The State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES

Thomas S. Burack, Commissioner

EMAIL ONLY

September 27, 2016

Michael D. Cimis, Assistant Director of Environmental Health & Safety
Dartmouth College
37 Dewey Field Road, Suite 6216
Hanover, NH 03755

Subject: **Hanover** – Dartmouth College Rennie Farm Site, Hanover Center Road
DES Site #**201111109**, Project #27737

Report – Remedial Action Plan, prepared by GZA GeoEnvironmental, Inc. (GZA), and dated September 1, 2016

Dear Mr. Cimis:

The Department of Environmental Services (Department) has completed its review of the above-referenced Remedial Action Plan (RAP) Report for the Dartmouth College Rennie Farm site in Hanover. The RAP Report was recently submitted to the Department pursuant to our June 2, 2016 letter approving the additional investigations and remedial feasibility evaluation as previously proposed[1] by GZA. Consistent with these prior communications, the subject RAP Report provides a comprehensive summary of the findings of the environmental investigations completed to date, and the current conceptual model of hydrogeologic site conditions, as a basis for the proposed remedial strategy put forth by GZA. Our review comments follow below.

Overall Remedial Approach

The Department concurs that the available data suggest that the source for the 1,4-dioxane that continues to be detected in groundwater within and downgradient from the on-site source area (former animal carcass burial area) is likely aqueous-phase 1,4-dioxane in groundwater within overburden and uppermost fractured bedrock. As a consequence of seasonal fluctuations in groundwater elevations, the thin zone of overburden saturation recedes to the extent that the uppermost water table intermittently occurs within the underlying shallow bedrock. Based on this model of site hydrogeologic conditions, the remedial approach developed by GZA initially focuses on hydraulic containment of the 1,4-dioxane plume in both overburden and bedrock groundwater proximate to the source area. While the source area soil sampling data collected to date are not suggestive of significant residual 1,4-dioxane mass as contaminated soil, the proposed RAP conservatively includes additional detailed sampling and analysis of source area soils to evaluate this potential. If warranted based on the soil sampling results, additional contaminated soil excavation would be considered following operation and confirmatory performance monitoring of the hydraulic containment system.

[1] "Report – Supplemental Hydrogeologic Investigation – Phase I, Groundwater Management Zone Delineation and Water Supply Investigation" (dated May 6, 2016), prepared by GZA on behalf of the Dartmouth College Office of Environmental Health and Safety.

Based on our review of the findings of the remediation and investigative efforts completed to date, the Department concurs that the level of investigation has been sufficient to demonstrate that 1,4-dioxane (alone) is the primary groundwater contaminant associated with the on-site source area. The prior monitoring results (Appendix E of the RAP Report) have not detected radionuclides, metals, semi-volatile organic compounds (SVOCs), or other (i.e., not 1,4-dioxane) volatile organic compounds (VOCs) at concentrations exceeding the Department's Ambient Groundwater Quality Standards (AGQS). Relative to the VOCs, the Department notes that following the initial detection of 1,4-dioxane in site groundwater in April 2012, groundwater samples were collected from the original downgradient monitoring well network (GZ-2, GZ-3, and GZ-4) – 7 rounds between July 2012 and December 2013 – and analyzed for the Department's "Full-List" of VOCs (in addition to low-level analysis for 1,4-dioxane). Results from these monitoring events found only 1,4-dioxane at concentrations exceeding AGQS.

In addition, the Department acknowledges the recent confirmatory testing to assess the potential presence of contaminants other than 1,4-dioxane in groundwater, which has included:

- In September 2015, groundwater samples from downgradient (i.e., "plume") monitoring wells GZ-9L and GZ-10L, which had yielded samples with the highest concentrations of 1,4-dioxane detected in downgradient groundwater (up to 520 ug/l at GZ-9L), were collected and analyzed for the Full-List VOCs. No additional (i.e., non-1,4-dioxane) VOCs were detected in the GZ-9L and GZ-10L samples.

- More recently (May 2016), groundwater samples collected from 6 of the direct-push probes (GZG-11, 24, 32, 36, 42, and 44) installed within the source area were analyzed for Full-List VOCs (in addition to low-level analysis for 1,4-dioxane). No additional VOCs were detected at levels exceeding AGQS. By comparison, the 1,4-dioxane concentrations detected at the above-listed probe locations ranged between non-detectable (<0.25 ug/l) and 660 ug/l.

- Collection and analysis of groundwater samples from downgradient monitoring wells GZ-2, GZ-9L, and GZ-11L (June 2016) for the radiological parameters carbon-14, tritium, nickel-63, cesium-137, and lead-210. Of these analytes, only lead-210 was detected (in the GZ-9L sample). The reported lead concentration of 5.23 picocuries per liter (pCi/l) is slightly above the analytical reporting limit (5 pCi/l), and consistent with typical background levels.

- In June 2016, groundwater samples were collected from wells GZ-2 and GZ-6 for analysis for formaldehyde, which was not detected in either sample.

RAP Approval and Department Review Comments

Based on our review, the Department finds the remedial approach detailed in the RAP to be consistent with the current model of site conditions, and to provide an appropriate level of aggressive source-control measures to address the presence of 1,4-dioxane in groundwater. The Department thus approves the Proposed Remedial Alternative as presented in Section 9.0 of the RAP Report. The Department's approval is subject to the conditions and clarification requests presented below. We expect that each of these may be addressed by GZA and/or Dartmouth as part of the proposed Remedial Design Plans and Construction Specifications Report, or the work plan for the additional source area soil sampling as also proposed in the subject RAP Report.

Groundwater Monitoring Program

Based on the groundwater monitoring results summarized in Table 2 of the report, the sampling frequency for overburden monitoring wells GZ-5U and GZ-7U (each last sampled in July 2015) appears less than previously proposed by GZA (Section 5.0 of the May 2016 Supplemental Hydrogeologic Investigation Report) and approved by the Department. The Department suspects this may be due to the wells being dry, as was the case with source area well GZ-14U, however Table 2 entries for GZ-5U and GZ-7U simply indicate the wells were not included in the subsequent (i.e., post-July 2015) monitoring events. Please clarify.

In addition to the monitoring program defined in the May 2016 report, based on the discussion provided in Section 9.0 of the report, the Department understands that the scope of the groundwater monitoring program associated with performance monitoring of the groundwater remediation system is proposed to include: monthly water level measurement of all existing source area wells, the additional performance monitoring wells indicated in Figure 9 of the report, and existing wells GZ-6, GZ-7U, and GZ-7L. In addition, it appears that groundwater quality samples are to be collected from each of the above locations on a quarterly basis. The Department also recognizes that groundwater quality results from the additional wells currently being installed (triplet wells GZ-24 through GZ-28) will also entail incorporation of more monitoring locations into the monitoring program.

Please provide a table that summarizes the scope of the on-going groundwater and surface water monitoring program as currently proposed.

Additional Soil Sampling within Source Area

The Department concurs with the proposed additional source area soil sampling, understanding that the overall objective is to help assess if additional soil excavation or other supplemental remedial measures may be appropriate to directly address 1,4-dioxane presence in source area soils in efforts to accelerate remediation. While the anticipated laboratory analytical reporting limit for 1,4-dioxane in soil of 0.1 mg/kg is significantly less than the Soil Remediation Standard of 5 mg/kg, which is based on an estimated laboratory quantitation limit, the Department notes that due to the properties of 1,4-dioxane, the calculated leaching-based value of 0.04 mg/kg – as the threshold above which 1,4-dioxane in soil is expected to impact groundwater quality under generic site conditions – is much lower. Accordingly, as outlined in the RAP Report and based on our subsequent discussions with GZA, the Department understands that the data collected from the additional soil sampling will be used semi-quantitatively to assess the overall potential for discrete residual sources of 1,4-dioxane in the source area, and assess the mass of residual 1,4-dioxane potentially present as contaminated soil.

Groundwater Extraction and Treatment System

With regard to the conceptual design discussion for the proposed hydraulic containment remedial alternative, as presented in Section 9.0 of the report, we have the following technical comments and requests for further information:

- Bullet #4 under item #1 states that iron and manganese will be removed from groundwater using bag filters and granular activated carbon (GAC) as a pre-treatment step prior to treatment to remove 1,4-dioxane. The Department expects that bag filters may remove only

suspended iron and manganese particulates, and that neither the bag filters nor GAC would substantially reduce the concentrations of dissolved iron or manganese. Please discuss.

- The design flow rate for the groundwater treatment system is indicated as 15 gallons per minute (gpm), expandable to 25 gpm. However, there is nothing in the preceding sections that justifies the design flow rate. Please explain the justification for the flow rate.

- The Department assumes that the specifications and sizing of the Ambersorb contactors are based on adsorption of the 1,4-dioxane; please confirm/discuss.

- Bullet #6 calls for a treated water discharge to filtration beds. The total discharge capacity of the infiltration galleries is indicated to be "approximately 1 gpm" and is reported to be based on an evaluation of groundwater mounding. The two beds each have an area of 2,500 square feet (SF), for a total area of 5,000 SF. The stated 1 gpm capacity for the 5,000 SF infiltration galleries thus equates to less than 0.3 gallons per day per square foot, and appears low. However, since the primary discharge point for the treatment system is indicated to be the intermittent stream to the east of the source area (discharge to be permitted under a Remediation General Permit [RGP] from the US Environmental Protection Agency [USEPA]), the Department assumes that treated effluent flows will be adjusted to maximize the discharge capacity of the infiltration galleries (?); please discuss.

- No estimation of the mass of 1,4-dioxane to be removed in the treatment system is provided in the report. How were the sizes of the Ambersorb contactors determined and the frequency of steam regeneration estimated without an estimate for the mass of 1,4-dioxane being removed per day/week/month?

- Additional investigations should include estimating the individual well yields for the recovery wells and an overall flow to the treatment system.

- With regard to Figure 9 (Proposed Groundwater Extraction and Treatment System Layout), it appears the proposed most-northerly "plume" bedrock extraction well (separated from the other wells) is to be installed in the vicinity of existing monitoring well GZ-9. For clarity, Figure 9 should include a detail to show the new well's specific location and its proximity to well GZ-9; please provide. Also, it appears the treatment equipment is to be installed on a concrete pad; please confirm. Note that the concrete pad, if installed, will require provisions for handling stormwater.

- With regard to Figure 10 (Proposed Groundwater Treatment System Details/Equipment Plan):

    - Please provide an index for the letter symbols used in the instrumentation;
    - Tank 5300 is identified as a NAPL container storing the desorbed 1,4-dioxane. Please show how the liquid dioxane is transferred into the tank;
    - ECT_2 appears to have designed the treatment system and layout. Please confirm; and note that the plans will need to be stamped by a NH-licensed Professional Engineer (P.E.);
    - Figure 11 (see comments below) shows an air compressor to operate the extraction wells, but the air compressor is not shown on Figure 10. Where is the compressor to be located? Also, please show the air lines to the wells;

  - Figure 10 shows P1001 sump pump. It is assumed the pump is to pump spillage from the containment around the bag filters. Where does the discharge go? It is not shown in Figure 11; and,
  - Figure 11 indicates that the discharge from the Ambersorb contactors is directed to a treated water tank, and then pumped to the infiltration galleries or to a discharge point on the brook. There is no treated water tank shown in Figure 10 or a pump to discharge water to the infiltration beds from the tank.

- With regard to Figure 11 (Proposed Remedial System Process Diagram):

  - The condensate pump is shown to discharge to LGAC1, and LGAC2 is also shown as discharging to LGAC1. This appears to be in error (i.e., there is no discharge shown out of LGAC1). Please confirm;
  - The Bag Filters discharge to LGAC pretreatment, but no discharge from LGAC pretreatment is shown. Please revise the figure;
  - Tank 5300, NAPL Container, is shown in Figure 10 but not in Figure 11. It is assumed that this tank will hold the desorbed 1,4-dioxane. Please confirm and, if so, please show the method that will be used to place 1,4-dioxane into the tank;
  - The Dry Cooler pump is shown in Figure 10 but not in Figure 11. Please revise; and,
  - Please label, or show in the symbol panel, the steam lines, water softener lines, and groundwater treatment lines. To maintain consistency, please show discharge from lag Ambersorb vessel in blue.

Additional Characterization of Bedrock Hydrogeologic Conditions

As noted in Item 4(b) of Section 9.0 of the RAP Report, the Department acknowledges the proposed installation of two additional bedrock monitoring well couplets at locations just downgradient of the on-site source area. As noted therein, the objective is that the data from these additional wells will aid in the evaluation of the vertical distribution of 1,4-dioxane in fractured bedrock in the near-source/upper plume area of the site. Further downgradient, the Department notes the extensive investigations completed to date (approximately 15 bedrock monitoring wells) to assess the distribution of the 1,4-dioxane plume in fractured bedrock, and notes that several additional explorations are currently being drilled/installed.

As stated in Section 4.6.2, the Department understands that geophysical logging has not yet been completed at the #9 Rennie Road bedrock supply well. As such, key factors such as the depth of the contributing fractures and total well depth are not yet known for this well. Accordingly, as noted in Section 4.6.2 of the report, we concur that geophysical logging and discrete-zone sampling of the #9 Rennie Road well are needed. Please provide an update at to the status of these previously-proposed activities.

Errata and Text Corrections

Consistent with the prior reporting, the RAP Report refers to a total of 43 historical burial plots that we previously excavated as part of the prior remedial efforts. However, based on the historical documentation provided (Appendix E), it appears that 42 plots were historically used at the site. Please clarify.

Under Section 3.2 (Source Area Groundwater Screening), the reported concentrations of 1,4-dioxane detected in the groundwater samples collected from the direct-push (GZG-series) sampling points is indicated to range up to 660 ug/l (at GZG-11). Based on the data provided on Figure 6 and the laboratory reports in Appendix D, it appears that the highest concentration (670 ug/l) was found in the groundwater sample from GZG-23. Please confirm.

In Section 3.5.3 (and 4.7), the 1,4-dioxane concentration recently detected in the surface water sample collected from the "Stream-3" sampling location is reported as 5.2 ug/l; the Department understands that the correct value is 0.52 ug/l. Please confirm.

Under Section 3.6 (Hydraulic Testing), the constant head test is indicated to have been performed on overburden monitoring well GZ-14U; also, the twelfth bullet point under Section 5.0 (Conclusions) states that the constant head was performed on bedrock well GZ-20L. The Department believes the references should be to bedrock well GZ-14L as the pumping well used for the constant head test. Please confirm.

Bullet item #3 in Section 6.0 (Recommendation) discusses monitoring wells to be installed and shown on "Figure 13." This appears to refer to Figure 12. Please confirm.

The Department acknowledges Dartmouth's timely submittal of the comprehensive GZA RAP Report. As noted above, the Department expects that our comments and requests for clarification associated with our conditional approval of the site RAP can be addressed via the proposed Remedial Design Plans and Construction Specifications Report, or the work plan for the additional source area soil sampling as also proposed in the subject RAP Report.

Should you have any questions with regard to any of our comments, please contact me directly at the Department's Waste Management Division.

Sincerely,

Waste Management Division

Digitally signed by Waste Management Division
DN: cn=Waste Management Division, o=NHDES, ou=Waste Management Division, email=lisa.newton@des.nh.gov, c=US
Date: 2016.09.27 11:25:03 -04'00'

Paul Rydel, P.G.
Hazardous Waste Management Bureau
Tel: (603) 271-3116
Fax: (603) 271-2181
Email: paul.rydel@des.nh.gov

ec: Michael J. Wimsatt, PG, WMD Director
Karlee Kenison, PG, HWRB State Sites Supervisor
Fred McGarry, PE, DEE, WMD
David Gordon, MPH, Environmental Health Program
Twila M. Kenna, Ph.D., Manager, DHHS Radioactive Materials Program
James Wieck, PG, GZA GeoEnvironmental, Inc.
Attention Health Officer, Town of Hanover