

# Health Consultation

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REVIEW OF PROPOSALS FOR AIR MONITORING AND RISK  
ASSESSMENT AT THE NORTHAMPTON SANITARY LANDFILL  
NORTHAMPTON, HAMPSHIRE COUNTY, MASSACHUSETTS

EPA FACILITY ID: MAR000010512

**Prepared by the  
Massachusetts Department of Public Health**

JULY 9, 2009

Prepared under a Cooperative Agreement with the  
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Agency for Toxic Substances and Disease Registry  
Division of Health Assessment and Consultation  
Atlanta, Georgia 30333

## **Health Consultation: A Note of Explanation**

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

REVIEW OF PROPOSALS FOR AIR MONITORING AND RISK ASSESSMENT AT THE  
NORTHAMPTON SANITARY LANDFILL

NORTHAMPTON, HAMPSHIRE COUNTY, MASSACHUSETTS

EPA FACILITY ID: MAR000010512

Prepared By:

Massachusetts Department of Public Health  
Bureau of Environmental Health  
Community Assessment Program  
Boston, Massachusetts

Under a Cooperative Agreement with:  
Public Health Service  
Agency for Toxic Substances and Disease Registry  
U.S. Department of Health and Human Services  
Atlanta, Georgia

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## I. Summary

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<b>Introduction:</b>	This health consultation was conducted because residents of Northampton, Massachusetts, were concerned about potential exposures to air emissions from the Northampton Sanitary Landfill and Northampton City officials requested input from the Massachusetts Department of Public Health (MDPH) on their plans to measure air quality on the Landfill and in the residential neighborhood surrounding the Landfill. The top priority of ATSDR/MDPH is to ensure that the community has the best information possible to safeguard its health.
<b>Conclusion:</b>	MDPH cannot currently conclude whether breathing outdoor air in the neighborhood surrounding the Northampton Sanitary Landfill could result in health effects. The information we need to make a decision is not available. We are working with the City of Northampton and the Massachusetts Department of Environmental Protection (MassDEP) to gather the needed information.
<b>Basis for Decision:</b>	In order to reach a conclusion, MDPH needs outdoor air monitoring data from the neighborhood surrounding the Landfill collected over several 24-hour periods during a time of year when outdoor air is expected to be most affected by air emissions from the Landfill. These data are not currently available.
<b>Next Steps:</b>	<ul style="list-style-type: none"><li>❖ MDPH is working with the City of Northampton and the Massachusetts Department of Environmental Protection to measure air quality on the Landfill and in the residential neighborhood surrounding the Landfill.</li><li>❖ Air monitoring data are expected to be collected during October 2009.</li><li>❖ Upon request, MDPH will review data generated from this air sampling effort and/or additional environmental data related to the Landfill.</li></ul>
<b>For More Information:</b>	If you have concerns about your health, you should contact your health care provider. You may also call ATSDR at 1-800-CDC-INFO or MDPH at 617-624-5757 and ask for information on the Northampton Landfill.

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## **II. Background and Statement of Issues**

At the request of the mayor of Northampton, the local health department, and other city officials concerned about adequately characterizing and evaluating air emissions from the Northampton Sanitary Landfill and the air quality in the residential neighborhood surrounding the landfill, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH), initiated a Health Consultation providing two rounds of comments on a proposed scope of work (SOW) for air monitoring on and around the landfill and for a risk assessment incorporating this new data. This Health Consultation documents MDPH's review and comment process. In addition to this Health Consultation, MDPH completed two Health Consultations evaluating private drinking water sample data and available health data, including cancer incidence data.

The Northampton Sanitary Landfill is owned and operated by the City of Northampton as a municipal solid waste landfill, which accepts waste from 44 municipalities. The landfill began operating as a municipal solid waste landfill in 1969. Prior to 1969, the landfill property was operated as a gravel pit. The 40-acre landfill is located on a 52-acre parcel consisting of upland and wetland areas (Figure 1). The landfill consists of the original 22-acre unlined landfill cell and four additional lined landfill cells (Phase 1 through Phase 4). Waste is currently deposited in the Phase 4 cell and the other landfill cells are closed and capped (Dufresne-Henry 2005; MassDEP 2008). Capped portions of the landfill utilize an active landfill gas collection system that applies a vacuum to a system of landfill gas extraction wells and directs landfill gas to an enclosed flare for destruction (Tech Environmental 2007a). Currently, the City of Northampton is proposing the construction of an additional 20.5-acre cell, Phase 5/5B, to be constructed north of and overlapping onto the existing landfill areas (Dufresne-Henry 2005).

Residents in the vicinity of the landfill have expressed concern about the possible health effects of exposure to landfill air emissions. In an effort to address these concerns, the City of Northampton hired Brown and Caldwell to produce a SOW for ambient air monitoring on and around the landfill and the completion of a risk assessment evaluating residential exposures to site-related contaminants in ambient air.

### **III. Description of Air Pathway and Historical Air Sampling**

The Northampton Sanitary Landfill is located at 170 Glendale Road in Northampton, approximately 0.4 miles north of the border of the Town of Easthampton. The nearest residence is located adjacent to (approximately 170 feet west of) the landfill property. Residential properties abut the landfill property to the west along Glendale Road, to the south along Park Hill Road, and to the west along Park Hill Road. Approximately 756 people live within 0.5 miles of the landfill, based on a count of houses (assuming four people per house) (Figure 1) (MassGIS 2005).

In 2003, ambient air sampling and dispersion air modeling was completed by Dufresne-Henry, on behalf of the City of Northampton. Isopleth maps produced by the dispersion air model indicated that annual average concentrations of hydrogen sulfide and seven VOCs exceeded their respective Massachusetts guidelines for annual average concentrations in ambient air [Allowable Ambient Limit (AAL)] on the landfill property and extending off the landfill property (Appendices A and B). Table 1 summarizes the maximum modeled annual average concentrations of hydrogen sulfide and VOCs that exceeded AALs. Based on the isopleth maps, the area where annual average concentrations of tetrachloroethylene (PCE) exceeded its AAL of 0.003 ppb included residential areas along Westhampton Road north of the landfill and Park Hill Road to the south. The maximum modeled annual average concentration of PCE was 0.04 ppb. Due to the high modeled concentrations of PCE, additional air samples were collected in 2004 and the dispersion air model was re-run using these new sample data. According to the new modeling results, the area where concentrations of PCE exceeded the AAL did not extend into residential areas (Dufresne-Henry 2003 and 2004; MassDEP 1995).

In 2007, ambient air sampling and dispersion air modeling was completed by Tech Environmental, on behalf of the City of Northampton. Modeling results were used to calculate annual average impacts for all measured constituents. No estimated off-site concentrations of hydrogen sulfide or VOCs exceeded AALs (Tech Environmental 2007d).

Between August and November 2007, three grab air samples were collected from two residential properties (Residential Property A and B) in the vicinity of the landfill and one grab air sample was collected from the Northampton City Hall property, located approximately 4 miles east-northeast of the landfill property, as a background sample. Maximum concentrations of benzene and methylene chloride detected in residential samples exceeded their respective AALs and the maximum concentration of benzene exceeded its U.S. Agency for Toxic Substance and Disease Registry (ATSDR) cancer risk evaluation guide (CREG) of 0.03 ppb (Tech Environmental 2007b, c, and d). Table 2 summarizes the maximum detected concentrations of VOCs that exceeded AALs.

Between October 24 and November 9, 2007, at the request of the resident, MassDEP placed a hydrogen sulfide air monitoring instrument at Residential Property A. Hydrogen sulfide readings were recorded every 15 minutes, 24 hours per day for about 2 weeks, from October 24th through November 9th. The average concentration during the first week was 2 ppb and the maximum was 8 ppb. The average concentration during the second week was 4 ppb and the maximum was 8 ppb. The average and maximum concentrations for both weeks exceeded the MassDEP AAL of 0.65 ppb as well as the EPA Chronic Reference Concentration (RfC) of 1 ppb (MassDEP 2007b).

From April 2008 to January 2009, there were approximately 400 calls made to the landfill's Odor Complaint/Response Hotline (Northampton DPW 2009).

#### **IV. Scope of Work Review**

On November 10, 2008, the mayor, health department director, and other city officials asked MDPH to review the SOW for air monitoring and for a risk assessment incorporating this new data. On January 23, 2009, MDPH received a draft SOW for additional ambient air monitoring on and around the landfill and the completion of a risk assessment evaluating residential exposures to site-related contaminants in ambient air from the City of Northampton. On February 5, 2009, MDPH submitted a letter to the City of Northampton providing comments on the draft SOW. MDPH comments included recommendations on the

air sample detection limits, analyte list, and sample locations; as well as a recommendation that the risk assessment be written to be accessible to a lay audience (Appendix C).

To inform MDPH's review of the SOW, on December 3, 2008, MDPH personnel conducted a site walk of the landfill and the surrounding neighborhood with MassDEP personnel (Appendix E). MDPH reviewed data from previous air sampling events on and around the landfill, including samples collected on the landfill property in 2003, samples collected from on and around the landfill in June and July 2007, and samples collected from nearby residential properties in August through November 2007 (Dufresne-Henry 2003, 2004; Tech Environmental 2007b-e). MDPH reviewed dispersion air modeling/risk assessment reports completed by the City of Northampton's contractors in 2003 and 2007 to determine how the current proposed air sampling effort can improve upon past efforts (Dufresne-Henry 2003, 2004; Tech Environmental 2007d). In addition, MDPH reviewed several documents for guidance on the best methods to evaluate landfill gas emissions, including, but not limited to the U.S. Agency for Toxic Substance and Disease Registry's 2001 *Landfill Gas Primer – An Overview for Environmental Health Professionals* and U.S. Environmental Protection Agency's 2005 *Guidance for Evaluating Landfill Gas Emissions* (ATSDR 2009; EarthRes 2009; EPA 2004, 2005a, 2005b, 2007). See the References Reviewed section for a list of documents reviewed.

On February 17, 2009, MDPH received the revised SOW for review. On April 21, 2009, MDPH submitted a letter to the City of Northampton providing comments on the revised SOW. MDPH included the following recommendations: pre-define a range of meteorological conditions that are acceptable for sample collection; collect an off-site background sample; compare results to ATSDR comparison values; and explain and justify the use of an attenuation factor. MDPH also reiterated some comments from the February 5<sup>th</sup> comment letter, including recommendations on the sample detection limit and analyte list (Appendix D).

## **V. Conclusions**

ATSDR requires that overarching conclusion category statements be used to summarize the findings of a health consultation. Conclusion category statements are selected from site-specific conditions such as the degree of public health hazard based on the presence and duration of human exposure, contaminant concentration, the nature of toxic effects associated with site-related contaminants, presence of physical hazards, and community health concerns. MDPH cannot currently conclude whether breathing outdoor air in the neighborhood surrounding the Northampton Sanitary Landfill could result in health effects. The information we need to make a decision is not available. We are working with the City of Northampton and the Massachusetts Department of Environmental Protection to better characterize the potential impacts of landfill emissions on nearby residents, therefore, MDPH cannot currently conclude whether breathing contaminants detected in ambient air could harm nearby residents' health.

## **VI. Recommendations**

- Clearly state in the SOW the basis of selecting the specific locations for both the continuous and 24-hour samples (e.g., downwind versus upwind; maximum concentrations based on historical data; near off-site receptors, including possibly sensitive populations).
- Substances included in the monitoring/sampling program should be selected based on their importance from a health perspective, the likelihood that the compounds may be emitted from an operating solid waste landfill, and their frequency of detection in past sampling events. Based on our review of past air sampling data, we recommend that benzene, vinyl chloride, and hydrogen sulfide be included in the list of compounds to be analyzed.
- The analytical method selected should be able to detect benzene and vinyl chloride at levels at least as low as 0.04 ppb, based on available health-based guidance from ATSDR. The SOW should describe how the proposed sampling will avoid problems encountered with past sampling efforts, including lack of quality control, no

correlation with meteorological conditions, no background samples, and insufficient sampling time with respect to frequency and duration of sampling.

- The risk assessment should include an evaluation of air sampling data in comparison to typical background levels reported in the literature or government public health guidelines (e.g., ATSDR Toxicological Profiles). We suggest including a table listing the chemicals of concern along with their associated background concentrations.
- To ensure that the proposed sampling program has the best opportunity to capture worst-case concentrations of landfill emissions in the ambient air around the landfill, it is important to conduct sampling activities under pre-defined meteorological conditions. In addition, topography may influence local concentrations of landfill emissions and should be taken into consideration during the final selection of sample locations to capture worst-case landfill emissions.
- Due to variable meteorological conditions, it can be difficult to distinguish between background concentrations and inputs from off-site sources versus on-site source emissions. We recommend that, as part of each sampling round, a background sample be collected from a location sufficiently distant from the landfill to be outside of the influence of the landfill as well as other emission sources (such as major highways, busy roads, industrial pollution sources, and other landfills).
- The SOW proposes comparing air sample results to occupational guidelines in the absence of corresponding Massachusetts Threshold Exposure Limits (TELS). We do not advise using occupational guidelines because they reflect what workers are exposed to generally in an industrial versus a residential setting. We recommend, in the absence of TELS, results be compared to ATSDR air comparison values or other health-based guidelines for the general population, which MDPH can provide at your request.

- The SOW proposes calculating an attenuation factor for substances detected in ambient air collected from the landfill. In our experience, attenuation factors are typically calculated in the case of soil vapor intrusion to indoor air, not necessarily ambient air, thus we would appreciate the inclusion of citations of other landfill emissions studies where an attenuation factor has been calculated for ambient air, as well as the rationale for including this calculation in the risk assessment report. If, upon collection of the data, the city of Northampton feels the use of an attenuation factor is appropriate, please first discuss its proposed use with MassDEP.

## **VII. Public Health Action Plan**

The purpose of the Public Health Action Plan is to ensure that this health consultation not only identifies potential public health hazards, but also provides a plan of action designed to mitigate and prevent adverse health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR/MDPH to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by ATSDR/MDPH are as follows:

- Upon request, MDPH will review data generated from this air sampling effort and/or additional environmental data related to the landfill.

## **VIII. Documents Reviewed**

### **Site-specific References Reviewed**

Dufresne-Henry, Inc. 2003. Odor Evaluation and Risk Assessment Study, Northampton Sanitary Landfill, Northampton, Massachusetts. July 2003.

Dufresne-Henry, Inc. 2004. Odor Evaluation and Risk Assessment Study Addendum, Northampton Sanitary Landfill, Northampton, Massachusetts. January 2004.

Dufresne-Henry, Inc. 2005. Northampton Regional Sanitary Landfill Phase 5/5B Expansion Project Draft Environmental Impact Report. September.

Massachusetts Department of Environmental Protection (MassDEP). 1995. Memorandum to Bob Donaldson, et al., RE: Revised Air Guidelines. December 6, 1995.

Massachusetts Department of Environmental Protection (MassDEP). 2007a. Jerome Meter Hydrogen Sulfide Data Acquisition Report (10/24/07 through 11/1/07), 981 Park Hill Road, Northampton. November 1, 2007.

Massachusetts Department of Environmental Protection (MassDEP). 2007b. Jerome Meter Hydrogen Sulfide Data Acquisition Report (11/2/07 through 11/9/07), 981 Park Hill Road, Northampton. November 9, 2007.

Massachusetts Department of Environmental Protection (MassDEP). 2008. Personal communication from Daniel Hall (MassDEP). December 3, 2008.

Massachusetts Geographic Information System (MassGIS). 2005. 1:5,000 Color Ortho Imagery. April 2005.

Northampton Department of Public Works (DPW). 2009. Northampton Landfill Odor Response/Complaint Logs. April 2008 – January 2009.

Tech Environmental. 2007a. LFG Control System Non-Major Comprehensive Plan Approval Application, Northampton Landfill, Northampton, MA. September 2007.

Tech Environmental. 2007b. Letter to James Laurila (Northampton DPW), RE: Northampton Landfill- Neighborhood Sampling. September 12, 2007.

Tech Environmental. 2007c. Letter to James Laurila (Northampton DPW), RE: Northampton Landfill- Neighborhood Sampling. October 19, 2007.

Tech Environmental. 2007d. Northampton Landfill Health Comparison Report, Northampton Landfill, Glendale Road, Northampton, MA. October 2007.

Tech Environmental. 2007e. Letter to James Laurila (Northampton DPW), RE: Northampton Landfill- Neighborhood Sampling. November 30, 2007.

### **General References Reviewed**

EarthRes Group, Inc. 2009. Ambient Air Monitoring Report, Chrin Brothers Sanitary Landfill, Williams Township, Northampton County, Pennsylvania. March 19, 2009. Available at <http://www.chrin.org/aamr.pdf>.

U.S. Agency for Toxic Substance and Disease Registry (ATSDR). 2001. Landfill Gas Primer – An Overview for Environmental Health Professionals. November 2001.

U.S. Agency for Toxic Substance and Disease Registry (ATSDR). 2009. Air Comparison Values in ppb (for VOC Compounds only). October 16, 2008.

U.S. Agency for Toxic Substance and Disease Registry (ATSDR). 2009. Air Comparison Values in  $\mu\text{g}/\text{m}^3$ . October 27, 2008.

U.S. Environmental Protection Agency (EPA). 2004. Research and Development, Measurement of Fugitive Emissions at a Region I Landfill. January 2004. Available at <http://www.epa.gov/appcdwww/apb/EPA-600-R-04-001.pdf>.

U.S. Environmental Protection Agency (EPA). 2005a. Guidance for Evaluating Landfill Gas Emissions. September 2005.

U.S. Environmental Protection Agency (EPA). 2005b. A Case Study Demonstrating U.S. EPA Guidance for Evaluating Landfill Gas Emissions from closed or Abandoned Facilities, Somersworth Sanitary Landfill, Somersworth, New Hampshire. October 2005. Available at <http://www.epa.gov/nrmrl/pubs/600r05142/600r05142.pdf>.

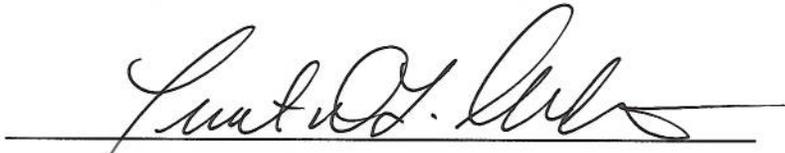
U.S. Environmental Protection Agency (EPA). 2007. Field Test Measurements at Five Municipal Solid Waste Landfills with Landfill Gas Control Technology, Final Report. April 2007. Available at <http://www.epa.gov/nrmrl/pubs/600r07043/600r07043.pdf>.

## **PREPARER**

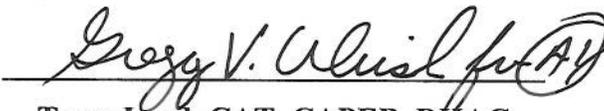
This document was prepared by the Bureau of Environmental Health of the Massachusetts Department of Public Health. If you have any questions about this document, please contact Suzanne K. Condon, Director of BEH/MDPH at 250 Washington Street, 7<sup>th</sup> Floor, Boston, MA 02108.

## CERTIFICATION

The Health Consultation, *Review of Proposals for Air Monitoring and Risk Assessment at the Northampton Sanitary Landfill, Northampton, Hampshire County, Massachusetts, MassDEP RTN 1-0000129*, was prepared by the Massachusetts Department of Public Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Health Consultation was initiated. Editorial review was completed by the cooperative agreement partner.

  
Technical Project Officer, CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this Health Consultation and concurs with its findings.

  
Team Lead, CAT, CAPEB, DHAC

## **Tables**

**Table 1**  
**Maximum modeled annual average concentrations of contaminants in ambient air at the Northampton Sanitary Landfill that exceeded comparison values**

Contaminant	Maximum modeled annual average ambient air concentrations (ppb)	75th Percentile NATA Background (ppb)	Air comparison value (ppb)
Benzene	0.35	0.2	Chronic EMEG/MRL = 3 CREG = 0.04 MassDEP AAL = 0.04
1,4-Dichlorobenzene	0.18	NA	Chronic EMEG/MRL = 10 MassDEP AAL = 0.030
Hydrogen sulfide	13.9	NA	Intermediate EMEG/MRL = 20 RfC = 1 Acute EMEG/MRL = 70 MassDEP AAL = 0.65
Methyl tert-butyl ether	1.36	NA	Chronic EMEG/MRL = 700 2003 EPA Region III RBC* = 0.44
Methylene chloride	0.32	0.2	Chronic EMEG/MRL = 300 CREG = 0.6 MassDEP AAL = 0.07
Tetrachloroethylene	0.04	0.05	Chronic EMEG/MRL = 40 MassDEP AAL = 0.003
Trichloroethylene	0.21	0.05	Intermediate EMEG/MRL = 100 Acute EMEG/MRL = 2,000 MassDEP AAL = 0.11
Vinyl chloride	0.43	0.1	CREG = 0.04 MassDEP AAL = 0.15

**Notes:**

NA = Not available

\*The 2003 EPA Region III Risk-Based Concentration (RBC) for methyl tert-butyl ether was provided because the source report compared contaminants to 2003 RBCs when MassDEP AALs were not available.

Modeled ambient air concentrations were provided for modeling completed in 2003 only, because modeled concentrations were not provided in the 2004 Dufresne-Henry *Odor Evaluation and Risk Assessment Study Addendum* or the 2007 Tech Environmental *Northampton Landfill Health Comparison Report*.

Table 1 (Continued)

**Data sources:**

Dufresne-Henry, Inc. 2003. Odor Evaluation and Risk Assessment Study, Northampton Sanitary Landfill, Northampton, Massachusetts. July 2003

Massachusetts Department of Environmental Protection (MassDEP). 1995. Memorandum to Bob Donaldson, et al., RE: Revised Air Guidelines. December 6, 1995.

U.S. Agency for Toxic Substance and Disease Registry (ATSDR). 2005. Public Health Assessment Manual. Atlanta: U.S. Department of Health and Human Services. January 2005.

U.S. Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Air Comparison Values. October 27, 2008.

U.S. Environmental Protection Agency (EPA). 2009. 1999 National-Scale Air Toxics Assessment, Table 1 - A list of background concentration values ( $\mu\text{g m}^{-3}$ ) used in the 1999 National-Scale Assessment by pollutant. Available at <http://www.epa.gov/ttn/atw/nata1999/99pdfs/backgroundtable.pdf>. Accessed on June 2009.

**Comparison values (source organization, reference):**

Acute EMEG = Environmental Media Evaluation Guide (i.e., for adult or childhood exposures of 14 days or less) (ATSDR 2008)

CREG = Cancer Risk Evaluation Guide for  $1 \times 10^{-6}$  excess cancer risk (ATSDR 2008)

Chronic EMEG/MRL = Environmental Media Evaluation Guide/Minimal Risk Level (i.e., for adult or childhood exposures greater than 1 year) (ATSDR 2008)

RfC = Chronic Reference Concentration (RfC) (for inhalation exposures over a lifetime) (EPA, ATSDR 2008)

2003 EPA Region III RBC = EPA Risk-Based Concentrations from 2003 (EPA, Dufresne-Henry 2003)

Intermediate EMEG = Environmental Media Evaluation Guide (i.e., for adult or childhood exposures greater than 15 days, but less than 1 year) (ATSDR 2008)

MassDEP AAL = Allowable Ambient Limits (MassDEP 1995)

**Table 2**  
**Concentrations of contaminants detected in ambient air samples collected from residential properties in the vicinity of the Northampton Sanitary Landfill that exceeded comparison values**

Sample ID Sample Date Location Description Contaminant	#1 - Residence A 8/21/2007 Front porch (ppb)	#2 - Residence A 9/23/2007 At edge of wooded area (ppb)	#3 - Residence B 10/26/2007 East of house (ppb)	#4 - City Hall 11/9/2007 Front Steps (ppb)	EPA 1999 NATA Background Concentrations (ppb)	Comparison Values (ppb)
Benzene	ND	0.05	ND	0.29	0.2	Chronic EMEG/MRL = 3 CREG = 0.03 MassDEP AAL = 0.04
Methylene chloride (dichloromethane)	0.83	0.26	ND	0.18	0.2	Chronic EMEG/MRL = 300 CREG = 0.9 MassDEP AAL = 0.07

**Notes:**

ND - Not detected

**Data Sources:**

Massachusetts Department of Environmental Protection (MassDEP). 1995. Memorandum to Bob Donaldson, et al., RE: Revised Air Guidelines. December 6, 1995.

Tech Environmental. 2007b. Letter to James Laurila (Northampton DPW), RE: Northampton Landfill- Neighborhood Sampling. September 12, 2007.

Tech Environmental. 2007c. Letter to James Laurila (Northampton DPW), RE: Northampton Landfill- Neighborhood Sampling. October 19, 2007.

Tech Environmental. 2007e. Letter to James Laurila (Northampton DPW), RE: Northampton Landfill- Neighborhood Sampling. November 30, 2007.

U.S. Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Air Comparison Values. October 27, 2008.

U.S. Environmental Protection Agency (EPA). 2009. 1999 National-Scale Air Toxics Assessment, Table 1 - A list of background concentration values ( $\mu\text{g m}^{-3}$ ) used in the 1999 National-Scale Assessment by pollutant. Available at <http://www.epa.gov/ttn/atw/nata1999/99pdfs/backgroundtable.pdf>. Accessed on June 2009.

**Comparison values (source organization, reference):**

CREG = Cancer Risk Evaluation Guide for  $1 \times 10^{-6}$  excess cancer risk (ATSDR 2008)

Chronic EMEG/MRL (adult/child) = Environmental Media Evaluation Guide/Minimal Risk Level (i.e., for adult or childhood exposures greater than 1 year) (ATSDR 2008).

MassDEP AAL = Allowable Ambient Limits (annual average) (MassDEP 1995)

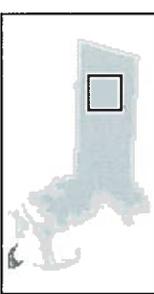
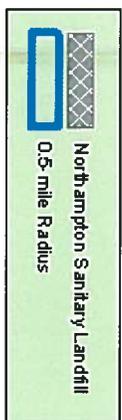
## **Figures**

Figure 1 - Location of the Northampton Sanitary Landfill, Northampton



Geographic data supplied by: Massachusetts Executive Office of  
Environmental Affairs, Massachusetts Geographic Data Technology, Inc.

9/10/2009 6/14/2009

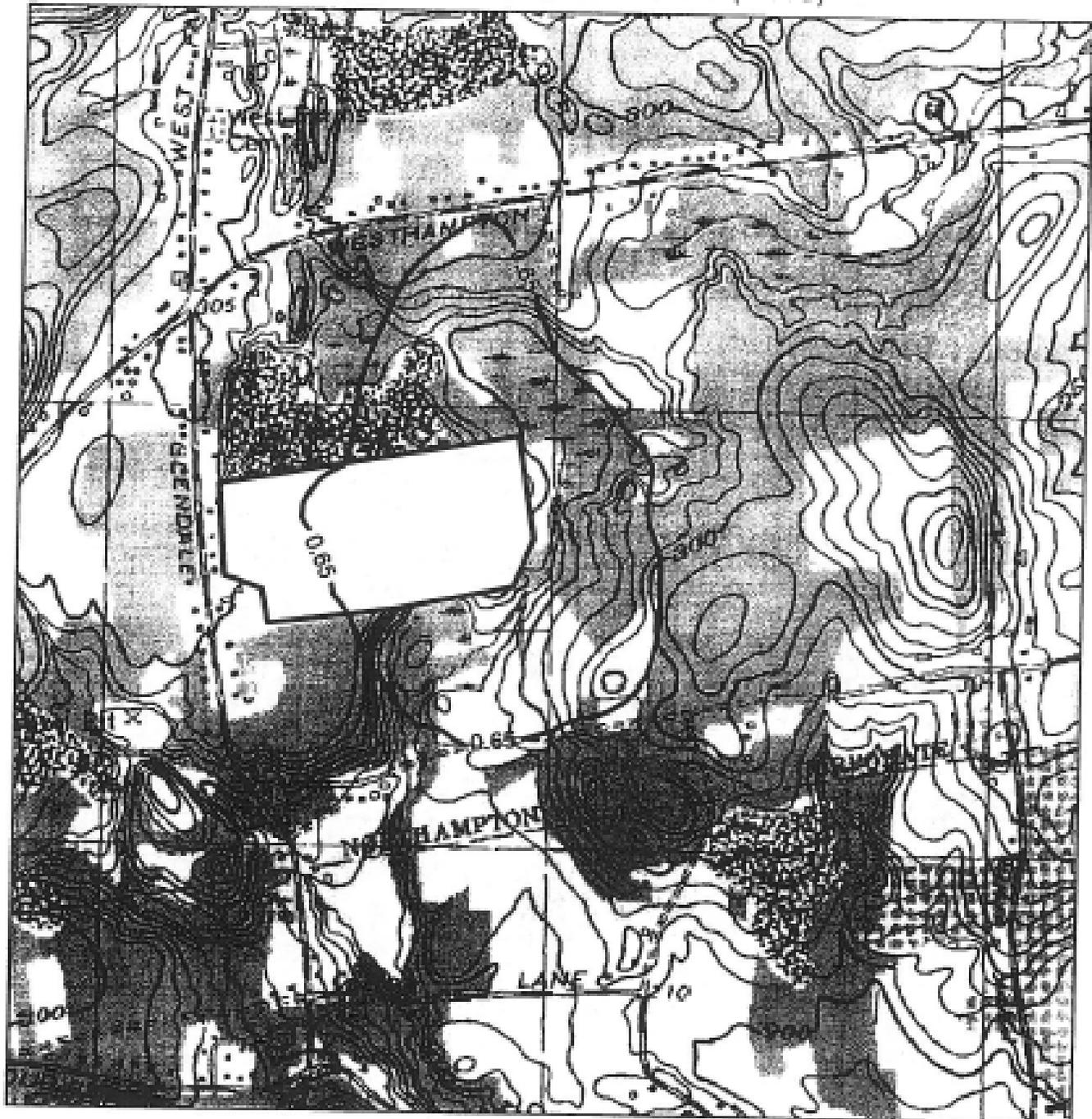


## **Appendices**

## **Appendix A**

Figure 7. Annual Massachusetts Ambient Air Level Exceedance Area Based on Conservative Sampling for Hydrogen Sulfide (in ppb) (Dufresne-Henry 2003)

FIGURE 7. ANNUAL MASSACHUSETTS AMBIENT AIR LEVEL EXCEEDANCE AREA BASED ON CONSERVATIVE SAMPLING FOR HYDROGEN SULFIDE (IN PPB)



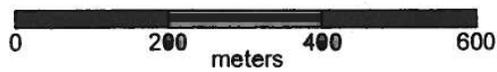
## **Appendix B**

Figure 10. Annual Massachusetts AAL Health Exceedances Based on Conservative Sampling Limits Volatile Organic Compounds ( $\mu\text{g}/\text{m}^3$ ) (Dufresne-Henry 2003)

FIGURE 10. ANNUAL MASSACHUSETTS AAL HEALTH EXCEEDANCES  
 BASED ON CONSERVATIVE SAMPLING LIMITS FOR  
 VOLATILE ORGANIC COMPOUNDS (ug/m3)



—————	Trichloroethene (0.11 ppb, 0.59 ug/m3)
—————	Vinyl Chloride (0.15 ppb, 0.38 ug/m3)
—————	Methylene Chloride (0.07 ppb, 0.24 ug/m3)
—————	1,4-Dichlorobenzene (0.03 ppb, 0.18 ug/m3)
—————	Benzene (0.04 ppb, 0.13 ug/m3)
—————	Methyl tert-butyl ether (0.44 ppb, 1.6 ug/m3)
—————	PCE (0.003 ppb, 0.02 ug/m3)



## **Appendix C**

**Massachusetts Department of Public Health Comment Letter, dated February 5, 2009**



The Commonwealth of Massachusetts  
Executive Office of Health and Human Services  
Department of Public Health  
Bureau of Environmental Health  
250 Washington Street, Boston, MA 02108-4619  
Phone: 617-624-5757 Fax: 617-624-5777  
TTY: 617-624-5286

DEVAL L. PATRICK  
GOVERNOR

TIMOTHY P. MURRAY  
LIEUTENANT GOVERNOR

JUDYANN BIGBY, M.D.  
SECRETARY

JOHN AUERBACH  
COMMISSIONER

February 5, 2009

James Laurila, P.E.  
Department of Public Works  
City of Northampton  
125 Locust Street  
Northampton, MA 01060

Subject: Northampton Landfill – Air Risk Assessment Scope

Dear Mr. Huntley:

The Massachusetts Department of Public Health (MDPH) has reviewed the preliminary draft proposed scope of work entitled, *Proposed Scope of Work, Air Risk Assessment, Northampton Landfill, Northampton, Massachusetts*. We are aware, by copy of a recent letter, that the Massachusetts Department of Environmental Protection has provided comments on the proposed scope. MDPH offers the following comments.

- The proposed scope includes conducting continuous onsite air monitoring for one month and 24-hour samples from up to ten locations, four of which are onsite and up to six at offsite locations. It is important to clearly state in the SOW the basis of selecting the specific locations for both the continuous and 24-hour samples (e.g., downwind versus upwind; maximum concentrations based on historical data; near off-site receptors, including possibly sensitive populations).
- The SOW states the samples will be analyzed for a select list of volatile organic compounds (VOCs). Substances included in the monitoring/sampling program should be selected based on their importance from a health perspective, the likelihood that the compounds may be emitted from an operating solid waste landfill, and their frequency of detection in past sampling events. Based on our review of past air sampling data, we recommend that benzene, vinyl chloride, and hydrogen sulfide be included in the list of compounds to be analyzed.
- As proposed, the analytical method for the onsite continuous air monitoring has limited value from a health perspective. The proposed method's detection limit of 0.01 ppm is too high to detect benzene and vinyl chloride at levels of potential health concern. The method selected should be able to detect benzene and vinyl chloride at levels at least as low as 0.04 ppb, based on available health-based guidance from ATSDR. MDPH anticipates that the analysis of the proposed 24-hour

samples will achieve the desired detection limits. If the proposed continuous air monitoring cannot achieve the above detection limits, then we suggest that more 24-hour samples be collected at multiple times (capturing worst case conditions, which should be described in the SOW). We note that past air sampling efforts (e.g., using summa canisters) did not result in useful data (lack of quality control, no correlation with meteorological conditions, no background samples, and insufficient sampling time with respect to frequency and duration of sampling). The SOW should describe how the proposed sampling will avoid these problems.

- Finally, we believe that the community, as an important stakeholder, will be interested in reviewing the risk assessment that will be written based on the environmental sampling results. The risk assessment should include an evaluation of air sampling data in comparison to typical background levels reported in the literature or government public health guidelines (e.g., ATSDR Toxicological Profiles). Some of the compounds detected in air on and around the landfill are also often present in ambient outdoor and indoor air across the United States. We suggest that the risk assessment be written in a manner that provides a clear explanation of what questions the risk assessment will/will not address and include an explanation of technical terms. We suggest including a table listing the chemicals of concern along with their associated background concentrations.

We appreciate the opportunity to continue to work collaboratively with local health and government officials, as well as residents of Northampton, to contribute to the development of this scope of work and to better address community environmental health concerns. It is our understanding that, based on comments received, another and more complete SOW will be drafted and shared for additional comments before the work begins. We are available to review and provide comments on the revised scope of work and look forward to hearing from you in this regard. If you would like to discuss our comments, please feel free to call us at 617-624-5757.

Sincerely,



Jan Sullivan, Director  
Community Assessment Program

Cc: Suzanne K. Condon, Associate Commissioner/Director, BEH  
Martha J. Steele, Deputy Director, BEH  
Daniel Hall, Section Chief, Solid Waste Management, MassDEP  
Edward Huntley, Director, Northampton DPW  
Mayor Mary Clare Higgins  
Xanthi M. Scrimgeour, Director, Northampton Health Department

## **Appendix D**

**Massachusetts Department of Public Health Comment Letter, dated April 21, 2009**



The Commonwealth of Massachusetts  
Executive Office of Health and Human Services  
Department of Public Health  
Bureau of Environmental Health  
250 Washington Street, Boston, MA 02108-4619  
Phone: 617-624-5757 Fax: 617-624-5777  
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GOVERNOR

TIMOTHY P. MURRAY  
LIEUTENANT GOVERNOR

JUDYANN BIGBY, M.D.  
SECRETARY

JOHN AUERBACH  
COMMISSIONER

April 21, 2009

James Laurila, P.E.  
Department of Public Works  
City of Northampton  
125 Locust Street  
Northampton, MA 01060

Subject: Northampton Landfill – Air Risk Assessment Scope

Dear Mr. Laurila:

The Massachusetts Department of Public Health (MDPH) has reviewed the scope of work (SOW) entitled, *Scope of Work, Air Risk Assessment, Northampton Landfill, Northampton, Massachusetts*, dated February 13, 2009. MDPH offers the following comments.

- To ensure that the proposed sampling program has the best opportunity to capture worst-case concentrations of landfill emissions in the ambient air around the landfill, it is important to conduct sampling activities under pre-defined meteorological conditions. “Managing” the meteorological conditions under which sampling is conducted is vital to the value of the resulting data in terms of addressing health concerns. Acceptable meteorological conditions for sampling, including ranges of barometric pressure and wind speed and direction, should be developed with and approved by the Massachusetts Department of Environmental Protection (MDEP) prior to initiating this sampling program. In addition, topography may influence local concentrations of landfill emissions and should be taken into consideration during the final selection of sample locations to capture worst-case landfill emissions.
- Due to variable meteorological conditions, it can be difficult to distinguish between background concentrations and inputs from off-site sources versus on-site source emissions. We recommend that, as part of each sampling round, a background sample be collected from a location sufficiently distant from the landfill to be outside of the influence of the landfill as well as other emission sources (such as major highways, busy roads, industrial pollution sources, and other landfills). Furthermore, as some of the compounds that have been detected in ambient air on and around the landfill are also often present in ambient outdoor and indoor air across the United States, the risk assessment report should include a comparison of air sample results to typical background levels

April 21, 2009

Letter to Mr. James Laurila, Northampton Department of Public Works

reported in the literature or government public health guidelines (e.g., ATSDR Toxicological Profiles).

- The SOW proposes comparing air sample results to occupational guidelines in the absence of corresponding Massachusetts Threshold Exposure Limits (TELs). We do not advise using occupational guidelines because they reflect what workers are exposed to generally in an industrial versus a residential setting. We recommend, in the absence of TELs, results be compared to U.S. Agency for Toxic Substance and Disease Registry (ATSDR) air comparison values or other health-based guidelines for the general population, which MDPH can provide at your request.
- The SOW proposes calculating an attenuation factor for substances detected in ambient air collected from the landfill. In our experience, attenuation factors are typically calculated in the case of soil vapor intrusion to indoor air, not necessarily ambient air, thus we would appreciate the inclusion of citations of other landfill emissions studies where an attenuation factor has been calculated for ambient air, as well as the rationale for including this calculation in the risk assessment report. If, upon collection of the data, the city of Northampton feels the use of an attenuation factor is appropriate, please first discuss its proposed use with MDEP.
- Finally, we would like to reiterate some points from our previous comment letter, dated February 5, 2009. The SOW did not provide an analyte list; substances included in the monitoring/sampling program should be selected based on their importance from a health perspective, the likelihood that the compounds may be emitted from an operating solid waste landfill, and their frequency of detection in past sampling events. Based on our review of past air sampling data, we recommend that benzene, vinyl chloride, and hydrogen sulfide be included in the list of compounds to be analyzed. The proposed sampling and analytical methods should be capable of detecting the selected analytes at levels comparable to risk-based comparison values (e.g. ATSDR comparison values).

We appreciate the opportunity to continue to work collaboratively with local health and government officials, as well as residents of Northampton, to contribute to the development of this scope of work and to better address community environmental health concerns. We look forward to reviewing the risk assessment report. If you would like to discuss our comments, please feel free to call us at 617-624-5757.

Sincerely,



Suzanne K. Condon, Associate Commissioner  
Director, Bureau of Environmental Health

Cc: Mayor Mary Clare Higgins, The Honorable  
Xanthi M. Scrimgeour, Director, Northampton Health Department  
Edward Huntley, Director, Northampton DPW  
Daniel Hall, Section Chief, Solid Waste Management, MassDEP  
Martha J. Steele, Deputy Director, BEH  
Jan Sullivan, Director Community Assessment Program, BEH

## **Appendix E**

**Massachusetts Department of Public Health Memorandum, RE: Northampton Sanitary  
Landfill Site Walk on December 3, 2008**

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# M E M O R A N D U M

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**DATE:** December 8, 2008  
**TO:** Northampton File  
**CC:** Jan Sullivan and Dalene LaPointe  
**FROM:** Jessica Burkhamer  
**RE:** Northampton Sanitary Landfill Site Walk on December 3, 2008

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On December 3, 2008, Massachusetts Department of Public Health (MDPH) personnel Jan Sullivan, Margaret Round, and Jessica Burkhamer conducted a site walk of the Northampton Sanitary Landfill with Dan Hall, Bureau of Waste Prevention, Massachusetts Department of Environmental Protection (MassDEP) Western Regional Office.

At 10:45, MDPH personnel met Mr. Hall at the corner of Clark Lane and Torrey Street in Easthampton, approximately 0.5 miles south of the Northampton Landfill. MDPH personnel and Mr. Hall walked east along Clark Lane to the intersection with Oliver Street and observed the closed and capped Oliver Street Landfill. No landfill odors were observed along Clark Lane. Hannum Brook and an unnamed stream flow north to south under Clark Lane through culverts. MDPH personnel observed that this section of Hannum Brook is approximately 3-4 feet wide and 6-12 inches deep. Mr. Hall pointed out the location along Hannum Brook that MassDEP collected sediment sample sed-1. The location was marked with blue flagging tape. Mr. Hall indicated that the sample locations were documented by the Northampton DPW with a global positioning unit (GPS) after the sampling event.

MDPH personnel and Mr. Hall drove to Park Hill Road and parked in front of No. 644 Park Hill Road. From No. 644 Park Hill Road, MDPH personnel and Mr. Hall walked west along the unpaved portion of Park Hill Road past Hannum Brook. This portion of Park Hill Road is undeveloped and consists of upland and wetland areas. MDPH personnel observed that Hannum

Brook flows north to south under Park Hill Road through a culvert. North of Park Hill Road Hannum Brook was not easily identifiable as a stream, instead it spread out to a wetland area approximately 20-30 feet across and water appeared to be 1-3 inches deep in places. South of Park Hill Road Hannum Brook was approximately 5-6 feet wide and 6-12 inches deep. MDPH personnel observed a slight orange tint to the sediment at this portion of Hannum Brook. MDPH personnel observed the locations of sed-2, sed-3, and sed-4 (Photo Nos. 1, 2, and 4). MDPH personnel observed a monitoring well triplet located along (south of) Park Hill Road (MW-NS, MW-NM, and MW-ND). Mr. Hall indicated that occasionally water can be observed flowing from the bases of these wells because they are artesian wells. Groundwater in this area is confined and under enough hydrostatic pressure to force water up out of the wells. MDPH personnel did not observe water at the base of these wells. MDPH personnel observed a 3-4 foot tall wire fence along both sides of the street along this portion of Park Hill Road. To access this portion of Hannum Brook and the wetland area around the brook, a visitor would have to climb over this fence. Mr. Hall stated that Mr. Brakey owns the property along either side of this section of Park Hill Road. Mr. Brakey owns and operates agricultural fields south of Park Hill Road. MDPH personnel detected slight transient landfill odors along Park Hill Road. MDPH personnel and Mr. Hall briefly spoke to the residents of No. 644 Park Hill Road. The residents indicated that they often notice landfill odors and they are concerned about what health effects the odors might have. They also reported that the odors are often stronger at a relative's house a few doors down (to the east). Mr. Hall noted that when he last spoke with these residents, they did not complain of landfill odors. MDPH personnel and Mr. Hall drove west along Park Hill Road. From the street, MDPH personnel observed No. 981 Park Hill Road located along (north of) Park Hill Road. MDPH personnel noted that the No. 981 Park Hill Road property slopes steeply up to the north and the residence is located approximately 15-25 feet above the rest of the residences located along Park Hill Road.

MDPH personnel and Mr. Hall drove from Park Hill Road to the Northampton Sanitary Landfill located along Glendale Road in Northampton. MDPH personnel observed that access to the landfill from Glendale Road is restricted by an 8-foot wooden fence and an 8-foot chain-link gate. MDPH personnel and Mr. Hall arrived at the landfill during regular operating hours and the gate at the entrance to the landfill was unlocked and open. Mr. Hall made his presence

known to a landfill employee and then MDPH personnel and Mr. Hall proceeded west along the landfill access road located south of the landfill and parked adjacent to the landfill gas-to-energy facility located along the landfill access road south of the landfill. MDPH personnel observed the landfill gas-to-energy facility. Noise from the facility appeared to be moderate when MDPH personnel were standing east of the facility and somewhat louder when standing north of the facility. Mr. Hall stated that by regulation, the noise from the landfill gas-to-energy facility must be under 10 decibels at the property line and that the noise level has been measured at the property line under this level. He mentioned that neighboring residents do complain about the noise from the facility, but do not seem to complain about noise from truck traffic or heavy equipment operating at the landfill.

MDPH personnel observed the landfill gas flare system and the working face of the landfill (Phase 4), located across the access road (northeast of) the landfill gas-to-energy facility. MDPH personnel observed some truck traffic to and from the working face and two pieces of heavy machinery actively grading the working face. MDPH noted a moderate odor at this location. Mr. Hall described this odor as “working face odor”. He indicated that this is the area that most of the odors emanate from because it cannot be attached to the flare system until it has reached capacity. He expects this landfill cell (Phase 4) to reach capacity in approximately 1.5 years. The Phase 4 cell will fill the valley between the original capped and unlined landfill to the east and the capped and lined Phase 3 cell located to the west. With the exception of the working face, all areas of the landfill are capped.

MDPH personnel and Mr. Hall proceeded north along the valley between the original landfill cell and the working face. MDPH personnel observed a 1-2 foot high mound topped with geotextile fabric extending the length of the valley between the two cells. Mr. Hall explained that at this is a leachate drainage channel. The channel is topped with a mound of gravel and geotextile fabric is placed over the channel to minimize odors (Photo No. 10). Leachate is directed into the municipal storm water collection system and is treated along with Northampton stormwater by a water treatment plant prior to being discharged into the Connecticut River. MDPH personnel observed a moderate odor adjacent to the leachate drainage channel. Mr. Hall described this odor as “leachate odor”.

At the north end of the valley, MDPH and Mr. Hall proceeded east up to the top of the working face. Mr. Hall indicated that this portion of the working face has been covered with daily cover material, which currently includes autofluff. He indicated that the autofluff is tested and certified to meet MassDEP's criteria for use as daily cover. Mr. Hall pointed out a small pool of standing water (approximately 2 feet across and 3-4 inches deep). He indicated that the pool of water likely consists of leachate and the bubbles slowly rising to the surface are probably landfill gas. Because of the constantly changing topography of the working face, the landfill gas collection system cannot be extended to this area until capacity has been reached. MDPH personnel asked Mr. Hall if surface water runoff from the landfill is currently a problem or if it was a problem in the past. Mr. Hall indicated that runoff from the working face is channeled into the municipal storm sewer. Stormwater sheeting off capped areas is not managed, but to his knowledge does not pose a problem for neighboring residents. Mr. Hall has been involved with the landfill since 1991, prior to the capping of the original unlined landfill cell (before that Mr. Mark Daly was DEP's contact person for the landfill). In Mr. Hall's experience, no residents have complained about stormwater runoff from the landfill.

MDPH personnel and Mr. Hall proceeded off the landfill itself, south across the landfill access road, and up a 15-20 foot high ridge that slopes up steeply to the south from the landfill access road. The landfill's border with Michael and Lillian Fedora's property (No. 238 Glendale Road) is at the top of this ridge. Mr. Hall indicated that he obtained the Fedora's permission to bring MDPH personnel onto their property. MDPH personnel and Mr. Hall proceeded south onto the Fedora property down a steep slope. This portion of the Fedora property is undeveloped and heavily wooded. MDPH personnel observed a wetland area at the bottom of the ridge. MDPH personnel and Mr. Hall proceeded south to the locations along the unnamed stream where sediment sample sed-5 and sed-6 were collected (Photo Nos. 14 and 15). At this point, the unnamed stream is broad and shallow. MDPH personnel estimated the stream to be 15-20 feet wide in places and 3-6 inches deep. MDPH personnel observed pronounced orange staining of the sediment at sed-6. MDPH personnel also observed a sheen on the surface water close to the sed-6 location. Mr. Hall believes that the sheen is due to the presence of iron bacteria. MDPH personnel asked Mr. Hall about the total petroleum hydrocarbon (TPH) analytical results of

sediment samples collected from this area. Mr. Hall stated that the City's lab indicated that TPH results were compromised by the presence of organic matter in the samples. He asked MassDEP's chemists to look at the results and they agreed that concentrations of TPH in sediment samples were biased high due to the presence of organic material.

MDPH personnel and Mr. Hall proceeded back to the landfill property and drove to the former leachate treatment facility at the west end of the landfill property. Mr. Hall stated that the leachate treatment facility was never actually used. MDPH personnel and Mr. Hall proceeded on foot east from the landfill access road to Hannum Brook. MDPH personnel observed the location of the background sediment sample sed-8 (Photo No. 16). Mr. Hall stated that this location is not truly upgradient of the landfill. It is located crossgradient from the landfill and would have had to have been collected further north to be upgradient. He indicated that further north Hannum Brook becomes an intermittent stream and in July 2008, when MassDEP conducted sediment sampling, Hannum Brook was dry further north. Mr. Hall indicated that he would have preferred to collect a background sediment sample further north, but due to the lack of water the decision was made to collect it east of the former leachate treatment facility.

MDPH personnel and Mr. Hall returned to the vehicle and departed the landfill property and proceeded south along Glendale Road. Mr. Hall pointed out the entrance to an active gravel pit along the west side of Glendale Road. He indicated that there is another unnamed stream on the gravel pit property and along part of that unnamed stream he has observed some minor orange staining in sediment. Based on what is known about groundwater flow at the landfill property and on an assessment of topographical maps he does not believe that this unnamed stream is hydrologically connected to groundwater beneath the landfill, but he will reassess this evaluation when additional monitoring wells are installed southwest of the landfill to evaluate groundwater flow direction in this direction.

At approximately 1:30 pm MDPH personnel returned Mr. Hall to his vehicle on Clark Lane. Mr. Hall departed from Clark Lane. MDPH personnel departed for the Boston office.





Photo 1: View of Hannum Brook and sed-2 from Park Hill Road, facing south-southeast. Taken on December 3, 2008.



Photo 2: View of monitoring well triplet MW-NS, MW-NM, and MW-ND from Park Hill Road, facing east-southeast. Taken on December 3, 2008.



Photo 3: View of sed-4 from Park Hill Road, facing north. Sediment sample sed-3 is located at the right hand side of the photo, but the flagging tape marking its location is obstructed by trees. Taken on December 3, 2008.



Photo 4: View of sed-3 (flagging tape marking location obstructed by trees) from Park Hill Road, facing north. Rusty wire fencing separating Park Hill Road from Hannum Brook and wetland area around it visible in foreground. Taken on December 3, 2008.



Photo 5: View of working landfill gas flare system in the foreground and the working face of the landfill in the background from landfill access road, facing north-northeast. Taken on December 3, 2008.



Photo 6: View of original landfill cell (capped and unlined) from landfill access road, facing northwest. Taken on December 3, 2008.



Photo 7: View of landfill gas to energy facility and landfill access road, facing west. Taken on December 3, 2008.



Photo 8: View of landfill gas to energy facility and 6-foot wooden fence along southern extent of landfill property. Taken on December 3, 2008, facing south.



Photo 9: View of the working face of the landfill (Phase 4) from the valley between the working face and the original capped unlined landfill cell. In this photo the working face is covered by daily cover, which includes autopluff. Taken December 3, 2008, facing northeast.



Photo 10: View of valley between the working face (left) and the original capped unlined landfill cell (right). In the center of the photo is a leachate drainage channel covered with gravel and topped with geotextile fabric to reduce odors. The stack for the flare system is visible in the background. Taken on December 3, 2008, facing south.



Photo 11: View of private residences along Glendale road from the northern extent of the working face. The northern slope of the original capped unlined landfill cell is visible on the left and the proposed landfill expansion area is on right. Taken on December 3, 2008, facing northwest.



Photo 12: View of the north slopes of Phases 3 and 4 from the northern extent of the working face. The landfill access road and the proposed landfill expansion area are visible in the background. Taken on December 3, 2008, facing northeast.



Photo 13: View of the top of the working face. Taken on December 3, 2008, facing south.



Photo 14: View of sed-6 location on Fedora property. Orange staining of sediment is clearly visible at this location. Taken on December 3, 2008, facing east.



Photo 15: View of sheen on the surface of the unnamed stream, possibly from iron bacteria. Taken on December 3, 2008.



Photo 16: View of sed-8 facing east. Taken on December 3, 2008.