install the probes and wells as required by the Landfill Rule. GNRA used a sand pack around the wells and probes instead of a gravel pack. A sand pack, with a lower permeability than a gravel pack, constricts the gas flow into the wells or probes. The constriction produces a greater pressure drop across the pack, thereby causing a lower methane flow rate from probes and wells. That is likely to underpredict the amount of LFG that is being generated and the amount of LFG that can be extracted. It also lowers the radius of influence. Therefore, if one desired to effect lower the LFG flow rates from the wells and probes and, hence, lower the subsequent calculated LFG emissions from the landfill, sand packs would be one way to achieve this end. In summary, because existing probes and wells do not meet the standard of the Landfill Rule, they cannot be used for measuring the emission rate and zone of influence, and for designing extraction wells.

It should be noted that the proposed recovery wells will use gravel, but the wells used to predict LFG recovery used sand.

Another item that should be noted is the fact that GNRA assumes all LFG emissions from 321 Landfill is exiting the vents. GNRA used the LFG flow rates and the methane concentrations in the vents to calculate total emissions. The assumption that all of 321 Landfill's LFG is coming out of the vents is not valid. For example, some of the highest LFG flow rates are in the perimeter of the 321 Landfill and the Blanchard property. There are additional LFG emissions on the perimeter of the 321 Landfill and the Drake property. Furthermore and importantly, the steep

eastern and southern slopes of the 321 Landfill were not checked for LFG emissions.

Recommendation: Obtain archival information concerning the construction details of the site's wells and probes from GNRA, the State, the County, and the Cargan Company. Then review these probes' and wells' spacing, depth, and sampling frequency in light of the project objectives.

Additional wells and probes should be installed according to the Landfill Rule, then monitored to log and evaluate the data.

7. Region IV made the comment that GNRA be prepared to collect additional waste/debris distribution (heterogeneity), porosity and moisture content data. GNRA replied that the C & D waste, near the Blanchard property, is the heterogeneity leading to off-site migration, with no other "significant heterogeneities in the waste in this area of the site." The current data for the site may be insufficient. For example, a slump or subsidence may cause fizzures or cracks in the waste/soil profile, which in turn act as conduits for the channeling of LFG migration both vertically and laterally.

If evidence of slumping, cracking, or other nonhomogeneity exists, additional testing may be required.

Recommendation: Check for evidence of slumping, cracking, or the existence of other nonhomogeneities.

8. Region IV commented that additional extraction wells are needed in the areas south of the proposed active extract well C-30. Region IV stated that these additional extraction wells would be closer to the area of the 321 Landfill with the highest LFG flow rates and methane concentrations, the central and southern portion of the landfill. GNRA replied that the existing passive vents and the proposed active LFG recovery wells in the northeastern portion of the site are sufficient to prevent off-site migration to the Blanchard and Drake properties.

If the only goal is to prevent off-site migration to the Blanchard and Drake properties the ERTC/REAC agree with the reply of GNRA---as long as there is a barrier wall between the site and the Blanchard and Drake properties to provide the primary mitigation to off-site migration.

If the goal is to prevent or minimize all off-site LFG migration from the three landfills, which may constitute a single landfill under the landfill rule, then the Region IV comment must be considered in a final methane recovery design plan. This will require additional monitoring and then the installation of active recovery wells throughout all three landfills.

Recommendation: Determine the goal for the project. Is the goal to just prevent off-site migration to the Blanchard and Drake properties? Or is the goal to prevent or minimize all off-site migration of LFG? If the goal is the former, then consider the recommendation in #11 below. If the goal is the latter, additional design information is needed. Furthermore, the entire draft methane recovery design plan must be prepared again with that goal in mind. It should be noted that if the landfills meet the requirements of the Landfill Rule, then the Landfill Rule's requirements would also have to met, and would become part of the project goal(s).

To prevent or minimize all off-site migration of LFG, an active recovery system in the central and southern portions of the 321 Landfill, similar to the former Cargan Company system, and in the other two landfills may need to explored. Then the income and the capital, operating and maintenance costs of this system need to be predicted.

Another option for the Drake and Blanchard properties needs evaluation. Although a barrier wall and active recovery system near the Drake and Blanchard properties will likely meet the objective of preventing LFG migration to those properties, the capital, operating, and maintenance costs of this system or any system need to be compared to buying the Blanchard property and moving the Blanchard business.

9. Region IV requested a justification for the number, location, and spacing of the vertical extraction wells. GNRA replied that in order to keep the extraction rate below the volume that will draw air into the waste, a GNRA example design flow rate had a radius of influence of 12.5 feet, although the six proposed recovery wells are 200 feet apart and, according to GNRA, provide a preferential flowpath for the LFG.

Recommendation: Please see recommendation in #11 below.

10. GNRA replied to install wells to 80 percent of the waste. GNRA proposed installation of a deep well adjacent to the C & D waste, which is a highly probable conduit of LFG migration from the center of the landfill to the Blanchard property. So to install a deep well adjacent to the Blanchard property, does this mean that one of the proposed active extraction wells C-27 or C-28 will be moved somewhat?

ERTC/REAC does not disagree with the details of GNRA's reply. However depending on the project goals and the requirements of the Landfill Rule, GNRA's reply does not fit in with a landfill-wide LFG recovery system or a perimeter system proposed by ERTC/REAC (see comments #8 & #11).

The GNRA response proposes a water curtain. This barrier method has specific problems associated with it. First, GNRA calculations predict that the water curtain would percolate 8 gallons of water/hour/foot of trench. Therefore, a 1,000 foot long trench would percolate, and hence consume, 192,000 gallons of water/day. Additionally, the low permeability of the soil would cause a relatively high mounding of the water. Furthermore, the introduced water from the water curtain will raise the water table. Then this higher groundwater level may be able to percolate through the waste causing more leachate.

Recommendation: Consider the use of a barrier wall instead of a water curtain. See #11 recommendation below.

11. Agree with the U.S. EPA comment that an active perimeter system should consist of extraction wells located near the Blanchard property line.

Recommendation: An active perimeter system in conjunction with a passive, vertical gas-impermeable barrier should be strongly considered. With an impermeable barrier installed at least to the depth of the groundwater table, the barrier-groundwater seal prevents lateral and downward movement of LFG from the 321 Landfill and the two adjacent landfills to the Blanchard and Drake properties.

The active system may be able to incorporate the roughly east-west line of surveyed gas vents, GV-1 to GV-24, among other possible appropriate wells and vents in the area. By extending the active system beyond the GV-13 to GV-21 proposed in the comments will also provide a level of protection from the lateral migration of LFG to the houses north-northwest of the 321 Landfill, the Starmount Subdivision. If wells GV-1 to GV-24 are not appropriate for this function, then additional active collection wells will be designed and installed. An active perimeter system should not work alone. Because of the GNRA stated impermeability of the soil, any active system will only be somewhat effective. Therefore, the active system should be designed with a redundant system as a barrier wall.

Three types of barrier walls were evaluated and are recommended: vibrated beam slurry wall, vertical poly curtain wall, and deep soil mixing. The budgetary cost estimates are listed below. All estimates are based on a wall that is 1000 linear feet and 80 feet in depth (80,000 sq ft), no unnatural overhead and underground obstructions (such as the C & D waste), site restoration not being provided, site safety level of "D" during installation, and other usual terms and conditions. The following are the technical considerations and budgetary costs:
* Vibrated beam slurry wall, permeability of 10^{-7} to 10^{-8} centimeters per second (cm/sec) (of water through the wall), advantage: conventional, disadvantage: cracking of soil/bentonite wall during drying, cost estimate $820,000 ($9/square feet (sg.ft.) plus $100,000 mobilization/demobilization), Source: Slurry Systems, Inc. Gary, IN;

* GSE Hyperflex high density polyethylene, permeability of 10^{-12} cm/sec, advantage: does not crack, disadvantage: