FIFTH FIVE-YEAR REVIEW REPORT FOR THE CHARLES GEORGE RECLAMATION TRUST LANDFILL SUPERFUND SITE MIDDLESEX COUNTY, MASSACHUSETTS

Prepared by

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Region 1
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06/24/15
Date

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LIST OF ACRONYMS

ACOE	Army Corps of Engineers
ARAR	Applicable or Relevant and Appropriate Requirement
BOH	Board of Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Difference
FYR	Five-Year Review
GPM	Gallons per Minute
HQ	Hazard Quotient
ICs	Institutional Controls
LRWU	Lowell Regional Wastewater (or Water) Utility
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NAUL	Notice of Activity and Use Limitation
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PAH	Polyaromatic Hydrocarbon
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
RAO	Remedial Action Objectives
ROD	Record of Decision
RPM	Remedial Project Manager

EXECUTIVE SUMMARY

This is the fifth Five-Year Review (FYR) for the Charles George Reclamation Trust Landfill Superfund Site (the Site) located in Tyngsborough, Middlesex County, Massachusetts. The purpose of this FYR is to review information to determine if the remedy is and will continue to be protective of human health and the environment. The triggering action for this statutory FYR was the signing of the previous FYR on June 24, 2010.

The Site is a 70-acre mixed industrial, municipal, and hazardous waste landfill located approximately one mile southwest of the town center of Tyngsborough, Massachusetts (Figure A-1). From the late 1950s until 1967, it was operated as a small municipal dump. In 1967, the landfill was expanded to its present size and began accepting both household and industrial wastes, including drummed and bulk chemicals containing volatile organic compounds and metal sludges. The Commonwealth of Massachusetts ordered closure of the landfill in 1983 and the Site was listed on the National Priorities List that same year. Groundwater samples collected from private wells near the Site contained volatile organic compounds and metals. Benzene, tetrahydrofuran, arsenic, 1,4-dioxane, and 2-butanone are representative of the contaminants detected.

The Site is being addressed in five stages: initial actions and four long-term remedial phases or operable units. In response to the 1983 discovery of contaminated well water in nearby residential wells, the U.S. Environmental Protection Agency (EPA) took the initial action of improving an above-ground pipeline that was supplying residents with a temporary alternative water supply. Other initial actions taken in 1983 and 1984 included the installation of a security fence and 12 gas vents at the landfill, and re-grading of the landfill to cover exposed refuse.

The initial actions addressed the immediate threats posed by the Site. EPA then initiated long-term remedial phases and subdivided the effort into four operable units. Operable Unit 1 refers to the provision of a permanent alternative water supply for areas affected by the contaminated groundwater plume from the Site. Operable Unit 2 (Source Control) involves control of the contamination source to reduce off-site migration of contaminants (i.e., capping of the landfill and collection of the leachate and landfill gas with interim treatment). Operable Unit 3 addresses contaminated groundwater migration, permanent treatment of landfill gas, and excavation of contaminated sediments in nearby Dunstable Brook (eliminated under Explanation of Significant Difference issued in September 1999) and Operable Unit 4 addresses leachate treatment. Construction complete status was attained for the entire Site in September 1998. The landfill cap, landfill gas collection/destruction system, and southwest groundwater collection trench (OU2 and OU3), and the groundwater/leachate collection system (OU3 and OU4) are in the operation and maintenance phase overseen by the Massachusetts Department of Environmental Protection (MassDEP).

This is the fifth FYR for the Site. The FYR is required because hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure. This FYR concluded that the remedy is functioning as designed and provides continued protectiveness with respect to human health, as well as potential ecological receptors. The groundwater data trends are mostly stable or continuing downward thus demonstrating that the remedy continues to function satisfactorily. The continued examination of offsite groundwater indicates that elevated levels of arsenic and 1,4-dioxane (not listed as a COC in the ROD) are migrating off site to the east, however, they appear to be confined to an area

immediately beyond the eastern collection trench where there is no private well water use, and where the terrain and land use preclude this from happening. This extent of 1,4-dioxane and arsenic should continue to be evaluated, and all components of the remedy, including the eastern collection system, should be subjected to an O&M inspection protocol where issues and potential corrective measures are described and reported in the weekly logs and in the semi-annual inspection report, and also to an optimization study to ensure that the goal of minimizing the off-site migration of potential contaminants is realized.

In order for the remedy to remain protective in the long term, institutional controls to control and regulate the installation and use of private water wells near the Site are advisable as a conservative measure. This is considered a conservative precautionary measure since an interstate highway (Rte. 3) and the marshy terrain would likely preclude residential dwellings with private wells to the immediate east of the Site. EPA has had ongoing discussions with the Tyngsborough Board of Health (BOH) regarding a policy that would have EPA and MassDEP consulted prior to installation of any private wells within a designated "well installation review zone" so that a proper evaluation can be conducted in order to accomplish this. Institutional controls to prevent future disturbance of the landfill cap are also needed. The Settling Defendants under a Consent Decree entered in 2003 are required to implement these institutional controls. A Notice of Activity and Use Limitation (NAUL) will ensure that the integrity of the remedy, including the landfill cap, is maintained, that certain uses on the Site (e.g. residential) will be restricted, and that extraction and use of groundwater at this Site will be prohibited. The NAUL is currently under development and is expected to be implemented by the end of the 2015.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Charles George Reclamation Trust Landfill Superfund Site		
EPA ID: MAD003809266		
Region: 1	**State:** MA	**City/County:** Tyngsborough, Middlesex
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: EPA ***[If "Other Federal Agency", enter Agency name]*****:** Click here to enter text.		
Author name (Federal or State Project Manager): Richard Fisher		
Author affiliation: EPA Region 1		
Review period: 12/16/2014 - 6/23/2015		
Date of site inspection: 5/5/2015		
Type of review: Statutory		
Review number: 5		
Triggering action date: 6/24/2010		
Due date *(five years after triggering action date)*: 6/24/2015		

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
None

Issues and Recommendations Identified in the Five-Year Review:

OU(s): *Sitewide*	**Issue Category:** Institutional Controls			
	Issue: Institutional controls not yet implemented.			
	Recommendation: PRPs to implement Notices of Activity and Use Limitations (NAULs) and EPA to provide guidance to BOH regarding guidelines for off-site well installations.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	Other	EPA	12/31/2015
OU(s): *OU3*	**Issue Category:** Monitoring			
	Issue: Extent of arsenic and 1,4-dioxane contamination.			
	Recommendation: Continue to monitor the extent of these contaminants (note that 1,4-dioxane is not listed in the ROD).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	5/1/2020

OU(s): *OU3/OU4*	**Issue Category:** Operations and Maintenance			
	Eastern collection trench groundwater extraction system.			
	Recommendation: The eastern collection system must be brought back on line as soon as possible. The system should also be subjected to an optimization study to ensure that off-site migration of groundwater contamination is minimized as much as is possible.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	12/31/2016

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU1	Short-term Protective	Click here to enter a date.

Protectiveness Statement:
OU1 refers to the provision of an alternate water supply for areas originally found to have been affected by the groundwater contaminant plume originating from the site. The remedy for OU1 currently protects human health and the environment because all areas known to have been impacted by contaminated groundwater have received an alternative water supply under OU1 (the original alternative supply) or OU3/OU4 (extensions to the original water supply lines). However, in order for this portion of the remedy to be protective in the long term, follow-up actions need to be taken. Specifically, institutional controls should be placed in the vicinity of the Site that would prevent or regulate both potable and non-potable uses, if warranted, of potentially impacted groundwater. The Town of Tyngsborough currently prevents potable use by not allowing installation of drinking water wells in areas that have access to public drinking water. However, additional institutional controls may be necessary to attain broader protectiveness in the long-term. These could include ordinances prohibiting, or advisories discouraging, installation of potable and non-potable water supply wells within the vicinity of the Site, regardless of the availability of a public water supply.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU2	Short-term Protective	Click here to enter a date.

Protectiveness Statement: OU2 addresses source control to reduce off-site migration of contaminants (i.e., capping of the landfill and collection of leachate and landfill gas). This operable unit also includes the remedial action objective of "abating additional impact to surrounding surface waters and wetlands." This portion of the remedy is protective in the short-term; however, in order for this portion of the remedy to be protective in the long term, follow-up actions need to be taken. Although access to the landfill is currently strictly controlled by MassDEP, formal institutional controls are needed to prevent future disturbance of the cap. The Settling Defendant is required to implement these onsite controls under a Consent Decree with EPA.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU3 and OU4	Short-term Protective	Click here to enter a date.

Protectiveness Statement:
OU3 focuses on containing contaminated groundwater migration and treating contaminated groundwater and OU4 addresses collection and treatment of leachate. The protectiveness of these remedies are presented together since contaminated groundwater and leachate are considered together in ROD III, and are treated together in a combined groundwater/leachate collection system that discharges to the Lowell Regional Wastewater Utility (LRWU). The remedies for OU3 and OU4 are protective in the short-term; however, in order for this portion of the remedy to be protective in the long-term, follow-up actions need to be taken. The eastern collection system must be brought back on line as soon as possible. The system should also be subjected to an optimization study to ensure that off-site migration of groundwater contamination is minimized as much as is possible. The ROD specifies that long-term protectiveness will be achieved once groundwater and leachate contaminant concentrations drop below MCLs. In the interim, institutional controls are needed to prevent exposure to these contaminated media. In the past, the Town of Tyngsborough prevented installation of drinking water wells in areas that have access to public water. However, additional institutional controls may be necessary to attain broader

protectiveness in the long-term. Specifically, this may require formalizing the moratorium on well construction where municipal water is available, and include advisories discouraging or guidelines involved with installation of potable and non-potable water supply wells within the vicinity of the Site, regardless of the availability of a public water supply. In addition, the Settling Defendant in the Consent Decree, entered in 2003 with EPA, is required to implement onsite institutional controls to maintain protectiveness in the long-term for contaminated leachate.

Sitewide Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Addendum Due Date (if applicable):* Click here to enter a date.

Protectiveness Statement:
Because the remedial actions of all operable units are protective in the short-term, the remedy is currently protective of human health and the environment. However, in order for the remedy to be protective in the long-term, the following follow-up actions are required: (1) establish enforceable institutional controls to prevent future disturbance of the landfill cap; (2) establish enforceable institutional controls on the Site to prevent potable water use from drinking water wells until MCLs are attained; (3) work with local officials on advisories/ordinances downgradient of the Site, to prevent or regulate potable water use from drinking water wells until MCLs are attained, and to prevent such wells from potentially impacting the distribution of the contaminant plume or affect capture; and (4) work with local officials on advisories/guidelines downgradient of the Site to ensure non-potable private well use does not result in unacceptable risk, and to prevent such wells from potentially impacting the distribution of the contaminant plume or affect capture; and (5) the eastern collection system must be brought back on line as soon as possible and be subjected to an optimization study to ensure that off-site migration of groundwater contamination is minimized as much as is possible.

I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) prepares FYRs pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Contingency Plan (NCP). CERCLA 121 states:

> "*If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews."*

EPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) Section 300.430(f)(4)(ii), which states:

> "*If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such actions no less often than every five years after the initiation of the selected remedial action*."

EPA conducted a FYR on the remedy implemented at the Charles George Reclamation Trust Landfill Superfund Site in Tyngsborough, Middlesex, MA. EPA was the lead agency for developing and implementing the remedy for the Site. Operations and maintenance (O&M) responsibilities for maintaining the Site have since been fully taken over by MassDEP in September 2009. MassDEP had taken over O&M responsibilities for OU2 in 1992, the OU3 flare in 1994, the OU3 trench in 2004, and the OU3/OU4 in 2009. MassDEP, as the support agency representing the State of Massachusetts during this FYR process, has reviewed all supporting documentation and provided input to EPA during this FYR process.

This is the fifth FYR for the Charles George Reclamation Trust Landfill Superfund Site. The triggering action for this statutory review is the previous FYR. The FYR is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure. The Site consists of four Operable Units, all of which are addressed in this FYR.

II. PROGRESS SINCE THE LAST REVIEW

Table 1: Protectiveness Determinations/Statements from the 2010 FYR

OU #	Protectiveness Determination	Protectiveness Statement
1	Short-term Protective	OU1 refers to the provision of an alternate water supply for areas originally found to have been affected by the groundwater contaminant plume originating from the site. The remedy for OU1 currently protects human health and the environment because all areas known to have been impacted by contaminated groundwater have received an alternative water supply under OU1 (the original alternative supply) or OU3/OU4 (extensions to the original water supply lines). However, in order for this portion of the remedy to be protective in the long term, follow-up actions need to be taken. Specifically, institutional controls should be placed in the vicinity of the Site that would prevent both potable and non-potable uses if warranted, of the groundwater. The Town of Tyngsborough currently prevents potable use by not allowing installation of drinking water wells in areas that have access to public drinking water. However, additional institutional controls may be necessary to attain broader protectiveness in the long-term. These could include ordinances prohibiting, or advisories discouraging, installation of potable and non-potable water supply wells within the vicinity of the Site, regardless of the availability of a public water supply.
2	Short-term Protective	OU2 addresses source control to reduce off-site migration of contaminants (i.e., capping of the landfill and collection of leachate and landfill gas). This operable unit also includes the remedial action objective of "abating additional impact to surrounding surface waters and wetlands." This portion of the remedy is protective in the short-term; however, in order for this portion of the remedy to be protective in the long term, follow-up actions need to be taken. Although access to the landfill is currently strictly controlled by MassDEP, formal institutional controls are needed to prevent future disturbance of the cap. The Settling Defendant is required to implement these onsite controls under a Consent Decree with EPA. Also, there remains a need to continue air emissions monitoring, and surface water and sediment sampling in Dunstable Brook and Flint Pond Marsh to more fully evaluate possible long-term impacts of PAHs on both human health and ecological receptors.
3 & 4	Short-term Protective	OU3 focuses on contaminated groundwater migration and OU4 addresses leachate treatment. The protectiveness of these remedies are presented together since contaminated groundwater and leachate are considered together in ROD III, and are treated together in a combined groundwater/leachate collection system that discharges to the LRWU. The remedies for OU3 and OU4 are protective in the short-term; however, in order for this portion of the remedy to be protective in the long-term, follow-up actions need to be taken. The ROD specifies that long-term protectiveness will be achieved once groundwater and leachate contaminant concentrations drop below MCLs. In the interim, institutional controls are needed to prevent exposure to these contaminated media. The Town of Tyngsborough currently prevents installation of drinking water wells in areas that have access to public water. However, additional institutional controls may be necessary to attain broader protectiveness in the long-term. Specifically, this may require prohibiting installation of potable and non-potable water supply wells within the vicinity of the Site regardless of the availability of a public water supply. In addition, the Settling Defendant in the Consent Decree, entered in 2003 with EPA, is required to implement onsite controls to maintain protectiveness in the long-term for

OU #	Protectiveness Determination	Protectiveness Statement
		contaminated leachate.
Sitewide	Short-term Protective	Because the remedial actions of all operable units are protective in the short-term, the remedy is currently protective of human health and the environment. However, in order for the remedy to be protective in the long-term, the following follow-up actions are needed: •Establish enforceable institutional controls to prevent future disturbance of the landfill cap. •Establishment of enforceable institutional controls on the Site, and work with local officials on advisories/ordinances downgradient of the Site, to prevent potable water use from drinking water wells until MCLs are attained. •Evaluate the risk of future non-potable groundwater uses (e.g., irrigation wells) to determine whether such uses should be restricted along with potable uses in the vicinity of Site. •Re-establish a formal groundwater monitoring program to allow continued evaluation of offsite contamination; the effectiveness of the groundwater extraction systems, and; potential impacts to human health. •Re-establish a formal surface water and sediment monitoring program to allow continued evaluation of PAH and metal contamination in nearby surface water bodies, their potential sources, and/or the potential risk to ecological receptors. •Update the O&M Plan such that it includes the establishment of mechanisms for evaluating the potential risk from vapor intrusion into occupied structures and continued stack emissions monitoring to evaluate potential risk through the ambient air pathway.

Table 2: Status of Recommendations from the 2010 FYR

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
Sitewide	Intermittent groundwater monitoring program. Limited groundwater data (only two sampling rounds) are available for the current five-year review period, including for arsenic contamination, which has been detected in offsite groundwater monitoring wells at concentrations exceeding the MCL. The limited groundwater data makes it difficult to conduct long-term trend evaluations and confirm long-term protectiveness, however, no known drinking water wells are currently affected.	Update the O&M Plan to include maintaining a groundwater monitoring program to evaluate extraction system effectiveness and assess onsite and offsite concentration trends. Target analytes may continue to include 1,4-dioxane and tetrahydrofuran which are not listed in the ROD. In addition, the state's Groundwater Use and Value determination should be examined, and, if necessary, revised. The groundwater cleanup levels should then be adjusted to reflect any revision to the use and value determination.	MassDEP	MassDEP	2012	Complete	April 2015
2	Potential impacts to ecological receptors due to PAHs and metals in sediment. Potentially significant concentrations of these compounds were observed in samples collected from Dunstable Brook and Flint Pond Marsh during the 2009 sampling round.	Collect additional sediment data from nearby water bodies to assess trends in PAH and metals concentrations potentially affecting ecological receptors.	EPA	EPA	1/1/2012	Completed	6/1/2015
Sitewide	Future groundwater and land use institutional controls have not been established to prevent groundwater use and access to the landfill cap in the future.	Institutional controls to prevent use of potentially contaminated groundwater should be established to maintain protectiveness over the long-term. Land-use restrictions should align with the Consent Decree to prevent future disturbance of the landfill cap.	EPA/State	EPA	1/1/2012	Ongoing	12/31/2015
1,2,3,4	Future non-potable groundwater use. Potential risks to human health associated with non-potable groundwater use (e.g., irrigation) have not been evaluated.	Future non-potable groundwater use should be evaluated to assess risk to human receptors, and to determine whether such uses should be restricted.	EPA	EPA	2015	Complete	6/1/2015
2	Stack emissions monitoring. Further	Update the O&M Plan to ensure that stack	State	State	2012	Complete	6/1/2015

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
	sampling of stack emissions is necessary to confirm that the remedy remains protective for the ambient air pathway.	emissions continue to be monitored every five years. Results should be evaluated and compared to prior results to confirm that the remedy remains protective for the ambient air pathway. Further evaluation of the dispersion of stack emissions to points of exposure is recommended if analytical results exceed ROD criteria.					
2,3,4	Vapor intrusion into occupied structures. There are no occupied structures that may be affected by soil vapors. Continued land use, groundwater quality, and soil gas monitoring are necessary to monitor changes in concentrations and land use during the upcoming review period.	During the current five year review period, VOCs continue to be detected in the groundwater being influenced by the Site. The concentration exceeded screening values for indoor vapor intrusion at one location. However, no changes to the incomplete exposure pathway for indoor air have occurred during that time. Update the O&M Plan to ensure that inspections and monitoring are done as necessary to confirm the continued incomplete exposure pathway to indoor air is maintained.	State	State	2012	Complete	6/1/2015

Recommendation 1

- MassDEP developed and is implementing a long-term groundwater monitoring program consisting primarily of annual monitoring for Site COCs plus 1,4-dioxane. The Massachusetts Drinking Water Guideline for tetrahydrofuran (THF) is given as 0.6 mg/L. Because the historical groundwater data of this analyte that is not listed in the ROD as a COC shows no exceedances of THF, this analyte is no longer included in the Site groundwater monitoring program. This monitoring program has been added into the Site O&M Plan, which was updated since the last FYR to consolidate the number of separate documents that now comprise it (see Appendix G). MassDEP has also contemplated a change in the state's Groundwater Use and Value determination for the Site and determined that since the entire area does not have municipal water supply, that the potential for water from the aquifer being used as a drinking water supply preclude any revision to the groundwater cleanup standards. This determination was verbally given from Dave Buckley of MassDEP to Richard Fisher of EPA, and then verified by email on June 11, 2015.

Recommendation 2

- EPA conducted additional surface water and sediment sampling in Dunstable Brook and in Flint Pond and its marshes in 2011. EPA has concluded that significant ecological impacts from the Site are unlikely in these water bodies and further monitoring is unnecessary.

Recommendation 3

- Notices of Activity and Use Limitations (NAULs) which shall constitute appropriate institutional controls that will restrict certain site activities and secure the remedy in order to ensure protectiveness at the Site are expected to be issued by the end of 2015. As an additional precaution, EPA has been working with the Tyngsborough Board of Health to develop guidance and or advisories to regulate the potential installation of private wells until MCLs have been achieved.

Recommendation 4

- EPA evaluated potential risk from non-potable water use by memorandum on June 8, 2015 (Appendix F), and concluded that irrigation with water is unlikely to have an unacceptable risk, as calculated based the conservative assumptions. Additionally, the location that the most elevated levels of Site contaminants have been detected are confined to an area in and around the eastern collection trench and immediately beyond in an area where there is no private well water use and where the terrain and land use preclude this from happening. As an additional precaution, EPA has been working with the Tyngsborough Board of Health to develop guidance and or advisories to regulate the potential installation of private wells until contamination levels have been reduced even further.

Recommendation 5

- MassDEP conducts stack testing every five years, in accordance with the Explanation of Significant Difference (ESD) for the Third ROD issued in September 1999 to the . The most recent test was conducted in January 2010. At the time of the most recent test, the thermal flare met the MassDEP emission limits set forth in the ROD. In order to document that the flare emissions testing will continue every five years, this was added to the Flare Inspection Checklist that is included in the O&M Plan.

Recommendation 6

- The continued monitoring of land use, groundwater quality, and soil gas have been continued to be conducted, showing that the vapor intrusion pathway is still incomplete. The continued monitoring of these have all been incorporated into the O&M Plan. Monitoring adjacent land use has been added to the semi-annual inspection report.

Remedy Implementation Activities

Table 3: Summary of Planned and/or Implemented ICs

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater and soil	Yes	Yes	Sitewide	Restrict certain site activities and groundwater use.	Notices of Activity and Use Limitations

System Operation/Operation and Maintenance Activities

Routine O&M activities have taken place since the last FYR. These routine activities are documented in the weekly checklists, weekly summaries, and the semi-annual Landfill/Security/Site Maintenance Inspection Checklist report. Examples of these are given in Appendix G. Over the last 2 years the eastern collection system has had a series of operational problems, including electrical, pump, and controls issues, which resulted in two of the three extraction pumps not being operational, resulting in a significant reduction in capacity since approximately April 2013 (weekly flow during the last week of March in 2013 of 116,904 gallons as compared to weekly flow during the last week of March 2015 of 12,642 gallons. MassDEP has stated that they have been working with their contractors to address the various issues and expects the recovery wells to be back on line in July 2015. The reduced capacity so far has not affected current protectiveness. While the weekly pump station logs that are printed out include pump run times for a given week, and show that two of the three eastern extraction wells had run for zero hours, the comment section of the logs that were reviewed did not include a description of a problem with these wells nor proposed corrective measures and timing. The semi-annual inspection report also did not include a reference to an issue with these extraction pumps, nor proposed corrective measures. EPA recommends that operational issues with all components of the remedy, including the eastern collection system, along with proposed corrective measures and timing be described in weekly logs as well as reported in the semi-annual inspection reports. An excerpt from the most recent quarterly report that is submitted to the Lowell Regional Wastewater Utility (LRWU) POTW is given in Appendix H. The flare stack test report is issued every five years in accordance with the ESD to the Third ROD, and the semi-annual perimeter soil gas monitoring report is included in the semi-annual report. The last flare stack test was conducted in January 2010. MassDEP has stated that the next flare stack test is due to be done in 2015. The 5-year stack testing schedule has been added as a line item on an updated flare stack inspection checklist that was incorporated into the recently updated O&M Plan.

The only noteworthy O&M issues during the FYR period has been a continuing issue with oxygen in the landfill gas being at levels too elevated to burn safely and oxidation on the flare stack. For the elevated oxygen issue, MassDEP evaluated the system and was unable to determine where leakage into the gas collection system may be occurring. They resolved the safety issue by discontinuing gas collection at the foot of the landfill which lowered the oxygen content of the collected gas to acceptably safe levels. Oxygen continues to be a problem and evaluations by the Army Corps of Engineers (conducting O&M for EPA) and DEP over the years have failed to determine an exact cause. The lower toe drain vents were shut off in order to reduce the potential for additional oxygen infiltration but it remains a problem. After completion of construction of the original flare by EPA (candlestick type), the Army Corps of Engineer (ACOE) contractor Tricil determined that not having an O_2 sensor was safety issue, and subsequently installed one. At that point the flare began shutting down due to O_2 after having run a few days. This problem persisted when MassDEP took over operations in approximately 1993. In approximately 1997, the flare was upgraded to the current enclosed flare and the ACOE looked into the O_2 infiltration issue and could not definitively identify the source. MassDEP subsequently conducted smoke tests and also ran a camera down the gas collection pipes looking for sources and none were identified. MassDEP also sealed other potential sources but again achieved no improvement. MassDEP decided to remove the gas vents nearest the toe drain since they were believed to be the most likely source of O_2 infiltration. This also did not result in any improvement, but MassDEP, in communication with EPA, left these off line just in case there was some value. Currently the flare runs for about 24 hrs before an alarm. Soil gas monitoring at the site boundary indicates methane is not migrating off site thus demonstrating that discontinuing the use of these soil gas collection points has not resulted in an issue. The condition of the flare stack will continue to be monitored.

III. FIVE-YEAR REVIEW PROCESS

Administrative Components

The PRP was notified of the initiation of the five-year review during a series of meetings to discuss the potential for a solar energy project beginning in Spring 2014. The Charles George Reclamation Trust Landfill Superfund Site Five-Year Review was led by Richard Fisher of the U.S. EPA, Remedial Project Manager for the Site. David Buckley, of the Massachusetts Department of Environmental Protection, assisted in the review as the representative for the support agency.

The review, which began on 12/16/2014, consisted of the following components:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection; and
- Five-Year Review Report Development and Review.

Community Notification and Involvement

A press release was issued stating that EPA conducts evaluations every five years on previously-completed clean up and remediation work performed at Superfund sites listed on the "National Priorities List" to determine whether the implemented remedies at the sites continue to be protective of human health and the environment. Further, five year review evaluations identify any deficiencies to the previous work and, if called for, recommend action(s) necessary to address them. The press release, including the start of the Charles George FYR, was issued on 1/5/2015, stated that there was a five-year review and invited the public to submit any comments to the U.S. EPA. Additionally, local government officials were contacted, including the local Board of Health agent, a representative of the Conservation Commission, and a representative from the Board of Selectmen. Several property owners with private wells were also engaged as part of the groundwater monitoring effort associated with the FYR. The results of the review and the report will be made available at the Site information repository located at the Tyngsborough Public Library, at the EPA Region I office at the OSRR Records and Information Center at (617) 918-1440, and on the EPA Region I web site.

Community involvement was high leading up to the issuance of ROD III and thereafter during construction. Construction completion was attained in 1998. Since the last five-year review in 2010, the only community concerns that have been voiced to the EPA, and subsequently addressed, were related to resident concerns about potential private well contamination and related to public official concerns about the potential impact of a solar energy development proposal. EPA has met with local officials and had given a representative a tour in June 2014 within the context of solar energy development proposals. Even though EPA advised that the current monitoring program has not shown any indication of Site-related contamination migrating to any private well locations, EPA collected samples from several private wells in the general area of the Site. None of these samples indicated contaminant levels above MCLs. Several residential property owners requested EPA investigate private well contamination to the north of Flint Pond, primarily because of what they referred to as salt contamination. Current monitoring data does not support this assertion, and EPA had determined that this is not Site related as described in a 1999 USGS report entitled Geophysical Surveys Near the Charles George Municipal Landfill and Flint Pond, Tyngsborough, MA.

Document Review

This five-year review consisted of a review of relevant documents including O&M records and monitoring data since the last FYR. These records included weekly checklists, weekly summaries, and the most recent semi-annual Landfill/Security/Site Maintenance Inspection Checklist report, some of which are given in Appendix G. The quarterly report that is submitted to the Lowell Regional Wastewater Utility (LRWU) POTW is given in Appendix H. The Site O&M Plan was updated since the last FYR to consolidate the number of separate documents that now comprise it (see Appendix G). The most recent flare stack test report, which is issued every five years, was issued in January 2010. MassDEP stated that the next test is due to be conducted later this year in 2015. The weekly pump station logs include pump run times for a given week, and show that two of the three eastern extraction wells had run for zero hours. The comment section of the logs that were reviewed did not include a description of a problem with these wells nor proposed corrective measures and timing. The semi-annual inspection report did not include a reference to an issue with these extraction pumps, nor proposed corrective measures. According to a MassDEP contractor review of the weekly pump station logs, these two of the three extraction pumps in the eastern collection trench may have been off line since potentially April 2013. MassDEP stated that the recovery wells would be back on line in July 2015. EPA recommends that operational issues with all components of the remedy, including the eastern collection system, along with proposed corrective measures and timing be described in weekly logs as well as reported in the semi-annual inspection reports. Applicable groundwater cleanup standards, as listed in the September 1988 ROD III, were reviewed for updates.

Data Review

<u>Summary:</u>

Additional groundwater data were collected from throughout, and adjacent to, the Site during the period since the last FYR during a monitoring event conducted in December 2014 through January 2015. Additionally, four private wells were sampled in the general vicinity of the site (one of which is immediately adjacent, but upgradient to, the Site). A review of the data did not show any COCs exceeding applicable cleanup standards in the private wells. In the last FYR, the vapor intrusion pathway was considered incomplete because potential off-site receptors were not present. It is still the case that potential off-site receptors are not present, and the only groundwater contaminant that resulted in a calculated indoor air value above an EPA regional screening level (RSL), benzene, was not detected in any of the wells during this past monitoring round. Therefore, a complete vapor intrusion pathway to potential off-site receptors is not present.

The data does show that contamination still exceeds cleanup standard for arsenic in, around, and immediately beyond the eastern collection trench (outside the site boundary), however, there are generally no increasing trends (an exception is a statistically indeterminate trend at one well, GEI-F2, that is in the eastern trench capture zone). Although the data shows that the arsenic contamination exists above the applicable standard (based on drinking water MCL) and at levels that could present risk based on a non-potable exposure route, beyond the site boundary to the east, it has only been detected within a limited area where there is no private well use. The monitoring program has included 1,4-dioxane despite it not being listed as a contaminant of concern (COC) in the ROD. Because it is not listed in the ROD, there is no ROD-listed performance standard for 1,4-dioxane. However, comparisons of the 1,4-dioxane monitoring data to a preliminary remedial goal (PRG) has shown exceedances at three wells on the east of the Site, two of which are located beyond the Site's eastern boundary in the same general area as the arsenic performance standard exceedances have been detected. Additionally, two other wells showed 1,4-dioxane PRG exceedances on the south side of the landfill. EPA has communicated with the Tyngsborough Board of Health regarding notification of EPA and MassDEP should any property owner apply for a well drilling permit downgradient of the eastern Site boundary, although this is a conservative precautionary measure since an interstate highway (Rte. 3) and the marshy terrain would likely preclude residential dwellings with private wells to the immediate east of the Site.

Surface water data were collected during two sampling events since the last FYR from a nearby intermittent stream at a location downgradient and outside the perimeter of the Site. The data were used to continue to evaluate ecological risk within the Dunstable Brook and Flint Pond. With this additional data, EPA has concluded that significant ecological impacts from the Site are unlikely in these water bodies and further monitoring is unnecessary.

Site Inspection

The inspection of the Site was conducted on 5/5/2015. In attendance were Richard Fisher, U.S. EPA; David Buckley of the Massachusetts Department of Environmental Protection (MassDEP), Mark Augustyniak, Project Manager of Watermark, and Brendan Lareau, Lead Technician of Watermark. The purpose of the inspection was to assess the protectiveness of the remedy. Watermark is currently under contract with MassDEP to conduct operations and maintenance (O&M) of the Site, including leachate/groundwater collection and treatment system. The treatment consists only of biocide and citric acid to keep iron in solution so that it does not impact system pipes. Watermark personnel participated in the inspection and responded to questions regarding the O&M at the Site. Watermark personnel are available 24 hours/day, 7 days a week, staff (one person) the facility twice per week, and conduct weekly inspections. The purpose of the inspection was to help assess the protectiveness of the remedy by observing the condition of the landfill topography, site fence, cover system (including vegetation), stormwater management, monitoring wells, and the treatment plant within the Site boundary - and changes in surrounding land use immediately beyond the Site boundary.

A Site Inspection Checklist Form was completed and is attached in Appendix C along with Site photographs taken during the inspection. The Site appeared secure and well-maintained, however, two of the three extraction pumps in the eastern collection trench were not functioning (WES-1 was functioning, while CDM-3 and PW-1A were not). The most recent weekly O&M report cited by Watermark staff that showed all three of these pumps working was a weekly report in April 2013. MassDEP stated that a series of electrical, pump, and controller issues were the reasons for these wells not functioning, and that this was discussed between the incoming (Watermark) and outgoing (Clean Harbors) contractors. MassDEP stated that the recovery wells would be back on line in July 2015. The following information is given to better define the scale of the issue. The flow rate for each of the pumps during April 2013 was given as: CDM-3, 0.5 gpm; WES-1, 1.6 gpm; and PW-1A, 8.8 gpm. The weekly flow for the last week of March 2013 was 116,904 gallons as compared to the weekly flow for the last week of March 2015 was 12,642 gallons. The weekly inspection checklist dated April 4, 2015 tabulated the weekly flow for these pumps as zero, however, this was not highlighted as a problem, nor was it described in the most recent semi-annual inspection report dated December 16, 2014. EPA recommends that operational issues with all components of the remedy, including the eastern collection system, along with proposed corrective measures and timing be described in weekly logs as well as reported in the semi-annual inspection reports. Additionally, Watermark staff stated during the FYR inspection process that the controller that allows for recording flow was not functioning between January 2 and January 5, 2015, but that this had since been resolved.

Other than these, no other significant issues were observed or described with Site conditions, operations, security, vegetation, or documentation (samples of O&M documentation are attached in Appendix G).

Interviews

During the FYR process, interviews were conducted with persons with an interest in the Site, including municipal officials (Kerri Oun, the Board of Health agent, and Kerri Oun, the Conservation Commission agent), David Buckley, the MassDEP project manager, and the MassDEP contractor conducting O&M at the Site. Representatives from the Board of Selectmen were contacted and given the opportunity to comment. The purpose of the interviews was to document any perceived problems or successes with the remedy that has been implemented to date. Interviews were conducted primarily by email, occasionally supplemented by phone calls, between December 2014 and April 2015. Interviews are summarized below and complete interviews are included in Appendix D. Additionally, unofficial interviews (i.e., conversations) were conducted with several Tyngsborough citizens who approached EPA staff during the December 2014-January 2015 groundwater monitoring event because of concerns of private well contamination. Dialogue has been ongoing with Town officials regarding potential solar development projects. These are both discussed above in the Community Involvement section.

The actual interview process resulted in mostly positive feedback, or nothing to comment on. The Board of Health agent would like to be better informed regarding Site operations, specifically changes that may occur. She provided assistance in reaching out to private well owners in the vicinity so that EPA was able to collect samples from their wells as a conservative precautionary measure. She has also been involved with ongoing discussions regarding potential private well installation guidelines or restrictions in the area. The Conservation Commission Directors commented on low pH in the discharge, however, based on follow-up discussion, it was determined that he was referring to a different permitted entity, with a NPDES stormwater permit, some distance away.

IV. TECHNICAL ASSESSMENT

Question A: Is the remedy functioning as intended by the decision documents?

No. The review of documents, data, Applicable or Relevant and Appropriate Requirements (ARARs), and risk assumptions indicate that the remedy continues to be protective of human health and the environment since impacted groundwater is not currently used, and access to the Site is fenced and secured, and the landfill is capped. Public water is available where groundwater is, or has been, impacted in the surrounding area. However, since two of the three extraction wells in the eastern collection trench have not been operating due to maintenance and repair work since potentially April 2013, the objective of reducing off-site migration of contaminated leachate appears to have been compromised. Groundwater extraction and treatment is ongoing and continues to be needed, since groundwater contaminant concentrations still exceed Performance Standards in some monitoring wells, primarily in perimeter wells on the southwest and east boundaries of the landfill, as well as beyond the eastern boundary. The landfill parcels are owned by entities related to the Charles George companies and access is restricted.

The ICs identified in the ROD and as agreed upon by the PRPs in the CD have not yet been implemented to restrict certain uses and maintain the integrity of the remedy at the Site. These will consist of Notices of Activity and Use Limitations (NAULs) and are expected to be implemented by the end of 2015. In addition, EPA and the Town of Tyngsborough are discussing institutional controls to control and regulate the installation and use of private water wells near the Site as a conservative measure. This would be considered a conservative precautionary measure since an interstate highway (Rte. 3) and the marshy terrain would likely preclude residential dwellings with private wells to the immediate east of the Site. EPA has ongoing discussions with the Tyngsborough Board of Health (BOH) regarding a policy that would have EPA and MASSDEP consulted prior to installation of any private wells within a designated “well installation review zone” so that a proper evaluation can be conducted in order to accomplish this.

Although the cleanup levels for one ROD-listed COC (arsenic) continue to be exceeded in the landfill area, and are likely to do so for the foreseeable future, the monitoring data indicates that the contamination has generally diminished over the past twenty years of monitoring. This has not been on a continuously declining trend, for example the level of 1,4-dioxane has increased since the last monitoring event five years ago by 214%, however, this may be a result of the eastern collection system not being fully operational. However, this off-site migration appears to be contained within an area where there is not private well use, nor is any anticipated due to surrounding land use and terrain (an interstate highway and a marsh which would both likely preclude development). It should also be noted that 1,4-dioxane levels detected in two wells on the southwest side also increased during the same time period by 90% and 140% respectively.

Figures and tables showing arsenic and 1,4-dioxane concentration spatial and temporal distribution are shown in Table 6 and Figures 1 and 2. Groundwater flow direction can be seen in the figures in Appendix B. All other groundwater cleanup goals are regularly achieved. Therefore, the remedial action continues to be protective.

Table 4: Summary of Inorganic Exceedances

Year	Sampling Event	Total # of Wells with Exceedances	Extraction Area	# of Wells with Exceedances	List of Wells Sampled by Event	Analytes in Exceedance of Standards* (number in column denotes analyte identity, as specified in footnote)
1994	April	8	East	4	E&E FIT2	8
					GEI-F2	8
					MW-5	8
					MW-5A	8,15
			Southwest	3	GEI-11	14
					MW-9	15
					MW-9A	8
			Upgradient	1	MW-1A	14
	November	5	East	4	E&E FIT2	8
					GEI-F2	8,11
					MW-5	8
					MW-5A	8
			Southwest	1	MW-9	8
1995	April	5	East	4	E&E FIT2	8

Year	Sampling Event	Total # of Wells with Exceedances	Extraction Area	# of Wells with Exceedances	List of Wells Sampled by Event	Analytes in Exceedance of Standards* (number in column denotes analyte identity, as specified in footnote)
					GEI-F2	8
					MW-5	8
					MW-5A	8
			Southwest	1	MW-9A	8
	October	8	East	6	CDM-4	8, 10, 12, 13, 15
					E&E FIT2	8
					GEI-F2	8
					MW-5	8
					MW-5A	8
					MW-6	9, 13, 14
			Southwest	2	MW-9	15
					MW-9A	8
1996	April	8	East	5	CDM-5S	8
					E&E FIT2	8
					GEI-F2	8
					MW-5	8
					MW-5A	8
			Southwest	2	MW-9	15
					MW-9A	8
			Upgradient	1	MW-1A	15
1999	April	6	East	5	CDM-5S	8
					E&E FIT2	8
					GEI-F2	8
					MW-5	8,15
					MW-5A	8
			Southwest	1	MW-9A	8
	October	6	East	5	CDM-5S	8
					E&E FIT2	8,14
					GEI-F2	8
					MW-5	8

Year	Sampling Event	Total # of Wells with Exceedances	Extraction Area	# of Wells with Exceedances	List of Wells Sampled by Event	Analytes in Exceedance of Standards* (number in column denotes analyte identity, as specified in footnote)
					MW-5A	8
			Southwest	1	MW-9A	8
2000	April	11	East	7	CDM-5S	8
					E&E FIT2	8
					GEI-F2	8, 15
					GWC-1	8, 10, 13
					JSB-1	15
					MW-5	8
					MW-5A	8, 14
			Southwest	2	MW-9	15
					MW-9A	8, 15
			Upgradient	2	MW-1	15
					MW-1A	15
	October	13	East	9	CDM-4	15
					CDM-5B	15
					CDM-5S	8, 15
					E&E FIT2	8, 15
					GEI-F2	8, 15
					GWC-1	8, 15
					JSB-1	15
					MW-5	8, 15
					MW-5A	8, 15
			Southwest	4	BF-11	15
					GEI-11	15
					MW-9	15
					MW-9A	8,15
2001	April	7	East	5	MW-5	8, 15
					GEI-F2	8, 12
					MW-5A	8, 15
					E&E FIT2	8
					CDM-5S	8
			Southwest	2	MW-8A	8

Year	Sampling Event	Total # of Wells with Exceedances	Extraction Area	# of Wells with Exceedances	List of Wells Sampled by Event	Analytes in Exceedance of Standards* (number in column denotes analyte identity, as specified in footnote)
					BF-10	11
2006	June	11	East	8	CDM-3	8
					CDM-5S	8
					E&E FIT2	8
					GEI-F2	8, 12
					MW-5	8
					MW-5A	8
					PW-1A	8
					WES-1	8
			Southwest	3	BF-10	8
					MW-8	8
					MW-8A	8
2009	December	12	East	8	CDM-3	8
					CDM-5S	8
					E&E FIT2	8
					GEI-F2	8, 12
					MW-5	8
					MW-5A	8
					PW-1A	8
					WES-1	8
			Southwest	4	BF-10	8
					MW-8	8
					MW-8A	8
					MW-9A	8
2014 thru 2015	Dec-14 thru Apr-15	18	East	5	MW-5	8
					GEI-F2	8
					MW-5A	8
					E&E FIT2	8
					CDM-5S	8

* List of Analytes:
8. Arsenic 10. Chromium 12. Lead 14. Silver 16. Antimony

9. Cadmium 11. Cyanide 13. Nickel 15. Thallium 17. Selenium

Table 5: Summary of VOC Exceedances

Year	Sampling Event	Total # of Wells with Exceedances	Extraction Area	# of Wells with Exceedances	List of Wells Sampled by Event	Analytes in Exceedance of Standards* (number in column denotes analyte identity, as specified in footnote)
1994	April	4	East	4	E&E FIT2	1
					GEI-F2	1
					JSB-1	1, 6
					MW-5	1
	November	8	East	5	E&E FIT2	1, 3, 4
					GEI-F2	1, 3
					GWC-2	4
					MW-5	1, 4
					MW-6	4
			Southwest	3	GWC-2	4
					MW-8	4
					MW-8A	4

Year	Sampling Event	Total # of Wells with Exceedances	Extraction Area	# of Wells with Exceedances	List of Wells Sampled by Event	Analytes in Exceedance of Standards* (number in column denotes analyte identity, as specified in footnote)
1995	April	4	East	4	E&E FIT2 GEI-F2 JSB-1 MW-5	1, 3 1, 3 3, 6 1
	October	4	East	4	CDM-4 E&E FIT2 GEI-F2 MW-5	3, 6, 9 1, 3 1, 3 1
1996	April	9	East	7	CDM-5B CDM-5S E&E FIT2 GEI-F2 JSB-1 MW-5 MW-5A	4 1, 3, 4, 5 1, 1, 3 4 1, 4 4
			Southwest	2	BF-10 SW-1	4 2
1999	April	2	East	2	CDM-5S GEI-F2	1 1, 3
	October	2	East	2	CDM-5S GEI-F2	1 1, 3
2000	April	3	East	3	CDM-5S GEI-F2 GWC-1	1 1, 7 1
	October	2	East	2	CDM-5S GEI-F2	1 3
2001	April	2	East	2	GEI-F2 CDM-5S	1, 3, 7 1
2006	June	1	East	1	CDM-3	1
2009	December	1	East	1	PW-1A	1

Year	Sampling Event	Total # of Wells with Exceedances	Extraction Area	# of Wells with Exceedances	List of Wells Sampled by Event	Analytes in Exceedance of Standards* (number in column denotes analyte identity, as specified in footnote)
2014-2015	Dec 2014 thru Apr 2015	5	East	3	JSB-1	8
					MW-5	8
					CDM-5S	8
			Southwest	2	MW-8	8
					MW-9	8

Notes:

* List of Analytes:

1. Benzene
2. Chlorobenzene
3. 1,2-Dichloroethane
4. Methylene Chloride
5. 1,1,2-Trichloroethane
6. Trichloroethene
7. Vinyl Chloride
8. 1,4-Dioxane

VOC - Volatile organic compounds

Table 6– Arsenic and 1,4-Dioxane Spatial and Temporal Distribution

Upgradient

Contaminant	MCL µg/l	PRGs µg/l	MW-1 4/16/94	MW-1 11/30/94	MW-1 4/18/95	MW-1 10/09/96	MW-1 4/23/96	MW-1 4/27/99	MW-1 10/18/99	MW-1 10/18/99	MW-1 4/26/00	MW-1 10/23/00	MW-1 4/6/01	MW-1 6/5/06	MW-1 12/4/09	MW-1 12/10/14
1,4-Dioxane	--	6.7	50 U	200 U	100 U	100 U	100 U	R			100 U	100 U	100 U	2.0 U	2.0 U	NS
Arsenic	10		4 U	1.7 U	1.8 U	2.1 U	7 J	5	2.2 U	2.2 U	2 U	7.6	2.3 U	1 U	0.3 J	ND

Southwest

Contaminant	MCL µg/l	PRGs µg/l	MW-8 4/16/94	MW-8 11/30/94	MW-8 4/18/95	MW-8 10/9/95	MW-8 4/23/96	MW-8 4/29/99	MW-8 10/19/99	MW-8 4/27/00	MW-8 10/25/00	MW-8 4/4/01	MW-8 6/6/06	MW-8 12/1/09	MW-8 12/9/2014
1,4-Dioxane	--	6.7	370	1900	1300	100 J	1300	68	45	520 J	640	310	370	200	**380**
Arsenic	10	-	42	19.5	10.6	29.7	38	14	9.8	24.8	25.9	22.3	14.3 J	18	ND

Contaminant	MCL µg/l	PRGs µg/l	MW-9 12/4/09	MW-9 12/16/14
1,4-Dioxane	--	6.7	12.0	**29**
Arsenic	10	-	1.4	ND

Contaminant	MCL µg/l	PRGs µg/l	MW-11 10/25/00	MW-11 12/3/09	MW-11 1/5/15
1,4-Dioxane	--	6.7	73 J	2.0 U	ND
Arsenic	10	-	7.4 U	1.4	ND

Contaminant	MCL µg/l	PRGs µg/l	BF-10 4/16/94	BF-10 4/30/94	BF-10 11/30/94	BF-10 4/18/95	BF-10 10/9/95	BF-10 4/18/96	BF-10 4/29/99	BF-10 10/20/99	BF-10 4/25/00	BF-10 10/24/00	BF-10 4/4/01	BF-10 6/5/06	BF-10 12/3/09	BF-10 12/11/14
1,4-Dioxane	--	6.7	200 U	100 U	200 U	100 U	100 U	100 U	50 U	50 U	100 U	100 U	100 U	1.6 J	8.7	NS
Arsenic	10	-	10.8	3.2 J		4.4 U	14.3	6.7 J	8	3.8	27.6	19.7	14.7	11.3 J	10.9	ND

Contaminant	MCL µg/l	PRGs µg/l	MW-9A 11/30/94	MW-9A 12/7/09	MW-9A 12/16/14
1,4-Dioxane	--	6.7	200 U	1.4 J	ND
Arsenic	10	-	8.3 B	10.4	ND

East

Contaminant	MCL µg/l	PRGs µg/l	MW-5 04/16/94	MW-5 11/30/94	MW-5 04/18/95	MW-5 10/09/95	MW-5 04/23/96	MW-5 4/27/99	MW-5 10/18/99	MW-5 4/25/00	MW-5 10/23/00	MW-5 4/4/01	MW-5 6/7/06	MW-5 12/3/09	MW-5 12/9/14
1,4-Dioxane	--	6.7	96	220	190	44 J	140	50 U	50 J	76 J	100 U	10 U	28	27.0 J	**23**
Arsenic	10		161	264	251	266	201	112	92.6	103		91.7	61.3 J	133.0	**130**

Contaminant	MCL µg/l	PRGs µg/l	GEI-F2 04/16/94	GEI-F2 11/30/94	GEI-F2 04/18/95	GEI-F2 10/09/95	GEI-F2 04/23/96	GEI-F2 4/28/99	GEI-F2 10/19/99	GEI-F2 04/25/00	GEI-F2 10/23/00	GEI-F2 4/4/01	GEI-F2 6/6/06	GEI-F2 12/3/09	GEI-F2 12/11/14
1,4-Dioxane	--	6.7	240	1100	590	450 J	180	16 J	20 J	59 J	130	150	140	66	NS
Arsenic	10		100	198	200	188	154	89	80.6	99.4		111	196 J	339	**230.0**

Contaminant	MCL µg/l	PRGs µg/l	JSB-1 04/16/94	JSB-1 04/18/95	JSB-1 10/09/95	JSB-1 04/23/96	JSB-1 4/30/99	JSB-1 10/20/99	JSB-1 04/26/00	JSB-1 10/27/00	JSB-1 4/4/01	JSB-1 6/8/06	JSB-1 12/1/09	JSB-1 3/17/15
1,4-Dioxane	--	6.7	110	180	3000 J	170	3 J	6 J	77 J	100 U	100 U	11	37.0	**61**
Arsenic	10		28.9	4.3 U	3.5 J	8.4 J	9.2	2.2 U	3.5 B		3.1	3 J	1.4	ND

Contaminant	MCL µg/l	PRGs µg/l	MW-12 12/7/09	MW-12 12/8/14
1,4-Dioxane	--	6.7	1.1 J	NS
Arsenic	10		1.8	ND

Contaminant	MCL µg/l	PRGs µg/l	MW-4 3/19/15
1,4-Dioxane	--	6.7	ND
Arsenic	10		ND

Contaminant	MCL µg/l	PRGs µg/l	CDM-6D 4/14/15
1,4-Dioxane	--	6.7	3.4
Arsenic	10		ND

Contaminant	MCL µg/l	PRGs µg/l	CDM-4 4/16/94	CDM-4 4/18/95	CDM-4 10/9/95	CDM-4 04/23/96	CDM-4 4/30/99	CDM-4 10/20/99	CDM-4 4/26/00	CDM-4 4/2/01	CDM-4 6/8/06	CDM-4 12/1/09	CDM-4 3/17/15

Contaminant	MCL µg/l	PRGs µg/l											
1,4-Dioxane	--	6.7	50 U	100 U	180 J	50 U	50 U	100 U	94 J	100.0 U	2.0 U	2 U	ND
Arsenic	10		17.8	2.7 J	250	5 U	4.2	2.2 U	2 U	2.3 U	0.53 J	0.36 J	ND

Contaminant	MCL µg/l	PRGs µg/l	MW-5A 4/16/94	MW-5A 11/30/94	MW-5A 4/18/95	MW-5A 10/9/95	MW-5A 4/23/96	MW-5A 4/27/99	MW-5A 10/19/99	MW-5A 4/25/00	MW-5A 10/23/00	MW-5A 4/2/01	MW-5A 6/7/06	MW-5A 11/30/09	MW-5A 12/8/14
1,4-Dioxane	--	6.7	59	200 U	100 U	100 U	100 U	50 U	50 U	100 U	100 U	100 U	4.5	2.4	NS
Arsenic	10		147	172	138	100	118	131	127	116		116	129 J	109	**68**

Contaminant	MCL µg/l	PRGs µg/l	CDM-6S 4/14/15
1,4-Dioxane	--	6.7	ND
Arsenic	10		ND

Contaminant	MCL µg/l	PRGs µg/l	MW-4B 3/19/15
1,4-Dioxane	--	6.7	ND
Arsenic	10		ND

Contaminant	MCL µg/l	PRGs µg/l	E&E FIT2 4/16/94	E&E FIT2 11/30/94	E&E FIT2 4/18/95	E&E FIT2 10/9/95	E&E FIT2 4/23/96	E&E FIT2 4/28/99	E&E FIT2 10/19/99	E&FIT2 4/24/00	E&E FIT2 10/23/00	E&FIT 2 4/2/01	E&E FIT2 6/6/06	E&E-FIT2 12/3/09	E&E FIT2 12/10/14
1,4-Dioxane	--	6.7	230	1000	1600	3300 J	1300	50 U	5 J	100 U	100 U	100 U	540	180	NS
Arsenic	10		248	178	161	174	151	81	93.3	55.4		71.6	89.1 J	33.4	**48**

Contaminant	MCL µg/l	PRGs µg/l	CDM-5S 4/24/96	CDM-5S DUP 4/24/96	CDM-5S 4/29/99	CDM-5S 10/21/99	CDM-5S 4/22/00	CDM-5S 4/4/01	CDM-5S 10/26/00	CDM-5S 6/7/06	CDM-5S 12/2/09	CDM-5S 1/6/15
1,4-Dioxane	--	6.7	1300 E	1500 E	6 J	15 J	570	400	540	440	210	**660**
Arsenic	10		330	327	301	272	318	297		289 J	370	**260**

Contaminant	MCL µg/l	PRGs µg/l	CDM-6D 04/18/95	CDM-6D 4/14/15
1,4-Dioxane	--	6.7	100 U	3.4
Arsenic	10		2.7	ND

Notes:
µg/l - micrograms per liter.
NP: Not reported by the laboratory.
NS: Not analyzed during this sampling event.
J: Estimated value; below quantitation limit.
DUP: Field duplicate sample
Values shown in Underlined and Bold type equal or exceed one or more of MCL and GW criteria.
MCL: Maximum contaminant Level, EPA 816-F-03-016 June 2003.
PRGs: Preliminary Remediation Goals, Region 9, October 2004.

U: Compound was not detected at specified quantitation limit.
UJ - Estimated non-detect.

Figure 1. Groundwater Monitoring Well Locations

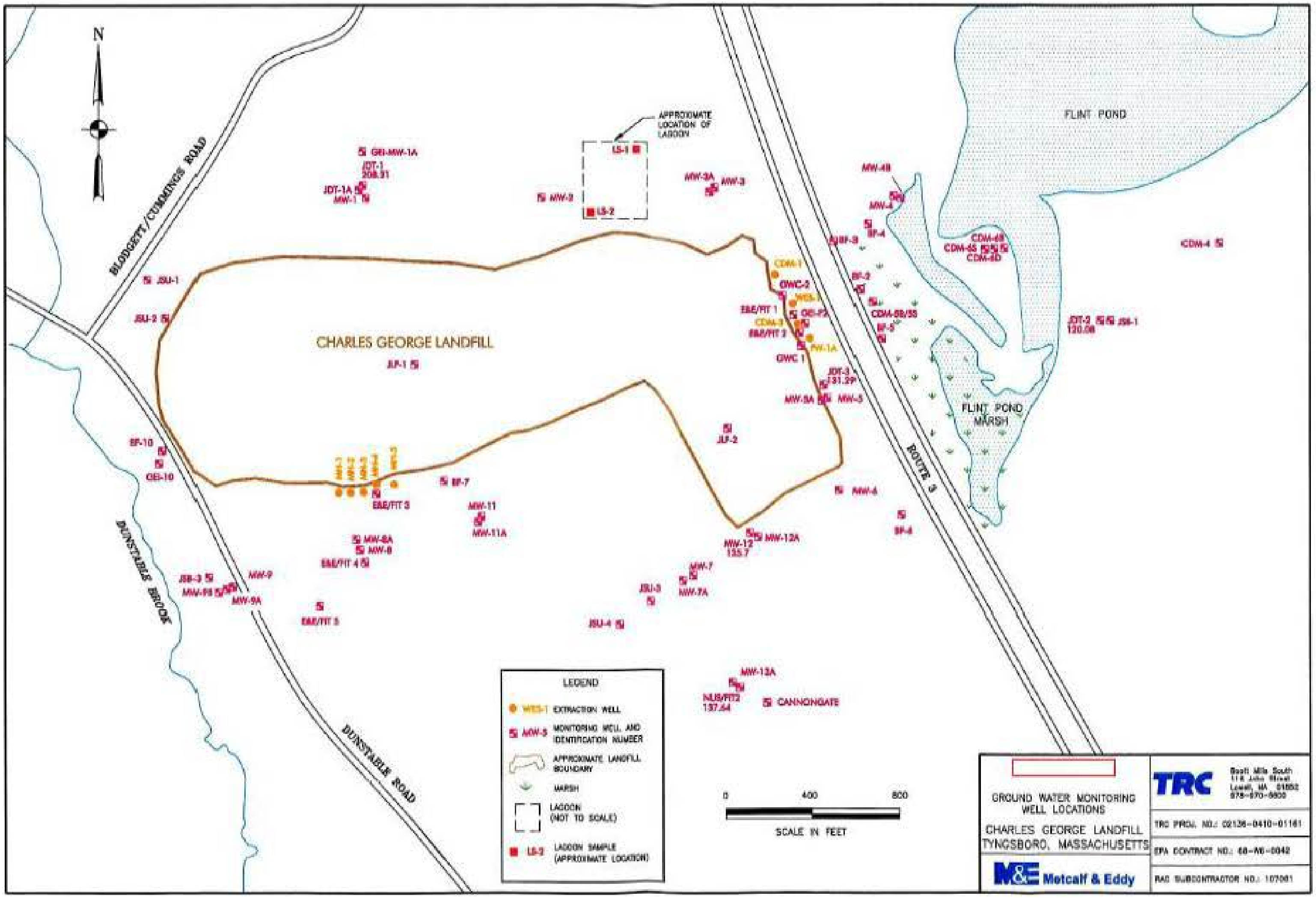


Figure 2. Groundwater Monitoring Well Locations – Aerial Photo

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy section still valid?

Yes. Table 7 presents the differences in toxicity values that have occurred since the remedy was selected in 1988 and since the 2010 Five Year review. Although many changes have occurred since the 1988 ROD, none of these changes appear to affect the protectiveness of the selected remedy because the groundwater is not being used for drinking purposes. The noted changes are underlined in Table 7. An underlined value means that the current value did not exist in 1988 or that the current value is more stringent than either the 1988 value or the 2010 value.

As noted in previous FYRs, since the cleanup levels were established for groundwater, the MCL for arsenic has decreased from 50 µg/l to 10 µg/l, while 1,4-dioxane was not listed as a COC in the ROD. However, these two contaminants will continue to be evaluated relative to current ARARs or PRGs (based on 1 x 10^{-5} excess cancer risk for 1,4-dioxane) since they are being detected beyond the eastern Site boundary.

Table 7. Comparison of 1988, 2010, and 2015 Toxicity Factors for Chemicals of Concern

Chemical of Concern	Oral Reference Dose (RfD) (mg/kg-day)			Oral Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$		
	1988	2010	2015	1988	2010	2015
2- Butanone	0.05	0.6	0.6	N/A	N/A	N/A
Benzoic Acid	N/A	4	4	N/A	N/A	N/A
Di-n-butylphthalate	0.1	0.1	0.1	N/A	N/A	N/A
4-Methylphenol (p-Cresol)	N/A	0.005	0.1	N/A	N/A	N/A
trans-1, 2-Dichloroethene	N/A	0.02	0.02	N/A	N/A	N/A
Toluene	0.29	0.08	0.08	N/A	N/A	N/A
Arsenic (a)	N/A	0.003	0.003	1.5	1.5	1.5
Benzene	N/A	0.004	0.004	0.052	0.055	0.055
Cadmium (food)	0.00029	0.001	0.001	N/A	N/A	N/A
Cadmium (water)	0.00029	0.0005	0.0005	N/A	N/A	N/A
Chromium (as VI)	0.005	0.003	0.003	N/A	N/A	0.5
Mercury (as salts)	0.002	0.003	0.0003	N/A	N/A	N/A
Benzo(a)anthracene (b)	N/A	N/A	N/A	11.5	0.73	0.73
Chrysene (b)	N/A	N/A	N/A	11.5	0.0073	0.0073
Benzo(b)fluoranthene (b)	N/A	N/A	N/A	11.5	0.73	0.73
Benzo(a)pyrene (b)	N/A	N/A	N/A	11.5	7.3	7.3
Indeno (1, 2, 3-c,d)pyrene (b)	N/A	N/A	N/A	11.5	0.73	0.73
Dibenz(a, h)anthracene (b)	N/A	N/A	N/A	11.5	7.3	7.3
Trichloroethene	N/A	N/A	0.0005	0.011	0.0059	0.046
bis(2-ethylhexyl)phthalate	0.02	0.02	0.02	0.00068	0.014	0.014
Methylene chloride	N/A	0.06	0.006	0.0143	0.0075	0.002
1, 2-Dichloroethane	N/A	0.02	0.006	0.035	0.091	0.091
Chloroform	N/A	0.01	0.01	0.081	0.031	0.031
1, 1-Dichloroethene	N/A	0.05	0.05	1.16	N/A	N/A
1, 1, 2, 2-Tetrachloroethane	N/A	0.004	0.02	0.2	0.2	0.2
Vinyl chloride	N/A	0.003	0.003	0.025	0.72	0.72
Carbon tetrachloride	N/A	0.0007	0.004	0.13	0.13	0.07
1, 1, 2-Trichloroethane	N/A	0.004	0.004	0.0573	0.057	0.057
Tetrachloroethene	N/A	0.01	0.006	0.0017	0.13	0.0021
Chlorobenzene	0.0057	0.02	0.02	N/A	N/A	N/A
Xylenes	0.2	0.2	0.2	N/A	N/A	N/A
Bromomethane	0.0004	0.0014	0.0014	N/A	N/A	N/A
Bromoform	0.02	0.02	0.02	N/A	0.0079	0.0079
Carbon disulfide	0.1	0.1	0.1	N/A	N/A	N/A
1, 4-Dioxane	N/A	N/A	0.03	N/A	N/A	0.1

1, 4-Dioxane was not an original contaminant of concern.

(a) Arsenic oral slope factor used in 1998 sediment reassessment was 1.75 $(mg/kg\text{-}day)^{-1}$.

(b) Oral slope factor (2005) for this compound is the same as that used for the 1998 sediment reassessment.

Underlined values either did not have values in 1988 or are more stringent than 1988 or 2010 values.

N/A = Not Available

The following guidance and risk assessment methodology recommendations have been issued since the last Five Year review. None of these affect the protectiveness of the selected remedy because the groundwater is not being used for drinking purposes.

- 2014 OSWER Directive Determining Groundwater Exposure Point Concentrations, Supplemental Guidance

In 2014, EPA finalized a Directive to determine groundwater exposure point concentrations (EPCs) http://www.epa.gov/oswer/riskassessment/pdf/superfund-hh-exposure/OSWER-Directive-9283-1-42-GWEPC-2014.pdf. This Directive provides recommendations to develop groundwater EPCs. The recommendations to calculate the 95% UCL of the arithmetic mean concentration for each contaminant from wells within the core/center of the plume, using the statistical software ProUCL could result in lower groundwater EPCs than the maximum concentrations routinely used for EPCs as past practice in risk assessment, leading to changes in groundwater risk screening and evaluation. In general this approach could result in slightly lower risk or lower screening levels. (Reference: USEPA. 2014. Determining Groundwater Exposure Point Concentrations. OSWER Directive 9283.1-42. February 2014.)

- 2014 OSWER Directive on the Update of Standard Default Exposure Factors

In 2014, EPA finalized a Directive to update standard default exposure factors and frequently asked questions associated with these updates. http://www.epa.gov/oswer/riskassessment/superfund_hh_exposure.htm (items # 22 and #23 of this web link). Many of these exposure factors differ from those used in the risk assessment(s) supporting the ROD(s). These changes in general would result in a slight decrease of the risk estimates for most chemicals. (Reference: USEPA. 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February 6, 2014.)

- 2012 OSWER Directive on Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil

Based on a compilation and review of data on relative bioavailability of arsenic in soil in 2012, arsenic was found to be less bioavailable via soil ingestion relative to other analytes. A default value of relative bioavailability (RBA) of 60% is now applied during soil/sediment ingestion calculations of risk/cleanup levels. This default RBA value reduces arsenic contribution to risk and/or increases arsenic cleanup levels. (Reference: USEPA. 2012. Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil and Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil Documents. OSWER Directive 9200.1-113. December 31, 2012.)

- Most current RSLs tables

Updated twice/year. Use most up-to-date tables as available at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/

- Most current VISLs tables

Updated periodically. Use most up-to-date tables as available at http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6

New IRIS toxicity values since 2010 for Site-related contaminants of concern include:

- **2010 1,4-dioxane** non-cancer toxicity value and 2013 cancer toxicity values

In 2010 and 2013, EPA finalized the toxicity assessment for 1,4-dioxane. The new values indicate that 1,4-dioxane is more toxic from both cancer and non-cancer health effects. These toxicity changes would result in increased non-cancer hazard and cancer risk from exposure to 1,4-dioxane.

- **2011 Methylene Chloride** cancer and non-cancer toxicity values

On November 18, 2011, EPA finalized the toxicity assessment for methylene chloride. The new values indicate that methylene chloride is more toxic from non-cancer health effects but less toxic from cancer health effects. These toxicity changes would result in an increased non-cancer hazard and a decreased cancer risk from exposure to methylene chloride.

- **2011 TCE** cancer and non-cancer toxicity values

On September 28, 2011, EPA finalized the December 2009 revised toxicity values for TCE. The new values indicate that TCE is more toxic from both cancer and non-cancer health effects. These toxicity changes would result in increased non-cancer hazard and cancer risk from exposure to TCE.

- **2012 PCE** cancer and non-cancer toxicity values

On February 10, 2012, EPA finalized the cancer and non-cancer toxicity values for PCE. These new values indicate that PCE is now more toxic from cancer health effects but less toxic from non-cancer hazard effects. Although cancer risks and non-cancer hazards from these contaminants may change due to the changes in toxicity values. These toxicity changes would result in an increased cancer risk and a decreased non-cancer hazard from exposure to PCE.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No new information has come to light that calls into question the protectiveness of the remedy, although the continued monitoring of the extent of arsenic and 1,4-dioxane contamination is warranted despite not being accounted for in the ROD at current performance standards. Because the MCL for arsenic has decreased from 50 µg/l to 10 µg/l since the cleanup levels were originally established, this has resulted in the need for continued scrutiny of arsenic levels beyond the eastern Site boundary.

The action-specific ARARs applicable to the landfill covering post-closure care have not changed. The federal RCRA regulations in 40 CMR Part 264 and the companion state regulations in 310 CMR 30.633 remain applicable to long-term post-closure care and groundwater monitoring.

Technical Assessment Summary

Based on the aforementioned, the remedy has progressed as expected in that the Site remains secure, contamination has been reduced Site wide and is limited to an area (primarily on site, and to the east) where exposure is not occurring. The extent of 1,4-dioxane and arsenic contamination in groundwater will continue to be monitored. The eastern collection system will be brought back on line, and it is recommended that it may be subjected to an optimization study. Additionally, the O&M inspection process should be made more robust such that malfunctioning recovery wells are adequately reported on and addressed in a timely manner. Protectiveness will be enhanced by these actions, as well as through ICs that are expected to be formalized by the end of 2015.

V. ISSUES/RECONENDATIONS AND FOLLOW-UP ACTIONS

Table 8: Issues and Recommendations/Follow-up Actions

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
Sitewide	Institutional Controls	EPA to assist PRPs implementing Notices of Activity and Use Limitations (NAULs) and EPA to provide guidance to BOH regarding guidelines for off-site well installations.	EPA	EPA	12/31/2015	No	Yes
OU3	Extent of arsenic and 1,4-dioxane contamination.	Continue to monitor the extent of these contaminants (note that 1,4-dioxane is not listed in the ROD).	EPA	EPA	5/1/2020	No	Yes

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
OU3/OU4	Eastern collection trench groundwater extraction system.	The eastern collection system must be brought back on line as soon as possible. The system should also be subjected to an optimization study to ensure that off-site migration of groundwater contamination is minimized as much as is possible	DEP	EPA	12/31/16	No	Yes

VI. PROTECTIVENESS STATEMENT

<table>
<tr><th colspan="3">Protectiveness Statement(s)</th></tr>
<tr><td>Operable Unit:
OU1</td><td>Protectiveness Determination:
Short-term Protective</td><td>Addendum Due Date (if applicable):
Click here to enter a date.</td></tr>
<tr><td colspan="3">Protectiveness Statement:
OU1 refers to the provision of an alternate water supply for areas originally found to have been affected by the groundwater contaminant plume originating from the site. The remedy for OU1 currently protects human health and the environment because all areas known to have been impacted by contaminated groundwater have received an alternative water supply under OU1 (the original alternative supply) or OU3/OU4 (extensions to the original water supply lines). However, in order for this portion of the remedy to be protective in the long term, follow-up actions need to be taken. Specifically, institutional controls should be placed in the vicinity of the Site that would prevent or regulate both potable and non-potable uses, if warranted, of potentially impacted groundwater. The Town of Tyngsborough currently prevents potable use by not allowing installation of drinking water wells in areas that have access to public drinking water. However, additional institutional controls may be necessary to attain broader protectiveness in the long-term. These could include ordinances prohibiting, or advisories discouraging, installation of potable and non-potable water supply wells within the vicinity of the Site, regardless of the availability of a public water supply.</td></tr>
<tr><td>Operable Unit:
OU2</td><td>Protectiveness Determination:
Short-term Protective</td><td>Addendum Due Date (if applicable):
Click here to enter a date.</td></tr>
<tr><td colspan="3">Protectiveness Statement:
OU2 addresses source control to reduce off-site migration of contaminants (i.e., capping of the landfill and collection of leachate and landfill gas). This operable unit also includes the remedial action objective of “abating additional impact to surrounding surface waters and wetlands.” This portion of the remedy is protective in the short-term; however, in order for this portion of the remedy to be protective in the long term, follow-up actions need to be taken. Although access to the landfill is currently strictly controlled by MassDEP, formal institutional controls are needed to prevent future disturbance of the cap. The Settling Defendant is required to implement these onsite controls under a Consent Decree with EPA.</td></tr>
<tr><td>Operable Unit:
OU3/OU4</td><td>Protectiveness Determination:
Short-term Protective</td><td>Addendum Due Date (if applicable):
Click here to enter a date.</td></tr>
</table>

Protectiveness Statement:
OU3 focuses on containing contaminated groundwater migration and treating contaminated groundwater, and OU4 addresses collection and treatment of leachate. The protectiveness of these remedies are presented together since contaminated groundwater and leachate are considered together in ROD III, and are treated together in a combined groundwater/leachate collection system that discharges to the LRWU. The remedies for OU3 and OU4 are protective in the short-term; however, in order for this portion of the remedy to be protective in the long-term, follow-up actions need to be taken. The eastern collection system must be brought back on line as soon as possible. The system should also be subjected to an optimization study to ensure that off-site migration of groundwater contamination is minimized as much as is possible. The ROD specifies that long-term protectiveness will be achieved once groundwater and leachate contaminant concentrations drop below MCLs. In the interim, institutional controls are needed to prevent exposure to these contaminated media. In the past, the Town of Tyngsborough prevented installation of drinking water wells in areas that have access to public water. However, additional institutional controls may be necessary to attain broader protectiveness in the long-term. Specifically, this may require formalizing the moratorium on well construction where municipal water is available, and include advisories discouraging or guidelines involved with installation of potable and non-potable water supply wells within the vicinity of the Site, regardless of the availability of a public water supply. In addition, the Settling Defendant in the Consent Decree, entered in 2003 with EPA, is required to implement onsite institutional controls to maintain protectiveness in the long-term for contaminated leachate.

Sitewide Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Addendum Due Date (if applicable):* Click here to enter a date.

Protectiveness Statement:
Because the remedial actions of all operable units are protective in the short-term, the remedy is currently protective of human health and the environment. However, in order for the remedy to be protective in the long-term, the following follow-up actions are required: (1) establish enforceable institutional controls to prevent future disturbance of the landfill cap; (2) establish enforceable institutional controls on the Site to prevent potable water use from drinking water wells until MCLs are attained; (3) work with local officials on advisories/ordinances downgradient of the Site, to prevent or regulate potable water use from drinking water wells until MCLs are attained, and to prevent such wells from potentially impacting the distribution of the contaminant plume or affect capture; (4) work with local officials on advisories/guidelines downgradient of the Site to ensure non-potable private well use does not result in unacceptable risk, and to prevent such wells from potentially impacting the distribution of the contaminant plume or affect capture; and (5) the eastern collection system must be brought back on line as soon as possible and be subjected to an optimization study to ensure

that off-site migration of groundwater contamination is minimized as much as is possible.

VII. NEXT REVIEW

The next five-year review report for the Charles George Reclamation Trust Landfill Superfund Site is required five years from the completion date of this review.

APPENDIX A

Existing Site Information

Physical Characteristics/Land and Resource Use

The Charles George Land Reclamation Trust Landfill Superfund Site (Site) is a 70-acre mixed industrial, municipal, and hazardous waste landfill located approximately one mile southwest of the town center of Tyngsborough, Massachusetts (Figure 1). The Site is bordered to the east by U.S. Route 3, Flint Pond Marsh, and Flint Pond. A residential neighborhood is located on the Pond's northern peninsula approximately one-half mile east of the Site. The Academy of Notre Dame private school is on the eastern shore of Flint Pond. Dunstable Road and Dunstable Brook border the Site to the west and south, and the Cannongate Condominium complex is located approximately 800 feet to the southeast. Blodgett Street and Cummings Road form the northwestern border of the Site.

Dunstable Brook flows in a southerly direction beyond the Site before turning east, then northeasterly, discharging into Flint Pond Marsh which in turn supplies Flint Pond. Flint Pond ultimately discharges to the Merrimack River.

Land use in the vicinity of the site is predominantly rural residential but also includes some light industry and light seasonal livestock grazing. An industrial park with a build-out capacity of 18 buildings has been constructed on the northern border of the site. Drinking water in the area is supplied by a water main installed as a result of the EPA's first ROD for the Site, water main extensions constructed by others, and private residential water supply wells. The public water supply is available to the area impacted by the Site, although some residents in the vicinity of the Site had chosen to retain their private water supply wells. The public water supply main is connected to the Lowell Regional Water Utility, which derives its water from the Merrimack River.

Figure A- 1. Site Locus

History of Contamination

Waste disposal activity at the Site was initiated in the mid 1950's. During the period between 1955 and when the land was purchased by Charles George Sr. in 1967, the Site was operated as a municipal dump. The Site continued to operate as a municipal landfill after acquisition by Charles George Sr. in 1967 and the Charles George Land Reclamation Trust (Charles George Sr. and Dorothy George, Trustees) in 1971. In 1973, the Trust was issued a permit by the Commonwealth of Massachusetts to handle hazardous wastes in addition to municipal and domestic refuse. Disposal of hazardous wastes and substances primarily in the form of drummed and bulk chemicals containing VOCs and toxic metal sludges continued from January 1973 to at least June 1976.

In 1982, the Tyngsborough Board of Health suspended the assignment of the Trust's land as a landfill. At approximately the same time, the Massachusetts Department of Environmental Quality Engineering (DEQE), now the MassDEP, ordered the closing of two wells serving the Cannongate Condominiums due to the presence of VOC contamination in the well water. The DEQE installed an above-ground water line from the North Chelmsford Water District to the condominiums to provide a temporary solution to the water shortage created by the loss of the wells.

Initial Response

EPA's involvement at the Site began with groundwater testing conducted in 1981 and 1982. The site was proposed for the NPL on October 23, 1981, and finalized on the NPL in September 1983. In that same year, EPA also allocated funds for a removal action at the Site to replace the DEQE's temporary water line with an insulated temporary water line. Other removal actions included construction of a security fence along the northwestern entrance to the landfill, re-grading and placement of soil cover over exposed refuse, and installation of twelve landfill gas vents. The basis for the removal action was documented in the first ROD issued on December 29, 1983. A remedial investigation (RI) and feasibility study (FS) were also begun in September 1983.

Summary of Basis for Taking Action

The initial action taken at the Site under the first ROD (USEPA, 1983) was based on the discovery of contamination in water from the wells that supplied the Cannongate Condominium complex to the south of the Site. The contaminants found included methyl ethyl ketone, acetone, toluene, benzene, methyl isobutyl ketone, trichloroethene, and 1,1-dichloroethane. Sampling of other private wells near the condominiums also began to show evidence of contamination. The first ROD extended a water line to affected residences to provide water from a neighboring town.

The basis for the second ROD (USEPA, 1985) was the poor condition of the abandoned landfill (lack of soil cover, exposed refuse, and leachate breakouts) that was allowing contaminants to migrate via surface runoff, groundwater passing through the waste, and gaseous emissions. Identified receptors included flora and fauna as well as humans coming into contact with surface waters and wetlands surrounding the Site. Landfill leachate and contaminated soil erosion were cited as having impacted the surrounding surface waters and wetlands. The potential migration of leachate into the bedrock aquifer was also cited as a concern. VOCs were detected in air samples from landfill vents and the surrounding environment, indicating that landfill gas control was also needed.

The third ROD (USEPA, 1988), addressing groundwater, leachate and sediment contamination, was based on a site-wide remedial investigation and risk assessment (Ebasco, 1988). The contaminants identified in Table 3-1 are those listed in the third ROD and are a representative subset of the contaminants identified at the Site that were selected for quantitative evaluation in the 1988 risk assessment.

Table A- 1. Contaminants Listed in ROD III

Groundwater and Leachate	Air	Sediment
Acetone	Benzene	Polycyclic Aromatic Hydrocarbons (PAHs)
Benzene	Bromoform	
Benzoic Acid	Bromomethane	Arsenic
2-Butanone	Carbon Disulfide	Cadmium
1,1-Dichloroethenene	Carbon Tetrachloride	
Ethylbenzene	Chlorobenzene	
4-Methyl-2-pentanone	Chloroform	
4-Methylphenol	Chrysene	
2-Methylphenol	1,2-Dichloroethane	
Phenol	1,1-Dichloroethene	
Toluene	Methylene Chloride	
Trichloroethene	1,1,2,2-Tetrachloroethane	
Arsenic	Tetrachloroethene	
Cadmium	Toluene	
Chromium	1,1,2-Trichloroethane	
Copper	Trichloroethene	
Mercury	Vinyl Chloride	
	Xylenes	

The site-wide remedial investigation and risk assessment (Ebasco, 1988) estimated human health risks and hazards that exceed the EPA risk management criteria from the following:

- Exposure to groundwater via ingestion during domestic use.
- Exposure to airborne emissions from the venting system via inhalation of ambient air.
- Exposure to sediments in Dunstable Brook via dermal exposure to carcinogenic PAHs.

In 1998, sediments in Dunstable Brook were sampled and analyzed for PAHs and the human health risk associated with exposure to these sediments (residential scenario) was reassessed. This reassessment was done because of changes in toxicity information and risk assessment practices that had occurred since the 1988 risk assessment was performed. Also, the 1998 results had showed decreased concentrations relative to the data used to support the third ROD. The 1998 reassessment concluded that the risk and hazard from exposure to Dunstable Brook sediments met EPA's risk management criteria. This reassessment formed the basis for EPA's decision to eliminate removal of Dunstable Brook sediments from the OU3 r

.

Table A- 2. Chronology of Site Events

Event	Date
Site was operated as a Municipal dump	Late 1950s through 1967
New owner expanded landfill and accepted both household and industrial wastes	1967 to 1976
Hazardous wastes accepted, including drummed and bulk chemicals containing volatile organic compounds (VOCs) and metal sludges	1973 to 1975
EPA proposes site for listing on National Priorities List (NPL)	October 23, 1981
Bedrock wells serving Cannongate Condominium found to be contaminated and shut down by the State - State installs temporary water line and orders closure of landfill	July 1982
Four private bedrock wells serving homes adjacent to condominiums also found to be contaminated	May 1983
EPA issues Notice to Charles George Land Reclamation Trust requesting cooperation in cleanup	May 1983
Final listing date on the NPL	September 8, 1983
EPA undertakes emergency remedial actions including improvement to Cannongate temporary water line and landfill measures (fencing, soil cover, and gas vents)	August 1983 - March 1984
First Record of Decision (ROD) selecting extension of City of Lowell's water supply system to serve Cannongate area (OU1)	December 29, 1983
Second ROD selecting landfill cap, gas collection/venting, and leachate collection (OU2)	July 11, 1985
Explanation of Significant Differences (ESD) to include an additional 24 residential tie-ins to the OU1 water line	May 1988
OU1 water line is activated	Fall 1988
Third ROD selecting long-term groundwater monitoring, incineration of landfill gas, contaminated groundwater extraction, leachate treatment, and excavation of Dunstable Brook sediments (OU3 and OU4)	September 29, 1988
Construction of landfill cap (OU2) completed	October 1990
Fifty-four Potentially Responsible Parties (PRPs) enter into Consent Decrees with EPA	1992
Construction of interim gas treatment flare and portion of groundwater extraction remedy completed	1993 -1994
Extraction well portion of groundwater remedy completed	1995

Leachate and groundwater temporary treatment system in operation	1991 to 1997
Contamination first discovered in monitoring wells on Notre Dame Academy property	October 1995

Contamination discovered in residential well water in Flint Pond neighborhood	August 1996
EPA evaluates alternatives for landfill gas treatment and selects enclosed flare to replace interim flare	1996
Existence of sanitary sewer connection near site is discovered, and evaluated as a replacement for on-site treatment of leachate and groundwater	1996 – 1997
Completion of water line extension to Notre Dame Academy	July 1997
Lowell Regional Wastewater Utility (LRWU) issues Industrial Discharge Permit allowing discharge of leachate and groundwater to sanitary sewer	January 1998
Construction for enclosed flare to replace interim flare is completed	April 1998
Completion of water line extension to Flint Pond neighborhood	June 1998
Dunstable Brook sediments sampled and risk re-calculated; results show sediment removal not necessary. Pump stations upgraded and Operations and Maintenance (O&M) building constructed on site to support long term O&M efforts	1998
Construction of sewer line from site to Flint Corner Municipal Pump Station including two pump stations	September 1998
Construction Complete status is attained for the Site	September 22, 1998
ESD issued to document changes to third ROD (additional water line extensions, selection of enclosed flare, elimination of Dunstable Brook sediment removal, and sanitary sewer extension for permanent leachate and groundwater disposal)	September 1999
Dorothy and Charles George settle all claims against them	March 2003
Long-Term Response Action (LTRA) period ends and O&M phase begins for OU4 – the Massachusetts Department of Environmental Protection (MassDEP) assumes responsibilities from EPA	September 2009
Completion of First Five-Year Review	August 31, 1995
Completion of Second Five-Year Review	March 22, 2000
Completion of Third Five-Year Review	June 28, 2005
EPA completed transfer of entire site O&M responsibilities to MassDEP	September 2009
Leachate and groundwater collection lagoon removed	October 2009
Completion of Fourth Five-Year Review	June 2010
Completion of Fifth Five-Year Review	June 2015

Remedy Selection

The Site was subdivided into four OUs for the purpose of investigation, remedy selection, and remediation. Three RODs for these OUs have been issued, as follows:

- ROD I: Provide an alternative water supply (OU1).
- ROD II: Control the contamination source (OU2) to reduce off-site migration of contaminants (i.e., cap the landfill and collect the leachate and landfill gas).
- ROD III: Provide treatment of groundwater, leachate and landfill gas and provide removal of Dunstable Brook sediments as the selected source removal remedy. ROD III covered both management of contaminated groundwater migration (OU3) and leachate treatment (OU4).

Operable Unit 1

ROD I, issued in December 1983, provided a permanent drinking water supply to local groundwater users by extending an existing water supply system (OU1). In early studies, local groundwater wells were found to contain VOCs associated with the site. The remedy minimized exposure and, therefore, provided a measure of protectiveness to human health. ROD I established as an objective a new water main to provide an uncontaminated alternative water service to the residents of the Cannongate Condominium complex and surrounding area specifically to:

- Mitigate and minimize danger to and provide adequate protection of public health and welfare from ingestion of contaminated drinking water.

To meet this objective, the 1983 ROD selected the extension of an existing (City of Lowell's) water supply system to Cannongate Condominiums. Residential well water users along Dunstable Road up to Cannongate Road and along Cannongate Road were also tied into the waterline extension. An ESD was issued during construction in 1988 to include these tie-ins, which totaled 24 in all.

Operable Unit 2

The final remedial action objectives selected in ROD II (1985) for addressing source control measures at the Site (OU2) are as follows:

- Abate additional impact to surrounding surface waters and wetlands.
- Minimize, to the extent possible, continued release to the groundwater.

- Control the emission of gases containing hazardous constituents to the surrounding residents.

- Minimize potential contamination of the water supplies and impacts on recreational uses around Flint Pond.

- Minimize potential exposure, via direct contact with leachate, to the surrounding public and wildlife.

- Secure the Site to eliminate unauthorized access.

- Comply with existing federal, state, and local laws.

- Ensure consistency with any off-site remedial alternatives, which may be selected in the third ROD as required by CERCLA sec. 101(24).

ROD II provided a cap for the Site consisting of a synthetic membrane and soil cover, a surface water management system, a passive landfill gas venting system, and a leachate collection system (OU2). These measures minimized the migration of contaminants through the air and groundwater and, therefore, provided a measure of protectiveness to human health. The landfill cover minimized storm water infiltration which reduces leachate generation. From 1991 to 1997, leachate and groundwater were collected and pumped into a 3.5 million-gallon storage lagoon and, at capacity, the wastewater was treated on-site in a temporary treatment facility. Treatment consisted of breakpoint chlorination, solids removal, and UV oxidation. The treated effluent was discharged to the eastern sedimentation pond with eventual discharge to Bridge Meadow Brook. Ambient Water Quality Criteria were met. Ten rounds of treatment were conducted, during which approximately 35 million gallons of wastewater were treated and discharged. The leachate collection system minimized impacts to off-site surface water and groundwater.

Operable Units 3 and 4

The remedial action objectives selected in ROD III (1988) to address management of contaminant migration at the Site (OU3 and OU4) to:

- Reduce potential future human health risks from ingesting benzene and arsenic in overburden groundwater southwest of the landfill.

- Reduce potential human health risks from benzene, arsenic, bis(2-ethylhexyl)phthalate, and trichloroethene in deep bedrock groundwater east of the landfill, with respect to use as a drinking water supply.

- Remediate shallow eastern groundwater to comply with Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs).

- Reduce potential human health risks posed by bromoform and various carcinogenic contaminants in landfill vent emissions (primarily, 1,1-dichloroethene, 1,1,2,2-tetrachloroethane, vinyl chloride, methylene chloride, and carbon tetrachloride).

- Reduce potential human health risks from PAHs in sediments west of Dunstable Road, in the leachate drainage way to Dunstable Brook, as well as short reaches of Dunstable Brook itself.

ROD III completed the remedial actions via treatment of the media controlled during implementation of ROD II. Due to several investigations made subsequent to the issuance of ROD III, EPA modified four of the five remedies under the third ROD. These changes included extending the existing municipal water supply system, installation of an enclosed flare, determining that removal of sediments from Dunstable Brook would not be necessary, and construction of a sanitary sewer extension, which provides an alternate remedy for leachate and groundwater treatment and discharge. An ESD was issued by EPA in 1999 to address these changes (USEPA, 1999).

The southwest groundwater collection trench has been operating since October 1993, and the eastern groundwater extraction system has been operating since 1995. Contaminated groundwater from these two extraction systems is collected at the West and East Pump Stations, respectively, where, starting in 1997, citric acid and a biocide are added to the wet wells for iron sequestration and microbial control. The collected water was originally pumped to the lagoon for temporary storage prior to transfer to the effluent monitoring station near the site entrance. The lagoon was retained for temporary storage of the contaminated groundwater to monitor the potential for dissolved iron precipitation while the efficacy of the treatment process (citric acid and biocide addition) was evaluated. From there, it is piped to the Cummings Road Pumping Station for discharge to the LRWU for treatment and disposal. This discharge is regulated by an LRWU industrial discharge permit. This system has continued to function without mishap or significant iron accumulation or deposition in the transfer piping or the temporary storage lagoon.

The residential well monitoring program started in 1989 was terminated in 1999 due partly to the now available municipal water supply near the landfill. In addition, certain residential wells in the Town of Dunstable near the Site were sampled in the past, but the historic absence of groundwater contaminants and in consideration of groundwater flow directions (Figures 2a, 2b, and 2c), sampling of these residential wells was deemed unnecessary. During the monitoring event of December 2015-January 2015, several private wells in the general vicinity of the Site were sampled as a conservative precautionary measure and were not found to contain contamination above applicable standards.

The landfill gas collection and venting system is comprised of a passive, crushed stone, gas collection trench system under the cap liner, which directs the landfill gas through 28 vents along the top of the landfill. Three existing monitoring wells (acting as gas vents) are connected to an active horizontal header pipeline that lies atop the landfill. Twelve pre-existing vents were capped off. Landfill gas is being routed to an enclosed flare as part of ROD III. The landfill gas collection system originally delivered landfill gas to an interim open flare, but was later replaced by the enclosed flare. The enclosed flare, provided for under ROD III, thermally destroys contaminants carried in the gas and minimizes impacts to the air. The lower toe drain vents were shut off in order to reduce the potential for additional oxygen infiltration, but it remains a problem. Soil gas monitoring at the site boundary indicates methane is not migrating off site thus demonstrating that discontinuing the use of these soil gas collection points has not resulted in an issue.

The need for excavation of sediments from Dunstable Brook was re-evaluated as part of the first five-year review (M&E, 1995). Sediments that were to be dredged and placed under the landfill cap during cover construction remain in the brook. The decision to dredge the brook had been based on a risk assessment of contaminant levels using toxicity assumptions valid at the time ROD III was issued in 1988. In 1989, EPA revised the relative absorption factors for PAHs, and in 1993, implemented the use of relative potency factors for carcinogenic PAHs (cPAHs). These changes were expected to result in decreased human health risk and hazard associated with exposure to sediments. Additional sediment data and a re-evaluation of relative absorption factors were presented in the First Five-Year Report (M&E, 1995). New risk calculations were not performed at that time, and EPA determined that more data was needed before dredging the brook. In 1998, EPA re-sampled brook sediments, re-evaluated the human health risks posed by cPAHs and determined that the concentrations of cPAHs are within the acceptable range of risk. This information was presented in the Second Five-Year Review Report (M&E, 2000) to support the decision not to dredge the brook. Additional sediment and surface water samples were collected since the last FYR to evaluate ecological risk within the Dunstable Brook and Flint Pond. With this additional data, EPA has concluded that significant ecological impacts from the Site are unlikely in these water bodies and further monitoring is unnecessary.

ROD III called for on-site treatment of groundwater and leachate with onsite discharge into the aquifer or offsite surface water discharge. During pre-design activities in preparation for conceptual design of the permanent treatment plant for OU4, it was discovered that a sanitary sewer had been constructed during the summer of 1996 approximately one mile from the site. EPA determined that the Site wastewater would meet the LRWU's pretreatment requirements. Directing the discharge to the LRWU is more cost effective, more environmentally protective, and more reliable than the onsite treatment plant specified in the ROD (USEPA, 1999). In order to implement this approach, the dissolved iron in the extracted leachate and contaminated ground water had to be controlled to prevent deposition in the transfer piping and the lagoon. Since January 1998, citric acid and biocide have been added to the collected leachate and groundwater to prevent iron biofouling of the discharge pipelines. Chemical addition occurs at both the East and West Pump Stations, from which the water is pumped to the effluent monitoring station prior to discharge to the LRWU via the Cummings Road Pump Station. The lagoon was subsequently bypassed, provisionally in 2000 and later, with approval by LRWU, in 2001 as a permanent measure. The lagoon was removed from the Site in October 2009.

Remedy Implementation

Additional details are presented in this section regarding the remedial actions conducted or being conducted at the site in accordance with the ROD objectives mentioned above. A site plan is provided in Figure 2.

OU1 Remedy Implementation

A water line, which provides an alternate water supply to serve the Cannongate area, was installed and activated in the fall of 1988. It was constructed under ROD I as OU1, and is now owned and operated by the Tyngsborough Water District (TWD). Since 1988, the line was extended (not by EPA as part of OU1) along Westford Road to the Westec Industrial Park. Under ROD III, EPA extended the line from the Westec Industrial Park location on Westford Road to Middlesex Road, to the Academy of Notre Dame school, up Middlesex Road to Kendall Road, and finally to Flint and Upton Roads. This extension is part of OU3 and was also turned over to the Tyngsborough Water Department (TWD) in 1998. The waterline in Dunstable Road was extended by others from the Cannongate Road/Dunstable Road EPA terminus, up Redgate Road, and also extended up Dunstable Road to Blodgett/Cummings Road to a commercial park constructed north of the Site. In 1998, EPA tied the Site into this system.

OU2, OU3, and OU4 Remedy Implementation: Source Control and Management of Migration

ROD II provided for source control by selecting a synthetic membrane cap with surface water diversion, off-gas collection and passive venting (now superseded by ROD III), and leachate seep collection. Construction of this cap and other remedial systems described above were completed in October of 1990. ROD III includes management of migration systems, control of groundwater and leachate, and groundwater/leachate disposal. MassDEP has O&M responsibilities for OU2, which constitutes the cap, surface water diversion system, the leachate collection system and the grounds within the fence (including the fence). MassDEP also has O&M responsibilities for the gas collection and the enclosed flare systems and the southwest groundwater extraction trench. MassDEP took over the financial responsibility for the southwest trench in September 2004 and fully funds these O&M responsibilities. EPA maintained O&M responsibilities for the eastern on-site leachate and groundwater collection and discharge systems for much of the 2005–2009 review period. In September 2009, this responsibility was transferred to MassDEP.

Landfill Cap, Leachate Collection, Groundwater Collection, and Treatment Systems

Construction of the synthetic landfill cap and appurtenant systems was initiated in early 1989 and completed in October 1990. Included in the construction of the cap were: a new shallow perimeter leachate toe-drain; two leachate pump stations with force mains flowing to a temporary leachate holding pond (lagoon); a passive gas collection and venting system; and a surface water diversion and sedimentation system. The old leachate collection systems on the east and west sides of the landfill, which were installed by the former landfill operator, were connected into pump stations.

The southwest groundwater extraction trench was completed and became operational in December 1993. It includes five wells that vary in depth from about 24 to 45 feet. The eastern groundwater extraction well field was completed in July 1995.

The eastern groundwater extraction system originally consisted of four extraction wells: CDM 1, CDM 2, CDM 3, and PW 1A (Figure 4). CDM 1 and CDM 2 had low yields and low concentrations of contaminants. CDM 2, which was open to both the overburden and shallow bedrock, was taken off line in 1996. CDM 1 was also taken off line the following year and currently is not pumped. In 1997, a new extraction well, WES 1, was constructed near CDM 2. WES 1 captures groundwater in overburden only and has a higher yield than CDM 2 when it was operating.

The First Five-Year Review (M&E, 1995) identified several significant problems with the leachate/groundwater collection systems. They included:

- Pump failure due to iron bacteria generating high dissolved iron loadings in the leachate and contaminated groundwater and subsequent oxidation and build-up of precipitated iron in the pump station wet wells resulting in frequent pump motor burnout

- High line pressures from iron deposition and accumulation in transfer piping and tube failure in the original peristaltic pump system. Maximum line and pump tube pressures were limited by a diaphragm system which frequently "burst", requiring frequent replacement.

- Lack of pump station access due to limited space and a hazardous atmosphere within the manhole caused by landfill gas (e.g., hydrogen sulfide) infiltration.

- Equipment corrosion also due to hydrogen sulfide infiltration.

These problems were later addressed by modifying the leachate and groundwater collection and pumping systems. The process of groundwater extraction, leachate collection and transfer was analyzed and the over-arching problem was determined to be the infiltration of atmospheric oxygen into the mixed flow during transfer from the extraction wells to the lagoon. The lagoon was used as a temporary storage prior to periodic interim treatments of its contents once it reached a capacity of 3.5 million gallons, approximately every six months. A "pig" injection station was installed at each wet well station as a temporary measure to allow the transfer lines to be cleaned to maintain a moderate pressure rise in the transfer piping until a more permanent solution could be developed and implemented. In 1996, the site contractor, Weston Solutions Inc. (formerly Roy F. Weston) evaluated treatment options and selected iron precipitation in a groundwater treatment plant they designed as described in the Final Report (Evaluation of Discharge Options). During the summer of 1997, a series of experiments was conducted by the New England USACE Division (now a District), which resulted in the recommendation of a continuous addition of sufficient chelant to sequester the dissolved iron in its reduced state and by the intermittent addition of a biodegradable biocide to limit bacterial activity in the wet wells where some exposure to atmospheric oxygen was inevitable.

Since December 1997/January 1998, citric acid and biocide have been added to the collected leachate and groundwater to prevent wet well biofouling and oxidized iron deposition in the discharge/transfer pipelines. Chemical addition occurs at both the East and West Pump Stations, from which the water is pumped to the effluent monitoring station prior to discharge to the LRWU via the Cummings Road Pump Station and its associated combined force main/gravity sewer located on Dunstable Road. EPA extended the Westford Road sewer line to the Site in 1998. The extension includes two off-site pump stations, two force main sections, and the remaining are gravity-fed sections. The EPA sewer line discharges to a pump station (built by others) located at the corner of Westford Road and Dunstable Road, locally known as Flint's Corner. At this time, EPA also constructed an O&M Building which houses equipment and vehicle storage, a wet laboratory, and an office. The extraction and discharge systems are monitored with a Supervisory Control and Data Acquisition (SCADA) system available in the building that provides for effluent monitoring and for remote access.

Landfill Gas Collection and Treatment System

The landfill gas collection and interim open flare gas destruction systems were constructed and became operational in 1994. During that year, landfill gas was characterized to determine the most appropriate destruction technology to meet the target cleanup levels established in ROD III. An enclosed flare system was determined to be the preferred alternative. Construction involved replacing the open flare stack with an enclosed flare stack. Some upgrading of the system was necessary, particularly the instrumentation and control panels, but most of the original system was utilized, including the flare building. This construction was completed in April 1998.

Landfill gas is collected via a system of 22 gas extraction vents and three existing groundwater monitoring wells (acting as gas vents) connected to an active horizontal header pipeline that lies atop the landfill. The pipeline is connected to a vacuum blower and enclosed flare for thermal treatment. There is no perimeter landfill gas collection system in place at the landfill.

The landfill vents are not typical, penetrating gas extraction wells. They are connected only to the gas venting layer located directly beneath the high-density polyethylene (HDPE) geo-membrane. Not all of the passive vents were tied into the header pipe system; those passive vents that were not connected to the gas extraction system were capped off and are no longer functional. However, methane is not being detected at concentrations above action levels.

Monitoring Systems

Monitoring of collected leachate/groundwater occurs at the effluent monitoring station located behind the O&M Building in order to comply with the LRWU permit. This includes continuous monitoring of pH, temperature and flow rate (in gallons per minute) occurs at the station along with collection of composite samples via a refrigerated ISCO® sampling unit and grab. The first section of the most recent submittal to the LRWU is attached in Appendix H that provides details regarding the sampling and reporting requirements.

Monitoring of landfill gas occurs at both the individual gas vents on top of the landfill as well as the flare/blower station. Sample taps are in place at each gas vent for collection of samples using hand-held instruments. Each vent also includes a pressure gauge to measure small changes in static pressure (either positive or negative) to allow adjustment to extraction rates from each vent, but these were generally not operational and have not been found to be useful for this Site. Automated monitoring at the flare/blower station involves the following parameters: flare temperature, landfill gas flow rate, vacuum pressure of the extracted landfill gas, and oxygen concentration of the extracted gas.

Although there are no permanent perimeter monitoring wells for measuring methane or landfill gas in the vadose zone, the MassDEP has monitored the soil gas using multiple, temporary, surficial probes installed by EPA in 1997. In general, gas migration has not been an issue at the Site in the past due to the lack of sensitive receptors such as nearby structures or buildings, and due to concentrations below action levels or non-detection of monitored parameters in these wells.

Operation and Maintenance

This section discusses the operation and maintenance of the remedy at the Charles George Landfill.

Remedy Operation and Maintenance Program

During this review period, MassDEP had O&M responsibilities at the Site – including the landfill cap and grounds within the fence, surface water diversion system, site security, southwest groundwater extraction trench, gas collection system, the enclosed flare system (i.e., OU2 and OU3), and the east groundwater extraction system and discharge systems (i.e., OU4 east and west pump stations and effluent monitoring station). During this review period, MassDEP updated the Sitewide O&M manual. MassDEP contracted Clean Harbors to perform O&M activities until October 2014, at which time they transitioned to Watermark.

MassDEP, and/or their O&M contractor, conducts Semi-Annual (twice per year) landfill security and maintenance inspections, along with weekly inspections of the perimeter fence, southwest groundwater extraction trench, and enclosed flare system, as well as perform semi-annual sampling of both the landfill gas collection system and 22 soil gas probes.

Semi-Annual landfill security and maintenance inspections consist of a complete walkover of the landfill cap inspecting for significant subsidence, bulging or evidence of deterioration. The inspections include observation of the roadways, perimeter fence, soil and gravel cover, drainage features, observation ports, toe-drain clean outs, and changes to surrounding land use. During these inspections, woody growth is removed from the cap and near cap drainage structures as necessary. A five-page "Landfill/Security/Site Maintenance" inspection checklist is used to document observations from the Semi-Annual inspection. The Semi-Annual Status Report also summarizes observations and maintenance activities related to the quarterly sampling of soil gas probes and gas collection system sample ports, as well as weekly inspections of the flare and southwest groundwater extraction trench.

Monitoring of landfill gas is accomplished through the sampling of 22 gas extraction points (former gas vents), two new sample ports that were installed in the gas collection header pipes, and three monitoring wells (JLF1, JLF1A and JLF2) that were tied into the gas collection system using handheld instruments outfitted with hydrogen sulfide (H2S) pods. Parameters measured during the quarterly gas sampling consist of oxygen (O2), carbon dioxide (CO2), hydrogen sulfide (H2S), methane (CH4), temperature, and pressure (vent suction). Monitored parameters and details concerning gas system maintenance are recorded for each sample location on "Gas Collection System Inspection Checklists", which are included in Semi-Annual Status Reports.

Each vent also includes a pressure gauge to measure small changes in static pressure (either positive or negative) and valves to allow adjustment to extraction rates from each vent. However, MassDEP reported that in the past the valves were generally not operational and previous attempts to spatially "balance" different vent flow rates have not proven useful.

On a weekly basis, the MassDEP contractor performs routine monitoring and maintenance at the flare/blower station. Monitoring includes measuring gas quality and flow rate, blower speed, pressure set point, flare high temperature, landfill gas pressure, nitrogen pressure, and extracted gas oxygen concentration. Automated monitoring at the flare/blower station displays flare temperature, landfill gas flow rate, vacuum pressure of the extracted landfill gas and oxygen concentration of the extracted gas. Observations from the weekly flare inspections are recorded on weekly "Flare Inspection Checklists", which are included in the Semi-Annual Status Reports.

Soil gas has been monitored since 1998 using multiple shallow probes that were installed near the perimeter of the Site in 1997 (55 temporary probes, total) as part of prior landfill gas migration studies. The current soil gas monitoring program consists of quarterly sampling of nineteen select probes. Monitoring is done with a handheld instrument that measures O2, CO2, H2S, and CH4. VOCs are also measured qualitatively at each probe using a photoionization detector (PID). Monitored parameters and details concerning probe maintenance are recorded on "Soil Gas Probe Monitoring Results" worksheets, which are included in the Semi-Annual Status Reports to MassDEP.

Weekly inspection activities performed by MassDEP contractors at the Southwest groundwater extraction system include ambient air monitoring in pump manholes, inspection of pumps, floats, hoses, and support cables in each of the pump wells, and recording the number of pumps operating and operating amperages. Air quality parameters monitored in the pump manholes consist of percent lower explosive limit (LEL), O2, CO2, and H2S. Details concerning extraction pump and trench maintenance are recorded on weekly "Southwest Groundwater

Collection Trench" worksheets, which are included in the Semi-Annual Status Reports to MassDEP.

During the review period, MassDEP contractors performed weekly site visits and monitoring of collected leachate and groundwater prior to discharge to the off-site sewer system. Weekly site visits included inspection and routine maintenance of the east extraction wells and East and West Pump Stations. Monitoring of collected leachate/groundwater occurs at the effluent monitoring station located behind the O&M Building. This station receives the discharge from the East and West Pump Stations and the leachate collection system prior to discharging to the LRWU. The first section of the most recent submittal to the LRWU is attached in Appendix H that provides details regarding the sampling and reporting requirements.

APPENDIX B

Groundwater Flow Contours

Figure B- 1. Overburden Groundwater Contours – May 2006

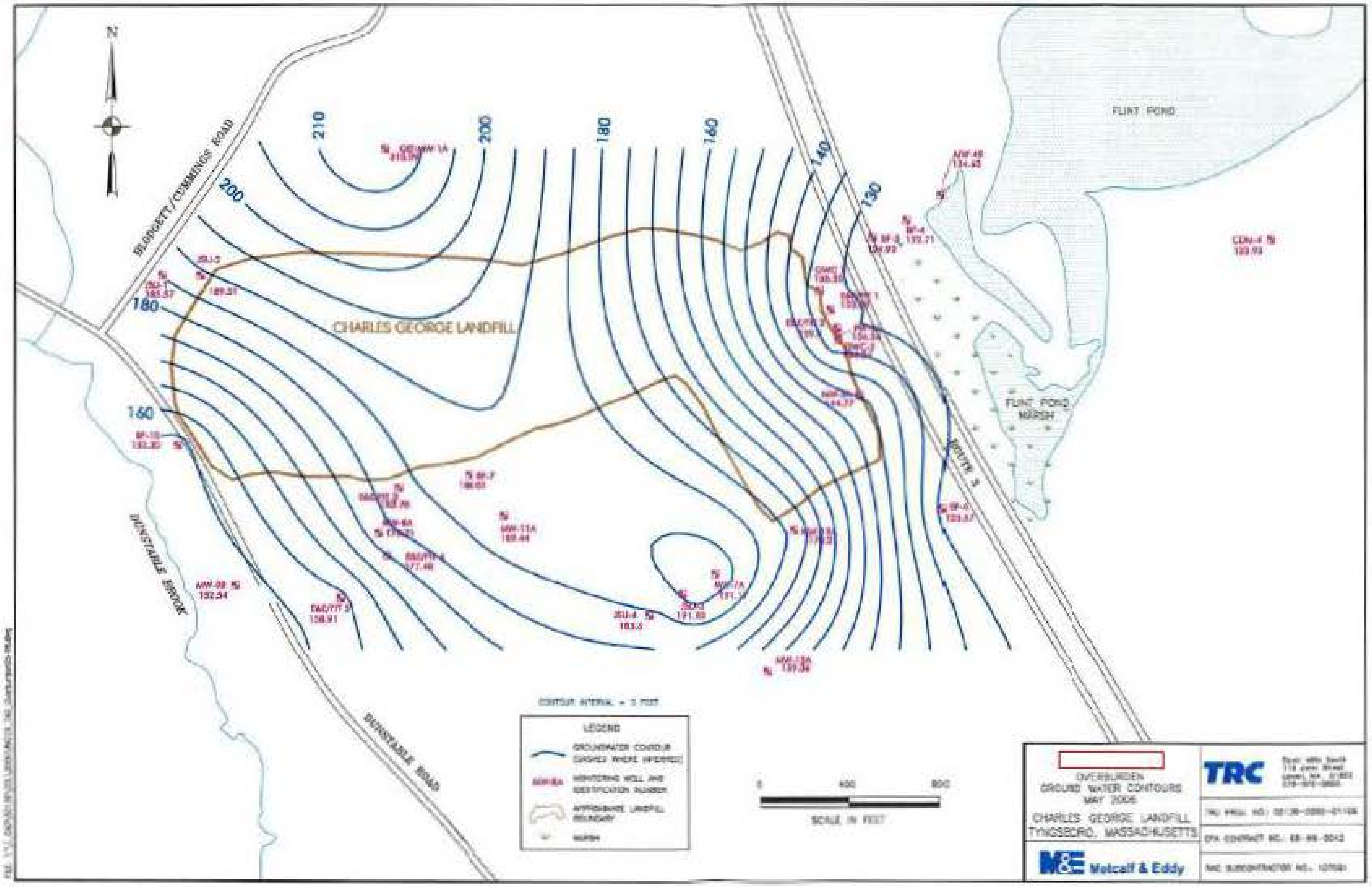


Figure B- 2. Shallow Bedrock Groundwater Contours – May 2006

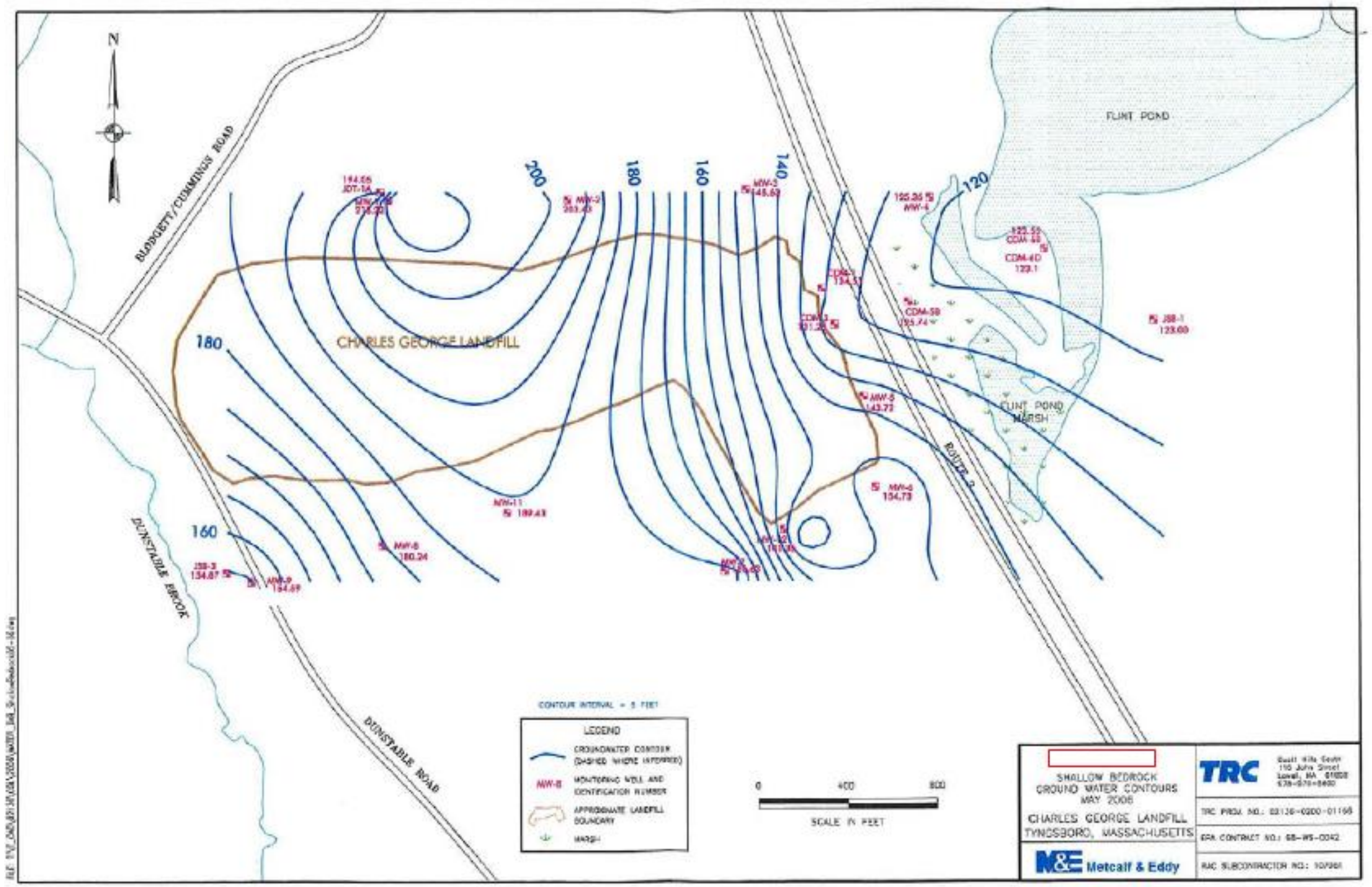
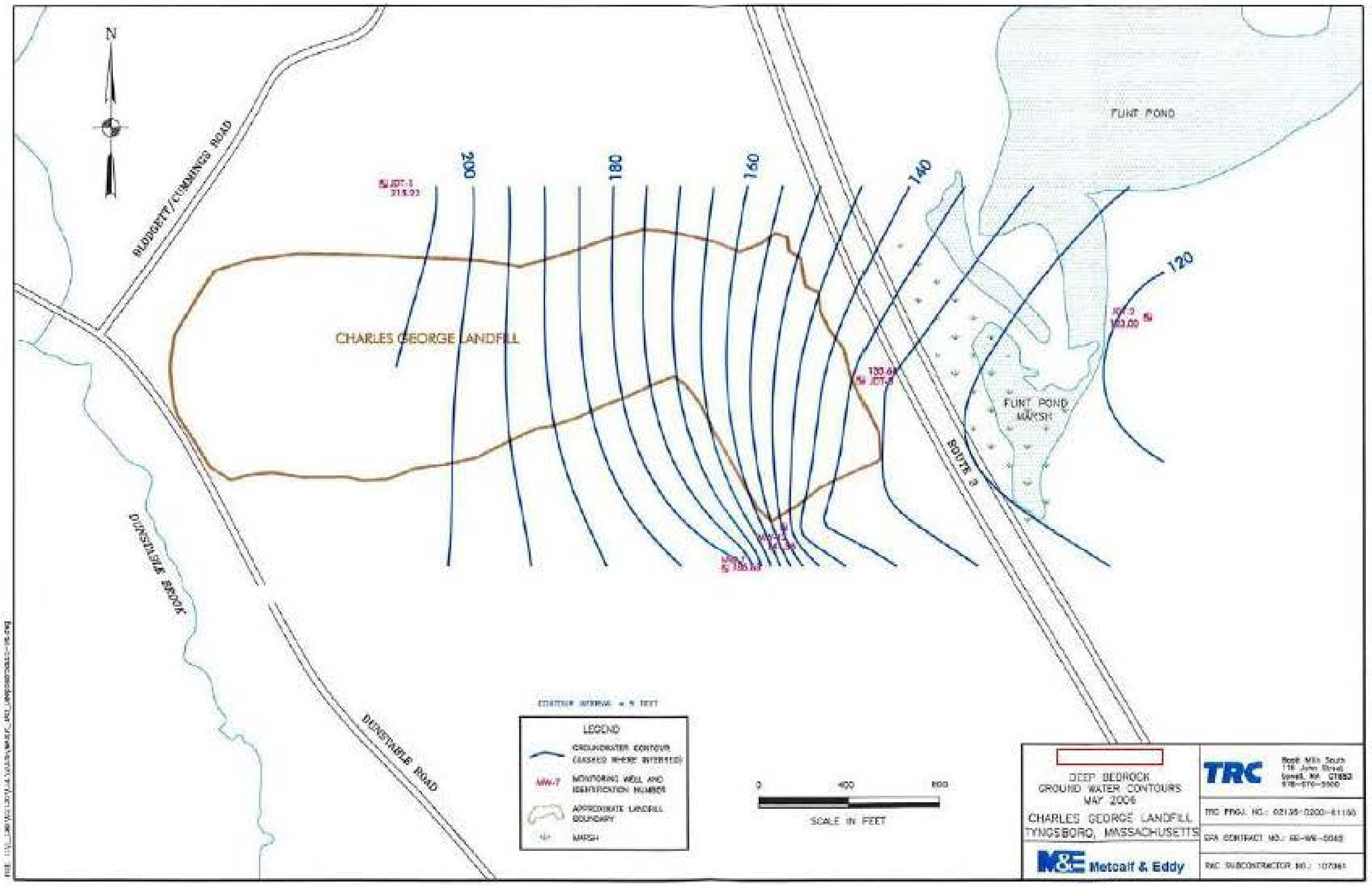


Figure B- 3. Deep Bedrock Groundwater Contours – May 2006



APPENDIX C

Five-Year Review Site Inspection

Site Inspection Checklist

I. SITE INFORMATION	
Site name: Charles George Landfill	**Date of inspection:**
Location and Region: Tyngsborough, MA, Region 1	**EPA ID:** MAD003809266
Agency, office, or company leading the five-year review: EPA	**Weather/temperature:**
Remedy Includes: (Check all that apply) ■ Landfill cover/containment ☐ Monitored natural attenuation ☐ Access controls ■ Groundwater containment ☐ Institutional controls ☐ Vertical barrier walls ☐ Groundwater pump and treatment ☐ Surface water collection and treatment ☐ Other____covered landfill (vegetative and armor) with leachate/groundwater collection for containment purposes._______	
Attachments: ☐ Inspection team roster attached ☐ Site map attached	
II. INTERVIEWS (Check all that apply)	
1. **O&M site manager** Name Mark E. Augustyniak Title Project Manager Date 05/05/2015 Interviewed ■ at site ☐ at office ☐ by phone Phone no. _978-452-9696__ Problems, suggestions; ☐ Report attached ____	
2. **O&M staff** Name Brendan S. Lareau Title Lead Technician Date 05/05/2015 Interviewed ■ at site ☐ at office ☐ by phone Phone no. 978-452-9696__ Problems, suggestions; ☐ Report attached ____	

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _MassDEP______________
Contac _David Buckley MassDEP Project Manager 5/19/15 617-556-1184_________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ________
Interview form provided

Agency ____________________________
Contact ____________________________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached

Agency ____________________________
Contact ____________________________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached

Agency ____________________________
Contact ____________________________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached

4. **Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents** ■ O&M manual ■ As-built drawings ■ Maintenance logs	■ Readily available ■ Readily available ■ Readily available	■ Up to date ■ Up to date ■ Up to date	☐ N/A ☐ N/A ☐ N/A
	Remarks _O&M Plan consolidated during the FYR process, with version control suggested by EPA to track changes so that it's a living document. O&M documentation did not highlight the long-duration issue of the eastern collection trench not in full operation, nor did it include corrective measures.			
2.	**Site-Specific Health and Safety Plan** ☐ Contingency plan/emergency response plan	■Readily available ☐ Readily available	■ Up to date ☐ Up to date	☐ N/A ■ N/A
	Remarks ___			
3.	**O&M and OSHA Training Records**	■ Readily available	■ Up to date	☐ N/A
	Remarks ___			
4.	**Permits and Service Agreements** ☐ Air discharge permit ☐ Effluent discharge ■ Waste disposal, POTW ☐ Other permits___	 ☐ Readily available ☐ Readily available ■ Readily available ☐ Readily available	 ☐ Up to date ☐ Up to date ■ Up to date ☐ Up to date	 ☐ N/A ☐ N/A ☐ N/A ☐ N/A
5.	**Gas Generation Records**	■ Readily available	■ Up to date	☐ N/A
	Remarks___			
6.	**Settlement Monument Records**	■ Readily available	☐ Up to date	☐ N/A
	Remarks___			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	☐ N/A
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	■ N/A
	Remarks___			
9.	**Discharge Compliance Records** ☐ Air ■ Water (effluent)	 ☐ Readily available ■ Readily available	 ☐ Up to date ■ Up to date	 ☐ N/A ☐ N/A
	Remarks___			
10.	**Daily Access/Security Logs**	■Readily available	■ Up to date	☐ N/A
	Remarks___			

IV. O&M COSTS		
1.	**O&M Organization** ■ State in-house ☐ PRP in-house ☐ Federal Facility in-house ☐ Other___	 ■ Contractor for State ☐ Contractor for PRP ☐ Contractor for Federal Facility

2. **O&M Cost Records**

■ Readily available ■ Up to date

■ Funding mechanism/agreement in place

Original O&M cost estimate____________________ ☐ Breakdown attached

NOTE: O & M costs are not available because PRP prefers not to disclose this information.

Total annual cost by year for review period if available

From__________	To__________	__$150,000 annually___	☐ Breakdown attached
Date	Date	Total cost	
From__________	To__________	__________________	☐ Breakdown attached
Date	Date	Total cost	
From__________	To__________	__________________	☐ Breakdown attached
Date	Date	Total cost	
From__________	To__________	__________________	☐ Breakdown attached
Date	Date	Total cost	
From__________	To__________	__________________	☐ Breakdown attached
Date	Date	Total cost	

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons:

V. ACCESS AND INSTITUTIONAL CONTROLS ■ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ■ Location shown on site map ■ Gates secured ☐ N/A

Remarks____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A

Remarks____

____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented	☐ Yes ☐ No ☐ N/A
Site conditions imply ICs not being fully enforced	☐ Yes ☐ No ☐ N/A

NOTE: Institutional controls have not been fully implemented yet. They are not in place yet for soil or groundwater; however, a draft NAUL is being reviewed by EPA and Mass DEP which will prevent soil excavation and groundwater use, and restrict residential use at the site. The PRP owns the entire site property and access is controlled by a fence. The PRP does not have any plans to transfer property, however, there has been frequent dialogue with developers regarding leasing the property for a solar energy facility.

Type of monitoring (*e.g.*, self-reporting, drive by) ________________________________
Frequency ____
Responsible party/agency ____
Contact ____
Name Title Date Phone no.

Reporting is up-to-date	☐ Yes ☐ No ☐ N/A
Reports are verified by the lead agency	☐ Yes ☐ No ☐ N/A
Specific requirements in deed or decision documents have been met	☐ Yes ☐No ☐ N/A
Violations have been reported	☐ Yes ☐ No ☐ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☐ ICs are adequate* ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ■ No vandalism evident
Remarks____
____

2. **Land use changes on site** ■N/A
Remarks__None. However a solar facility has been proposed on site.

3. **Land use changes off site** ■ N/A
Remarks___None observed.__

VI. GENERAL SITE CONDITIONS

A. Roads ■ Applicable ☐ N/A	
1.	**Roads damaged** ☐ Location shown on site map ■ Roads adequate ☐ N/A Remarks________________________________
B. Other Site Conditions	
	Remarks:
VII. LANDFILL COVERS ■ Applicable ☐ N/A	
A. Landfill Surface	
1.	**Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident Areal extent______________ Depth____________ Remarks_____No signficant areas observed.___________________
2.	**Cracks** ☐ Location shown on site map ■ Cracking not evident Lengths____________ Widths___________ Depths__________ Remarks________________________________
3.	**Erosion** ☐ Location shown on site map ■ Erosion not evident Areal extent______________ Depth____________ Remarks________________________________
4.	**Holes** ☐ Location shown on site map ■ Holes not evident Areal extent______________ Depth____________ Remarks________________________________
5.	**Vegetative Cover** ☐ Grass ☐ Cover properly established ■ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks__Some small areas of sparse vegetation. May have been a result of seasonal impact.
6.	**Alternative Cover (armored rock, concrete, etc.)** ☐ N/A Remarks________________________________
7.	**Bulges** ☐ Location shown on site map ☐ Bulges not evident Areal extent______________ Height____________ Remarks_______No significant bulges observed.________________________
8.	**Wet Areas/Water Damage** ☐ Wet areas/water damage not evident ☐ Wet areas ☐ Location shown on site map Areal extent______________ ☐ Ponding ☐ Location shown on site map Areal extent______________ ☐ Seeps ☐ Location shown on site map Areal extent______________ ☐ Soft subgrade ☐ Location shown on site map Areal extent______________ Remarks___Area of small ponding was described near gas pressure relief at summit. _
9.	**Slope Instability** ☐ Slides ☐ Location shown on site map ■ No evidence of slope instability Areal extent______________ Remarks________________________________
B. Benches ■ Applicable ☐ N/A	(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ■ N/A or okay
Remarks____
____

2. **Bench Breached** ☐ Location shown on site map ■ N/A or okay
Remarks____
____

3. **Bench Overtopped** ☐ Location shown on site map ■ N/A or okay
Remarks____
____

C. Letdown Channels ☐ Applicable ■ N/A
Remarks____
____

1. **Settlement** ☐ Location shown on site map ■ No evidence of settlement
Areal extent______________ Depth____________
Remarks____
____

2. **Material Degradation** ☐ Location shown on site map ■ No evidence of degradation
Material type_______________ Areal extent_____________
Remarks____
____

3. **Erosion** ☐ Location shown on site map ■ No evidence of erosion
Areal extent______________ Depth____________
Remarks____
____

4. **Undercutting** ☐ Location shown on site map ■ No evidence of undercutting
Areal extent______________ Depth____________
Remarks____
____

5. **Obstructions** Type_____________________ ■ No obstructions
☐ Location shown on site map Areal extent______________
Size____________
Remarks____
____

6. **Excessive Vegetative Growth** Type____________________
■ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent______________
Remarks____
____

D. Cover Penetrations ☐ Applicable ☐ N/A

1. **Gas Vents** ■ Active ☐ Passive
■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance
☐ N/A
Remarks____
____

2. **Gas Monitoring Probes**
☐ Properly secured/locked ■ Functioning ■ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks____
____

3.	**Monitoring Wells** (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks__ Several require minor maintenance of covers and locks – although primarily are located within the secured site.
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ■ N/A Remarks____ Extraction (leachate and groundwater) wells CDM-3 and PW-1A in the eastern collection trench not operating due to a controller issue. Watermark staff stated that the most recent weekly report they could find showed them all operating in April 2013.
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ■ N/A Remarks______
E. Gas Collection and Treatment ■ Applicable ☐ N/A	
1.	**Gas Treatment Facilities** ■ Flaring ☐ Thermal destruction ☐ Collection for reuse ■ Good condition ☐ Needs Maintenance Remarks: oxidation on flare stack. No impact on functionality, should continue to be obseved.__Flare emissions testing is due, since it's been more than five years.
2.	**Gas Collection Wells, Manifolds and Piping** ■ Good condition ☐ Needs Maintenance Remarks___Discontinued use of the collection points at the base of the landfill to reduce oxygen levels in the system.___
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ■ Good condition ☐ Needs Maintenance ☐ N/A Remarks______
F. Cover Drainage Layer ☐ Applicable ☐ N/A	
1.	**Outlet Pipes Inspected** ■ Functioning ☐ N/A Remarks______
2.	**Outlet Rock Inspected** ■ Functioning ☐ N/A Remarks______
G. Detention/Sedimentation Ponds ■ Applicable ☐ N/A	
1.	**Siltation** Areal extent______ Depth______ ☐ N/A ■ Siltation not evident Remarks______
2.	**Erosion** Areal extent______ Depth______ ■ Erosion not evident Remarks______
3.	**Outlet Works** ■ Functioning ☐ N/A Remarks______
4.	**Dam** ☐ Functioning ■ N/A Remarks______

H. Retaining Walls ☐ Applicable ■ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement____________ Vertical displacement_______________
Rotational displacement____________
Remarks____
____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks____
____

I. Perimeter Ditches/Off-Site Discharge ■ Applicable ☐ N/A

1. **Siltation** ■ Location shown on site map ■ Siltation not evident
Areal extent______________ Depth____________
Remarks____
____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
■ Vegetation does not impede flow
Areal extent______________ Type____________
Remarks____
____

3. **Erosion** ☐ Location shown on site map ■ Erosion not evident
Areal extent______________ Depth____________
Remarks____
____

4. **Discharge Structure** ■ Functioning ☐ N/A
Remarks____
____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ■ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
Areal extent______________ Depth____________
Remarks____
____

2. **Performance Monitoring** Type of monitoring__________________________
☐ Performance not monitored
Frequency_______________________________ ☐ Evidence of breaching
Head differential__________________________
Remarks____
____

IX. GROUNDWATER/SURFACE WATER REMEDIES ■ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ■ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing, and Electrical

☐ Good condition ☐ All required wells properly operating ■ Needs Maintenance ☐ N/A

Remarks____Extraction (leachate and groundwater) wells CDM-3 and PW-1A in the eastern collection trench not operating due to a controller issue. Watermark staff stated that the most recent weekly report they could find showed them all operating in April 2013.

____
____

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances

■ Good condition ☐ Needs Maintenance

Remarks____

____

3. Spare Parts and Equipment

■ Readily available ■ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks____

____

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ■ N/A

1. Collection Structures, Pumps, and Electrical

☐ Good condition ☐ Needs Maintenance

Remarks____

____

2. Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances

☐ Good condition ☐ Needs Maintenance

Remarks____

____

3. Spare Parts and Equipment

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks____

____

C. Treatment System ☐ Applicable ■ N/A

1. **Treatment Train** (Check components that apply)

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon adsorbers (both vapor and liquid phase carbon)
☐ Filters____
☐ Additive (*e.g.*, chelation agent, flocculent)__________________________________
☐ Others____
☐ Good condition ☐ Needs Maintenance
☐ Sampling ports properly marked and functional
☐ Sampling/maintenance log displayed and up to date
☐ Equipment properly identified
☐ Quantity of groundwater treated annually:
☐ Quantity of surface water treated annually:
Remarks____Only biocide and citric acid to inhibit iron precipitation from fouling the lines.____

2. **Electrical Enclosures and Panels** (properly rated and functional)

☐ N/A ☐ Good condition ☐ Needs Maintenance
Remarks____
____

3. **Tanks, Vaults, Storage Vessels**

☐ N/A ■ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
Remarks___Proper storage for drums of biocide and citric acid for treating to keep iron in solution to prevent fouling.__

4. **Discharge Structure and Appurtenances**

☐ N/A ■ Good condition ☐ Needs Maintenance
Remarks____
____

5.	**Treatment Building(s)** ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks______________________________
6.	**Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks: Several require minor maintenance of covers and locks – although primarily are located within the secured site.
D. Monitoring Data	
1.	Monitoring Data ☐ Is routinely submitted on time ■ Is of acceptable quality
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ■ Contaminant concentrations are declining
D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks______________________________
OTHER REMEDIES	
	If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. N/A
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). <u>Containment may be compromised at eastern collection trench due to inoperable extraction pumps.</u>
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. O&M procedures/documentation not indicating there's a problem with the eastern collection trench pumps, nor do they indicate an impending corrective measure. During inspection process, Watermark staff and MassDEP stated that the controller for the inoperable pumps is scheduled to be repaired.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. If the two extraction pumps in the eastern collection trench are brought back on line, then presumably containment will be improved (and subsequently, its protectiveness.
D.	**Opportunities for Optimization**

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

To ensure that containment at the eastern collection trench is maximized, in addition to bringing the system up to full operation, an optimization study may be in order.

APPENDIX D

Interview Records

INTERVIEW RECORD – STATE AND LOCAL CONSIDERATIONS			
Site Name: Charles George Landfill			**EPA ID No.:** MAD003809266
Subject: Fifth Five-Year Review (2015)			**Date:** April 23,2015
Type: Telephone X Visit Other X **Location of Visit:**			Incoming Outgoing
Contact Made By:			
Name: Richard Fisher	**Title:** Remedial Project Manager		**Organization:** EPA
Individual Contacted:			
Name: Kerri Oun	**Title: Health Agent**		**Organization: Tyngs BOH**
Telephone No: 978 649 2300 x 118 **Fax No:** **E-Mail Address: koun@tyngsboroughma.gov**		**Street Address: 25 Bryant Lane Town Hall** **City, State, Zip:** Tyngsborough, MA 01879	

Summary Of Conversation

Q: What is your overall impression of the project?
A: The project was before my time but DEP seems to have a good handle of the project. I am glad to see ongoing review of the project.

Q: Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.
A: No

Q: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
A: Not that I am aware of.

Q: Do you feel well informed about the site's activities and progress?
A: I have received ground water reports but feel I am not well informed of any other activities that goes on at the landfill.

Q: Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
A: Please keep open communication with our office of any plans for the landfill.

Q: In the FYR conducted in 2005, EPA was told that the Town of Tyngsborough had instituted a policy against installation of water supply wells on parcels having access to the municipal water supply. Is this policy still in place? Is there a policy for those parcels that may not have access to the municipal supply that may be near the landfill? Are any of these policies formalized into documentation that I could get copies of?

Basically, I would like to know if there's any procedure, document, or policy that limits, regulates, or provides guidance for potential private well installation in your town that would account for the presence of the Charles George landfill. If there isn't, I would like to discuss with you the possibility of your instituting something in the way of a regulation, guidance, or written policy that would ensure that the owner of any parcel contemplating a well installation in the area of the landfill could only do so in a manner that would not present a human health risk.

A: I am not aware of Tyngborough's policy that limits or regulates potential well installation near the landfill. The Town does have a well regulation and water testing requirements for new wells. Since my 5 years as Health Agent in Tyngsborough, the BOH has not issue any well permit to anyone near the landfill who has access to Town's water. With that said, I would love to get your inputs in developing a guidance for potential private well.

INTERVIEW RECORD – STATE AND LOCAL CONSIDERATIONS			
Site Name: Charles George Landfill			**EPA ID No.:** MAD003809266
Subject: Fifth Five-Year Review (2015)			**Date:** April 23, 2015
Type: Telephone Visit Other **Location of Visit:**			Incoming Outgoing
Contact Made By:			
Name: Richard Fisher	**Title:** Remedial Project Manager		**Organization:** EPA
Individual Contacted:			
Name: Matthew Marro	**Title: Conservation Director**		**Organization: Tyngs Con Com**
Telephone No: 978 649 2300 x 119 **Fax No: 888-435-5999** **E-Mail Address: mmarro@tyngsboroughma.gov**		**Street Address: 25 Bryant Lane Town Hall** **City, State, Zip:** Tyngsborough, MA 01879	

Summary Of Conversation

Q: What is your overall impression of the project?
A: I have gained much knowledge of the site and the consent decree in the last 5 years. It appears to be a well organized operation.

Q: Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.
A: I inspect the area by windshield 3 times a week. I also receive and review the NPDES monitoring reports and maintain those records.

Q: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
A: none

Q: Do you feel well informed about the site's activities and progress?
A: yes

Q: Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
A: continue to add to lines of communications to this office for example memos and letters produced copied to my office.

Q: Are you aware of any issues the five-year review should focus on?
A: I noted that within the last 5 years the NPDES reports show violations of PH due mainly to unrelated ambient conditions. I also noted upstream ambient conditions cited in the last 5 year analysis.
I would recommend that this issue continue to be explored to ensure that effluent or other water analysis does not show an elevated test parameter that is influenced by upstream conditions.

Q: Have there been any changes in the site or surrounding property in the last five years, or are changes planned?
A: Citizens energy is currently working with the town, DEP and EPA on placing a solar field. The Conservation Commission is also in the midst of accepting a conservation restriction from the Charles Georges Family which is the final item of compliance with the consent order with EPA. It is a 15 acre site which appears to be unaffected by the landfill.

INTERVIEW RECORD – STATE AND LOCAL COSIDERATIONS		
Site Name: Charles George Landfill		**EPA ID No.:** MAD003809266
Subject: Fifth Five-Year Review (2015)	**Time:** 9:00	**Date:** 5/21/15
Type: Telephone Visit Other **Location of Visit:**		Incoming Outgoing
Contact Made By:		
Name: Richard Fisher	**Title:** Remedial Project Manager	**Organization:** EPA
Individual Contacted:		
Name: David Buckley	**Title:** Project Manager	**Organization:** MassDEP
Telephone No: 617-556-1184 **Fax No:** **E-Mail Address:** david.buckley@state.ma.us	**Street Address:** 1 Winter St, 6th floor **City, State, Zip:** Boston, MA 02108	

Q: What is your overall impression of the project?
A: *The site remedial components continue to be protective of public health and the environment.*

Q: Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.
A: *Routine communications between MassDEP, its O&M contractor and EPA are frequent and productive. Communications between the agencies and other stakeholders are as necessary and productive.*

Q: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
A: *MassDEP is not aware of any complaints, violations, or other incidents at the site or against any party associated with the site.*

Q: Do you feel well informed about the site's activities and progress?
A: *Yes*

Q: Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
A: *No*

Q: Are you aware of any issues the five-year review should focus on?

A: *ICs need to be implemented.*

Q: Have there been any changes in the site or surrounding property in the last five years, or are changes planned?

A: *No changes in activities or uses are observed on the site or the surrounding properties in the past five years.*

INTERVIEW RECORD – STATE AND LOCAL COSIDERATIONS

Site Name: Charles George Landfill	**EPA ID No.:** MAD003809266	
Subject: Fifth Five-Year Review (2015)	**Time:** 13:00	**Date:** 05/05/2015
Type: Telephone Visit X Other **Location of Visit:** Charles George Landfill	Incoming Outgoing	

Contact Made By:		
Name: Richard Fisher	**Title:** Remedial Project Manager	**Organization:** EPA
Individual Contacted:		
Name: Mark E. Augustyniak	**Title:** Project Manager	**Organization:** Watermark
Telephone No: (978) 452-9696 Ext. 313 **Fax No:** (978) 453-9988 **E-Mail Address:** mark.augustyniak@watermarkenv.com	**Street Address:** 175 Cabot Street **City, State, Zip:** Lowell, MA 01854	

Summary Of Conversation

Q: What is your overall impression of the project?
A: Watermark has been the Operation and Maintenance Contractor for the Charles George Reclamation Trust Landfill since October 2014. Past and current remedial actions appear to have been performed successfully and continue to protect human health and the environment.

Q: Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.
A: As the Operation and Maintenance Contractor, Watermark conducts Site visits, performs inspections, and completes reporting as outlined in the Charles George Reclamation Trust Landfill Operation and Maintenance Services Scope of Work.

Q: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
A: To my knowledge, there have been no complaints, violations, or other incidents related to the site requiring a response by Watermark.

Q: Do you feel well informed about the site's activities and progress?
A: Yes, David Buckley (MassDEP Project Manager) has kept Watermark updated on Site activities and progress.

Q: Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
A: At this time, I do not have any comments, suggestions, or recommendations regarding the site's management or operation.

Q: Are you aware of any issues the five-year review should focus on?
A: At this time, I am not aware of any issues the five-year review should focus on.

Q: Have there been any changes in the site or surrounding property in the last five years, or are changes planned?
A: With only 8+ months of site experience, Watermark cannot comment on any changes over the last five years. In regard to future changes, Watermark has been made aware of the potential for solar panel installation at the Charles George Reclamation Trust Landfill.

APPENDIX E

Sediment and Surface Water Ecological Risk Evaluation

Sediment and Surface Water Ecological Risk Evaluation

In 2011, surface water and sediment samples were collected from water bodies in the vicinity of the Site to assess potential adverse effects on ecological receptors. Samples were obtained from Flint Pond and Flint Pond Marsh east of the landfill, and from Dunstable Brook on the west (Figure E-1). Previous surface water and sediment co-located sample pairs were collected from these aquatic habitats in 1993, 1999, 2006, and 2009.

Surface water samples collected in 2011 were analyzed for dissolved inorganics. VOCs were not analyzed because they have been detected previously only at trace levels below ecological benchmarks. As shown in Table 6-4, in 2011 in Dunstable Brook, benchmarks were exceeded for aluminum, barium, iron and manganese. Of these, only aluminum and iron have National Recommended Water Quality Criteria (NRWQC), with NRWQC of 87 µg/l and 1000 µg/l, respectively. Barium and manganese have non-criteria benchmarks which are considered to be highly conservative because they are based on absence of effects in limited laboratory tests on aquatic organisms, rather than concentrations known to have adverse effects. In 2011, aluminum was 210 µg/l in the upstream background station (SW-6) and 140 µg/l in the more downstream station (SW-3A) that is adjacent to the landfill; therefore any potential impact due to aluminum is probably not related to the landfill. In 2011, iron was 260 µg/l (below the NRWQC of 1000 µg/l) in the background station SW-6 and 3700 µg/l in the downstream station SW-3A. Iron often exceeds the NRWQC of 1000 µg/l without effect on aquatic organisms because the iron precipitates in the presence of dissolved oxygen and is not bioavailable. Any impacts are generally related to a physical effect in which iron flocculent changes the habitat quality, rather than a chemical toxicity effect. There is uncertainty whether there were any NRWQC exceedances by copper and lead because the detection limits in 2011 were higher than the NRWQC. Copper slightly exceeded the NRWQC in SW-5 in 2009, but not in any other stations at any date. Lead exceeded the NRWQC in SW-5 and SW-6 in 2006. Both of these stations are upstream from the landfill. Since the lead and copper concentrations have been lower than the background stations in the more downstream stations adjacent to the landfill, it is concluded any potential impacts due to lead and copper are unlikely and not related to the landfill.

Similar to Dunstable Brook, surface water benchmarks were exceeded for aluminum, barium, iron, and manganese in 2011 in Flint Pond and Flint Pond Marsh. Aluminum exceeded its NRWQC in SW-15 in Flint Pond Marsh, and iron exceeded its NRWQC in SW-14 and SW-15 in Flint Pond Marsh. NRWQC were not exceeded in Flint Pond. The exceedances by barium and manganese are not considered ecologically significant because the benchmarks for these inorganics are highly conservative. Of note is the very high concentration of iron (20,000 µg/l) in SW-15. This concentration of dissolved iron is impossible due to the insolubility of iron in the presence of dissolved oxygen so the sample may have been contaminated with particulate iron. The co-located sediment sample (SED-15) also had a very high iron concentration (90,000 mg/kg), suggesting that this sample area may have high iron, perhaps due to leachate from the landfill. Nevertheless, since iron is generally not chemically toxic due to lack of bioavailability in the presence of dissolved oxygen, any impacts would be localized and due to the physical effect of iron flocculent on the habitat, rather than chemical toxicity. There is uncertainty whether there were any NRWQC exceedances by copper and lead because the detection limits in 2011 were higher than the NRWQC. Copper has not exceeded NRWQC in Flint Pond or Flint Pond Marsh at any other sampling period. Lead exceeded its NRWQC only once before in SW-8 in 2006. Therefore, it is probable that copper and lead did not exceed the NRWQC in 2011. The surface water results indicate that ecological impacts due to chemical toxicity are unlikely in Dunstable Brook, Flint Pond, and Flint Pond Marsh. There is no evidence that contaminant concentrations are increasing in these water bodies, with the possible exception of the increased iron at SW-15 and SED-15 in Flint Pond Marsh. Any impact due to iron would be localized in this area and be due to the physical effects of iron precipitation, rather than chemical toxicity. As a result, it is concluded that significant ecological impacts are unlikely in these water bodies and further monitoring is unnecessary.

Sediment samples collected in 2011 were analyzed for PAHs and inorganics. VOCs were not analyzed because acetone was the only VOC that had exceeded its ecological benchmark previously, and acetone occurs naturally in organic-rich sediments. As shown in Table 6-5, in 2011 there were numerous exceedances of the no-effect benchmarks (Threshold Effect Concentration) by PAHs and inorganics. However, for PAHs in 2011 there were no exceedances of the effect-based benchmark (Probable Effect Concentration). There is uncertainty about the frequency of exceedance of no-effect benchmarks for PAHs because the detection limits were often higher than the no-effect benchmark. Nevertheless, none of the detection limits were higher than the effect-based benchmark; therefore it can be concluded that the effect-based benchmarks were not exceeded by PAHs. Aquatic impacts are rarely found unless the concentrations exceed effects-based benchmarks; therefore it is concluded that PAHs probably do not have impacts. There is no evidence that PAH concentrations are increasing. For inorganics in 2011, there were exceedances of no-effect benchmarks in Dunstable Brook, Flint Pond and Flint Pond Marsh, but no exceedances of effect-based benchmarks except for lead in one location (SED-11 in Flint Pond Marsh). Limited local impacts may occur in this location, but the absence of exceedances of effect-based benchmarks elsewhere suggests that impacts are unlikely. There are no apparent trends in concentrations of inorganics with the possible exception of increased iron at SED-15 and increased lead at SED-11, both in Flint Pond Marsh. It is concluded that adverse effects are unlikely except at a few localized areas and that continued monitoring is unnecessary.

Table E- 1. Inorganic Analytes in Surface Water

		Dunstable Brook																		
		SW-3			SW-3A			SW-3B		SW-4		SW-5					SW-6			
Analyte	Benchmarks	6/21/06	12/2/09	12/6/11	12/2/09		12/6/11	12/2/09	12/6/11	12/2/09	12/6/11	6/23/09	6/21/06	12/2/09	12/2/09 DUP	12/6/11	6/23/99	6/21/06	12/2/09	12/8/11
Aluminum	87[a]	82.6 J	**114** U	**120** U	**105** U		**140**	**108** U	**120** U	**121** U	**120** U	70	200 UJ	**120** U	**120** U	**120** U	**204**	**88.2** J	**189** U	**210**
Antimony	30[b]	2 U	0.25 U	22 U	0.21 U		22 U	0.23 U	22 U	0.2 U	22 U	NS	2 U	0.2 U	0.19 U	22 U	NS	2 U	0.22 U	22 U
Arsenic	150[c]	1.9	0.91 J	22 U	0.89 J		22 U	0.8 J	22 U	0.94 J	22 U	ND	6.2	0.93 J	0.8 J	22 U	ND	1.8	0.92 J	22 U
Barium	4[b]	**16.2**	**17.1** J	**51**	**14.8** J		**22** U	**15.4** J	**22** U	**14.4** J	**22** U	**17.8**	**69.1**	**14.8** J	**14.8** J	22 U	**16.2**	**15.4**	**10.9** J	**22** U
Beryllium	0.66[b]	**1** U	**1** U	**9** U	**1** U		**9** U	**1** U	**9** U	**1** U	**9** U	ND	**1** U	**1** U	**1** U	**9** U	ND	**1** U	**1** U	**9** U
Cadmium	0.25[c]	**1** U	1 UJ	**11** U	0.01 J		**11** U	1 UJ	**11** U	**1** UJ	**11** U	ND	**1** U	1 UJ	1 UJ	**11** U	ND	**1** U	0.0069 J	**11** U
Calcium	--	9610	11600	53000	10200		8200	10600	8200	8960	8000	18800	62900	9120	9620	7600	14700	8620	7390	5300
Chromium	74[c]	0.36 J	0.28 J	22 U	0.19 J		22 U	0.34 J	22 U	0.33 J	22 U	ND	0.53 J	0.36 J	0.3 J	22 U	ND	0.48 J	0.6 J	22 U
Cobalt	23[b]	0.43 J	0.71 J	22 U	0.67 J		22 U	0.68 J	22 U	0.69 J	22 U	2.8	1 J	0.85 J	0.83 J	22 U	ND	0.59 J	1.3 J	22 U
Copper	9[c]	0.9 J	1.1 J	**45** U	0.87 J		**45** U	1 J	**45** U	0.91 J	**45** U	**10.5**	0.68 J	0.9 J	0.93 J	**45** U	8.9	0.82 J	1.3 J	**45** U
Iron	1000[a]	512	571	**3700**	469		340	655	270	444	290	794	**3030**	451	440	250	555	494	742	260
Lead	2.5[c]	1 UJ	0.28 U	**22** U	0.3 J		**22** U	0.32 J	**22** U	0.32 J	**22** U	ND	**3.9** J	0.45 J	0.28 U	**22** U	ND	**7.4** J	0.33 J	**22** U
Magnesium	--	1910 J	2600	6700	2360		1800	2460	1800	2240	1800	4070	10200 J	2280	2260	1800	2990	1770 J	1740	1200
Manganese	120[b]	72.6	7.4 J	**510**	3.8 J		91	19.3 J	82	9.4 J	**140**	**259**	**1010**	10.8 J	6.8 J	82	**638**	87.1	87.1 J	32
Mercury	0.77[c]	0.2 U	0.2 U	NR	0.2 U		NR	0.2 U	NR	0.2 U	NR	ND	0.2 U	0.2 U	0.2 U	NR	ND	0.2 U	0.2 U	NR
Nickel	8.2[c]	2.6	3.1	**22** U	2.4		**22** U	2.5	**22** U	2.3	**22** U	ND	5.6	2.3	2.2	22 U	ND	2.8	1.9	**22** U
Potassium	--	2540 J	2830	NR	2540		NR	2640	NR	2410	NR	3740	13000	2470	2480	NR	2690	2380 J	1690	NR
Selenium	5[c]	5 U	5 U	**22** U	5 U		**22** U	5 U	**22** U	5 U	**22** U	ND	5 U	5 U	5 U	**22** U	ND	5 U	5 U	**22** U
Silver	0.36[b]	**1** U	0.01 U	**11** U	0.01 U		**11** U	0.009 U	**11** U	0.0057 U	**11** U	ND	**1** U	0.0075 U	0.015 U	**22** U	ND	**1** U	0.035 J	**11** U
Sodium	--	30000	34300	NR	31500		NR	32800	NR	30600	NR	43900	1E+05	31700	31100	NR	38800	27800	21700	NR
Thallium	12[b]	1 U	0.02 U	**22** U	0.018 U		**22** U	0.014 U	**22** U	0.013 U	**22** U	NS	1 U	0.011 U	0.015 U	**22** U	NS	1 U	0.02 U	**22** U
Vanadium	20[b]	0.52 J	0.38 J	**56** U	0.56 J		**56** U	0.4 J	**56** U	0.42 J	**56** U	ND	0.3 J	5 U	0.57 J	**56** U	2.1	0.57 J	0.53 J	**56** U
Zinc	120[c]	4.1 U	10.7 J	22 U	13.8 J		22 U	16.5 J	22 U	18 J	22 U	15.3	4.6 U	11.9 J	16.9 J	22 U	17.5	5.6 U	19.5 J	22 U

Table E-1 (continued). Inorganic Analytes in Surface Water

		Flint Pond						Flint Pond Marsh								
	Benchmarks	SW-8			SW-9			SW-11			SW-14			SW-15		
		6/20/06	12/1/09	12/7/11	6/20/06	12/1/09	12/7/11	6/20/06	6/20/06 DUP	12/1/09	6/20/06	12/1/09	12/7/11	6/20/06	12/1/09	12/7/11
Aluminum	87[a]	200 UJ	43.5 U	**120** U	200 UJ	45.3 U	**120** U	200 UJ	200 UJ	90.4 U	200 UJ	41.6 U	**120** U	200 UJ	42.2 U	**130**
Antimony	30[b]	2 U	0.23 U	22 U	2 UJ	0.25 U	22 U	2 U	2 U	0.22 U	2 U	0.3 U	22 U	2 U	0.38 U	22 U
Arsenic	150[c]	3.6	0.65 J	22 U	2	0.92 J	22 U	3.8	3.4	1 UJ	3.8	0.52 J	22 U	11.1	0.77 J	22 U
Barium	4[b]	**15.6**	**17.4** J	**22** U	**17.9**	**17.9** J	**22** U	**36.7**	**33.6**	**151** J	**50.6**	**144** J	**52**	**12.5**	**80.3** J	**32**
Beryllium	0.66[b]	**1** U	**1** U	**9** U	**1** U	**1** U	**9** U	**1** U	**1** U	0.093 J	**1** U	**1** U	**9** U	**1** U	**1** U	**9** U
Cadmium	0.25[c]	**1** U	1 UJ	**11** U	**1** U	0.12 J	**11** U	**1** U	**1** U	1 UJ	**1** U	0.043 J	**11** U	**1** U	1 UJ	**11** U
Calcium	--	15200	12900	13000	12800	12200	10000	33500	32300	26000	34400	52400	23000	27800	34000	19000
Chromium	74[c]	0.32 J	0.36 J	22 U	0.22 J	0.54 J	22 U	0.14 J	0.14 J	0.38 J	0.2 J	0.35 J	22 U	0.35 J	0.53 J	22 U
Cobalt	23[b]	1.1	0.23 J	22 U	0.39 J	0.33 J	22 U	0.26 J	1 U	3.4 J	0.68 J	3.5 J	22 U	0.71 J	1 J	22 U
Copper	9[c]	1.4 J	0.65 J	**45** U	0.67 J	0.77 J	**45** U	0.65 J	0.69 J	2 U	0.71 J	0.72 J	**45** U	3.8	2 J	**45** U
Iron	1000[a]	**1450**	337	250	257	391	340	64.3 J	42.2 J	171 J	66.1 J	8.2 U	**4400**	740	**1100**	**20000**
Lead	2.5[c]	**97.9** J	0.23 U	**22** U	1 UJ	0.29 U	**22** U	1 UJ	1 UJ	0.15 U	1 UJ	0.24 U	**22** U	1 UJ	1.1	**22** U
Magnesium	--	2540 J	2430	2300	1970 J	2230	1800	4940 J	4780 J	4760	5190 J	9360	3300	4110 J	5580	2600
Manganese	120[b]	**1530**	**171** J	120	**324**	**199** J	**140**	**344**	**344**	**5060** J	**1430**	**8330** J	**1200**	**711**	**1690** J	**2200**
Mercury	0.77[c]	0.2 U	0.2 U	**22** U	0.2 U	0.2 U		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U		0.2 U	0.2 U	
Nickel	8.2[c]	2.2	1.1	**22** U	1.8	1.2	**22** U	4.1	4.3	3	4.8	6.2	**22** U	4.9	3.3	**22** U
Potassium	--	4170 J	2620		2760 J	2550		6450	6310	3450	6170	8470		7010	10200	
Selenium	5[c]	5 U	5 U	**22** U	5 U	5 U	**22** U	5 U	5 U	5 U	5 U	0.76 U	**22** U	5 U	0.85 U	**22** U
Silver	0.36[b]	**1** U	0.018 U	**11** U	1 U	0.02 U	**11** U	**1** U	**1** U	0.017 U	**1** U	0.016 U	**11** U	**1** U	0.017 U	**11** U
Sodium	--	48800	34900		38100	35300		122000	119000	132000	120000	526000		107000	571000	
Thallium	12[b]	1 U	0.018 U	**22** U	1 U	0.014 U	**22** U	1 U	1 U	0.069 U	1 U	0.047 U	**22** U	1 U	0.016 U	**22** U
Vanadium	20[b]	0.13 J	5 U	**56** U	0.15 J	5 U	**56** U	0.17 J	1 U	5 U	0.31 J	5 U	56 U	0.38 J	5 U	**56** U
Zinc	120[c]	9.5 U	12.4 J	22 U	6.6 U	12.7 J	22 U	4.2 U	2.5 U	9.6 J	3.3 U	34.4 J	22 U	13.6	14.7 J	22 U

Notes:
All units reported in micrograms per liter (µg/l)
PAL = project action limit (TRC,2006b)
Values shown in bold equal or exceed a PAL; nondetects are in bold if the detection limit is higher than the PAL. Underlined values exceed NRWQC.
J = estimated value
U = analyte not detected at specified quantiation limit
ND = not detected
NS = not analyzed during sampling event
-- = no established PAL
DUP = field duplicate sample
a =National Recommended Water Quality Criteria for Non-Priority Pollutants (Freshwater CCCs)
b = Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1997 Revision (Tier II Values: Secondary Chronic Value)
c = National Recommended Water Quality Criteria for Priority Pollutants (Freshwater CCCs)
1999 samples were unfiltered - results reported represent total recoverable concentrations
2006, 2009, and 2011 samples were filtered-reported results represent dissolved concentrations

Table E- 2. Organic Analytes Exceeding Ecological Benchmark Values in Sediment

				Dunstable Brook															
Analytes	TEC	PEC	ORNL	SED-3				SED-3A		SED-3B		SED-4		SED-5				SED-6		
				6/21/06	12/2/09	12/2/09 DUP	12/6/11	12/2/09	12/6/11	12/2/09	12/6/11	12/2/09	12/6/11	6/21/06	6/21/06 DUP	12/2/09	12/6/11	6/21/06	12/2/09	12/7/11
VOCs																				

2-Butanone			270	19 JEB	41 J	17 UJ		98		R		100		130 EB	NA	190		1400 JEB	17 J	
2-Hexanone			22	R	15 U	17 U		28 U		R		18 U		11 U	NA	22 U		R	28 U	
Acetone			8.7	87 JEB	130 J	20 J		340 J		R		140 J		610 JEB	NA	250 J		1700 JEB	240 J	
Benzene			160	R	15 U	17 U		28 U		R		18 U		11 U	NA	22 U		R	28 U	
PAHs																				
Anthracene	57.2	845		64	74 J	25 J	60 U	62	120 U	95 J	90 U	6.8	120 U	46	17	8.7	110 U	3.3 U	19	160 U
Benzo(a)anthracene	108	1050		64	150	130	86	130	120 U	170 J	90 U	25	120 U	82	53	32	110 U	22 J	49	160 U
Benzo(a)pyrene	150	1450		3.3 U	110	110	88	69	120 U	110 J	90 U	24	120 U	66	90	24	110 U	3.3 U	69	160 U
Benzo(b)fluoranthene				NA	NA	NA	120	NA	130	NA	98	NA	120 U	NA	NA	NA	110 U	NA	NA	160 U
Benzo(g,h,i)perylene				NA	NA	NA	65	NA	120 U	NA	90 U	NA	120 U	NA	NA	NA	110 U	NA	NA	160 U
Benzo(k)fluoranthene				NA	NA	NA	60 U	NA	120 U	NA	90 U	NA	120 U	NA	NA	NA	110 U	NA	NA	160 U
Chrysene	166	1290		150	140	130	98	96	140	160 J	100	39	120 U	350	240	39	110 U	59	74	160 U
Dibenz(a,h)anthracene	33			3.3 U	26	26	60 U	17	120 U	31 J	90 U	7	120 U	78	66	9.8	110 U	3.3 U	23	160 U
Fluoranthene	423	2230		110	400 J	220 J	190	380	230	520 J	170	50	120 U	54	170	45	120	44	140	180
Fluorene	77.4	536		11 J	170 J	27 J	60 U	240	120 U	290 J	90 U	11	120 U	14	13	8.3 U	110 U	19 J	12	160 U
Indeno(1,2,3-cd)pyrene				NA	NA	NA	60	NA	120 U	NA	90 U	NA	120 U	NA	NA	NA	110 U	NA	NA	160 U
Naphthalene	176	561		3.3 U	250 J	9.3 J	60 U	400	120 U	600 J	90 U	6.6 U	120 U	3.3 U	4.2 J	8.3 U	110 U	3.3 U	9.6 U	160 U
Phenanthrene	204	1170		56	510 J	170 J	100	640	140	870 J	110	47	120 U	40	120	41	110 U	44	120	160 U
Pyrene	195	1520		150	320	210	170	310	200	430 J	170	67	120 U	350	230	68	130	110	150	160 U
Total PAH	1610	22800		608	2150	1057	1037	2344	840	3276	648	277	0	1080	1003	268	250	301	656	180

Notes:
All units reported in micrograms per kilogram (ug/Kg)
Values shown in bold exceed no-effect benchmarks; underlined values exceed effect benchmarks; nondetects are in bold if the detection limit is higher than the no-effect benchmark. EB = detected in equipment blank
J = estimated value
U = analyte was not detected at the specified quantitation limit
R = rejected value
UJ = estimated nondetect
NA = not applicable/not available
DUP = field duplicate sample
TEC = Threshold Effect Concentration (Macdonald et al, 2000). Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39, 20-31. PEC = Probable Effect Concentration (Macdonald et al, 2000). Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39, 20-31. ORNL = Oak Ridge National Laboratory (1997).Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision

Table E- 3. Inorganic Analytes Exceeding Ecological Benchmark Values in Sediment

				Dunstable Brook															
Analyte	TEC	PEC	ECO	SED-3				SED-3A		SED-3B		SED-4		SED-5			SED-6		
				6/21/06	12/2/09	12/2/09 DUP	12/6/11	12/2/09	12/6/11	12/2/09	12/6/11	12/2/09	12/6/11	6/21/06	12/2/09	12/6/11	6/21/06	12/2/09	12/8/11
Arsenic	9.79	33		**26**	**42.1**	**33.1**	4.3	**23.7**	**30**	**31.5J**	**16**	9.1	**15**	**64**	9.2	7.8	**25**	9	**14**
Cadmium	0.99	4.98		0.46J	0.17J	0.19J	1U	0.47J	0.98U	0.31J	0.98U	0.15J	0.98U	0.4J	0.24J	0.98U	**1.2J**	0.72UJ	**1.1**U
Iron			20000	**24000**	**37100EB**	**31800**	6900	**23100EB**	**25000**	**25100JEB**	17000	7440EB	15000	**54000**	9830EB	8000	**28000**	14200EB	14000
Lead	35.8	128		23	17.1J	14.2J	**43**	30J	28	27.1J	16	19.4J	28	22	22J	28	**61**	**61.9J**	**41**
Manganese			460	**1500**	**509J**	377J	70	**1040J**	800	**2360J**	**1500**	273J	**1800**	440	248J	**480**	**3600**	81.6J	**670**
Nickel	22.7	48.6		21	**29.4**	**27.1**	7.2	**32.8**	**30**	**31.7J**	19	15.9	18	**37**	22.3	12.0	**38**	15.6	**31**

				Flint Pond								
Analyte	TEC	PEC	ECO	SED-8				SED-9				
				6/24/99	6/20/06	12/1/09	12/7/11	6/24/99	6/20/06	12/1/09	12/7/11	12/7/11 DUP
Arsenic	9.79	33		2.6	**17**	1.9	9.6	**48.6**	**46**	1.9	**16**	**15**
Cadmium	0.99	4.98		ND	0.14J	0.26UJ	1.0U	0.24	0.19J	0.44UJ	**1.3**	**1.2**

Iron			20000	2190	5500	3310EB	5500	7020	11000	1650EB	11000	10000
Lead	35.8	128		2.7	23	5.2J	10	21.2	17	7.6J	**53**	**49**
Manganese			460	19.4	47	42.4J	100	428	**480**	19.3J	**690**	**620**
Nickel	22.7	48.6		1.4	5.1J	5.7	9.2	15.9	19	5.3	24	22

				Flint Pond Marsh												
Analyte	TEC	PEC	ECO	SED-11					SED-14				SED-15			
				6/24/99	6/20/06	6/20/06 DUP	12/1/09	12/7/11	6/24/99	6/20/06	12/1/09	12/7/11	6/24/99	6/20/06	12/1/09	12/7/11
Arsenic	9.79	33		**10.6J**	**21**	**25J**	**9.8J**	7.3	**27.6**	8.1J	**17.9J**	**18**	**25**	**25**	**18.6J**	**23**
Cadmium	0.99	4.98		0.34	0.48J	0.53J	0.93J	**1.9**	0.48	0.49	1.8R	1U	0.25	0.25	1.5R	**4.0**U
Iron			20000	9360	13000	15000J	2780JEB	3000	17600	6900	12800JEB	14000	10000	10000	16000JEB	**90000**
Lead	35.8	128		20.9	14	15J	**126J**	**<u>240</u>**	11.3	18	**45.6J**	**58**	6.3	6.3	26.2J	**77**
Manganese			460	296	**580**	**660J**	**1320J**	**1100**	**676**	150	**766J**	160	**540**	**540**	278J	**1400**
Nickel	22.7	48.6		10.8	12	13J	**26.9J**	**24**	11.3	11	**28.7J**	22	9.0	9	**30.9J**	**34**

Notes:
All units reported in milligrams per kilogram (mg/Kg)
Values in bold exceed no effect benchmark; values underlined exceed effect benchmark; nondetects are in bold if the detection limit is higher than the no-effect benchmark.
J = estimated value
U = not detected at specified quantiation limit
UJ = not detected at estimated quantitation limit
DUP = field duplicate
TEC = Threshold Effect Concentration (MacDonald et al 2000)
B = found in blank
R = rejected sample
PEC = Probable Effect Concentration (MacDonald et al 2000)
ECO = Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, June 1992.

Figure E- 1. Surface Water and Sediment Sampling Locations

APPENDIX F

Human Health Risk Evaluation for Irrigation Use of Groundwater

Estimated risk associated with irrigation of residential lawns with water from various groundwater sources at Charles George Landfill Superfund Site.

May 19, 2015

The purpose of this technical memorandum is to evaluate the potential risks of non-potable use of groundwater at Charles George Landfill Superfund Site. As detailed below, highly conservative (health protective) assumptions were made to estimate the risks to a residential child who might incidentally ingest surface soil that had been irrigated with groundwater from various groundwater monitoring wells at the Site. With the possible exception of three wells that had arsenic at elevated concentrations, it is concluded that there would be no significant cancer or non-cancer risk.

To estimate risk, it was assumed that irrigation with untreated groundwater would occur at a rate of 60 inches of water per year for a given area of lawn, and that all of the inorganics in the water would accumulate from year to year over a 6 year duration in the top 1 centimeter (cm) of a surface soil that had a density typical of sandy loam. This is a conservative assumption because dissolved inorganics would pass to some degree down through the soil, rather than accumulate at the surface. It was also assumed that there would be no re-distribution in the soil due to leaching, freezing and thawing, or mixing by soil organisms. Standard default EPA exposure factors were used to represent exposure of a residential child age 1-6 years old, weighing 15 kilograms, who would contact this soil for 350 days per year for 6 years and have incidental ingestion of 200 milligrams (mg) soil per day. It was conservatively assumed that the ingested soil would all be from the top 1 cm and there would be 100% absorption of the ingested inorganics in the digestive tract, except for arsenic which has an EPA default relative bioavailability of 60%. Toxicity values for the detected inorganics were obtained from standard EPA databases. Risks were not calculated for the nutrients calcium, magnesium, potassium, and sodium. Risks for lead were not estimated because lead was detected in only 2 of 19 wells at concentrations of 1.6 and 0.43 microgram per liter (µg/l). Volatile organic chemicals were not evaluated because they would volatilize rapidly from the soil. Dermal and inhalation risk of inorganics in soil was not evaluated because the inorganics do not penetrate the skin and do not volatilize.

Exposure concentrations were estimated by calculating the concentrations of inorganics that would accumulate per given surface area irrigated with 60 inches of water per year. Based on a computerized literature search for information about turf maintenance, 60 inches of water per year is a reasonable irrigation rate for fairways and greens of gold courses in the northeastern United States. This irrigation rate is highly conservative because a homeowner probably would not irrigate at this high a rate. The calculated annual incremental level of each inorganic was added to the assumed background concentration already in the soil so that each year's incremental addition of inorganics would be added to the background concentration for each of 6 years. The background concentration was assumed to be the same as the concentration in "natural" soil as reported by the Massachusetts Department of Environmental Protection (MADEP) in "Technical Update Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil". As detailed in the attached table, the predicted concentrations of inorganics added to the assumed background concentration were calculated for 6 years of irrigation.

Using the equations provided in the table, the predicted concentrations were used to calculate an ingested Average Daily Dose (ADD) over a 6-year exposure duration that was then divided by the EPA Reference Dose (the no effect dose) to calculate a Hazard Quotient. Hazard Quotients less than 1 are considered by EPA to represent a dose likely to have no chronic health effects. Hazard Quotients greater than 1 are considered by EPA to represent a potentially unacceptable health risk. As detailed in the attached table for the worst case well (CDM-5S), the cancer risk associated with an exposure duration of 6 years during childhood over a lifetime of 70 years was calculated by multiplying the ingested Lifetime Average Daily Dose (LADD) by the oral cancer slope factor. Arsenic was the only carcinogenic inorganic among those detected. Cancer risks greater than 1E-04 (1×10^{-4}, or 1-in-10,000) are considered by EPA to represent a potentially unacceptable health risk.

The concentrations of inorganics in groundwater from 19 wells measured in 2014 and 2015 are presented in Table 1. The predicted concentrations in soil after 6 years of irrigation and their associated non-cancer risks are provided in separate tables for each well. As shown in these tables, the HQ for each inorganic was less than 1 for all wells except GEI-F2, E&E FIT2, and CDM-5S. The HQ was greater than 1 for the latter three wells due to arsenic. The arsenic concentrations in these wells were 230 µg/l, 48 µg/l, and 260 µg/l, respectively, with associated HQ values of 7.2, 2.2, and 8.0. The cancer risk associated with the highest arsenic concentration (Well CDM-5S) was 1.8E-04 (see Table).

There is a high level of uncertainty and conservativeness associated with this risk evaluation. It is likely that the inorganics applied to the lawn in the irrigation water would leach down through the top layer of soil and be mixed by soil organisms, rather than accumulate on the surface. The exposure assumption that a child would ingest 200 mg/day of soil by hand to mouth transfer is conservative because the soil transfer would be less for a lawn than for bare dirt. The exposure assumption that the child would play on the lawn for 350 days per year is unlikely because the child would not be playing on the lawn during winter. Finally, it is likely that typical irrigation of lawns by homeowners would be considerably less than 60 inches of water per year. It would be more realistic to lower each of these exposure parameters by a factor of 2, resulting in an irrigation rate of 30 inches per year, an ingestion rate of 100 mg/day, and an exposure frequency of 150 days per year. The combined multiplicative effect of these three two-fold factors would be an overall decrease of risk by about 8-fold (i.e. ½ x ½ x ½ = 1/8). Such a decrease would lower the arsenic HQ to 1 or less (e.g. HQ=8/8=1 for well CDM-5S) and would lower the cancer risk associated with groundwater from the worst case well (CDM-5S) from 1.8E-05 to 2.3E-05, which is within EPA's acceptable risk range. Therefore, it is concluded that irrigation with water from GEI-F2, E&E FIT2, and CDM-5S is unlikely to have an unacceptable risk, given the highly conservative assumptions, and that irrigation with water from the other wells definitely does not have an unacceptable risk.

Table F-1. Residential child non-cancer and cancer risk associated with irrigation using water from well CDM-5S.

Chemical	Cw (mg/L)	WA (in³/ in²)	CF1 (L/in³)	CF2 (in²/cm²)	SASV (cm²/cm³)	SD (cm³/g)	CF3 (g/kg)	Annual Added Cs (mg/kg)	Background Cs (mg/kg)	Year 6 Cs (mg/kg)
Aluminum	0	60	1.64E-02	1.55E-01	1.00E+00	7.04E-01	1.00E+03	0	10000	10000
Arsenic	0.26	60	1.64E-02	1.55E-01	1.00E+00	7.04E-01	1.00E+03	28	20	187
Barium	0.15	60	1.64E-02	1.55E-01	1.00E+00	7.04E-01	1.00E+03	16	50	147
Copper	0	60	1.64E-02	1.55E-01	1.00E+00	7.04E-01	1.00E+03	0	40	40
Iron	36	60	1.64E-02	1.55E-01	1.00E+00	7.04E-01	1.00E+03	3863	20000	43177
Manganese	5.5	60	1.64E-02	1.55E-01	1.00E+00	7.04E-01	1.00E+03	590	300	3841
Nickel	0.048	60	1.64E-02	1.55E-01	1.00E+00	7.04E-01	1.00E+03	5	20	51
Vanadium	0	60	1.64E-02	1.55E-01	1.00E+00	7.04E-01	1.00E+03	0	30	30
Zinc	0.32	60	1.64E-02	1.55E-01	1.00E+00	7.04E-01	1.00E+03	34	100	306

Risk after 6 years exposure as child

Chemical	Year 6 Cs (mg/kg)	IR (mg/day)	EF (days/yr)	ED (yrs)	CF4 (kg/mg)	RBF (unitless)	AT-nc (days)	BW (kg)	ADD (mg/kg-d)	RfD (mg/kg-d)	HQ	AT-c (days)	LADD (mg/kg-d)	SF (mg/kg-d)-1	ELCR
Aluminum	10000	200	350	6	1.00E-06	1.0	2190	15	1.28E-01	1.0E+00	1.3E-01	25550	1.10E-02	--	--
Arsenic	187	200	350	6	1.00E-06	0.6	2190	15	1.44E-03	3.0E-04	4.8E+00	25550	1.23E-04	1.5	1.8E-04
Barium	147	200	350	6	1.00E-06	1.0	2190	15	1.87E-03	2.0E-01	9.4E-03	25550	1.61E-04	--	--
Copper	40	200	350	6	1.00E-06	1.0	2190	15	5.11E-04	4.0E-02	1.3E-02	25550	4.38E-05	--	--
Iron	43177	200	350	6	1.00E-06	1.0	2190	15	5.52E-01	7.0E-01	7.9E-01	25550	4.73E-02	--	--
Manganese	3841	200	350	6	1.00E-06	1.0	2190	15	4.91E-02	1.4E-01	3.5E-01	25550	4.21E-03	--	--
Nickel	51	200	350	6	1.00E-06	1.0	2190	15	6.51E-04	2.0E-02	3.3E-02	25550	5.58E-05	--	--
Vanadium	30	200	350	6	1.00E-06	1.0	2190	15	3.84E-04	5.0E-03	7.7E-02	25550	3.29E-05	--	--
Zinc	306	200	350	6	1.00E-06	1.0	2190	15	3.91E-03	3.0E-01	1.3E-02	25550	3.35E-04	--	--

Cw = concentration in water
Cs = concentration in soil
CF = Conversion factor
IR = soil ingestion rate
EF = exposure frequency
ED = Exposure duration
AT-nc = averaging time, non-cancer
AT-c = averaging time, cancer
LADD = Lifetime Average Daily Dose

SF = oral cancer Slope Factor
ELCR = Elevated Lifetime Cancer Risk
BW = body weight
ADD = Average Daily Dose
RfD = oral Reference Dose
HQ = Hazard Quotient
RBF = oral Relative Bioavailability Factor for soil
WA = Water added to surface
SASV = soil area per soil volume
SD = soil density

Background from:"MADEP Technical Update Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil"

Assumptions:
Irrigation rate of 60 inches of water per year for a given area
Soil density is 0.7 cm^3/g (typical of loam)
All added metals remain in top cm of surface soil
Ingested soil is from top cm of surface soil

Equations:
Annual added Cs = Cw*WA*CF1*CF2*SASV*SD*CF3
Year 6 Cs = Background Cs +(6 *annual added Cs)
ADD = Year 6 Cs*IR*EF*ED*CF4*RBF*1/AT*1/BW
HQ = ADD/RfD
LADD = Year 6 Cs*IR*EF*ED*CF4*RBF*1/AT-c*1/BW
ELCR = LADD * SF

APPENDIX G

Operations & Maintenance (O&M) Documentation

MassDEP
Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

One Winter Street Boston, MA 02108 • 617-292-5500

Charles D. Baker
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Karyn E. Polito
Lieutenant Governor

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Secretary

Martin Suuberg
Commissioner

Comprehensive Operations and Maintenance Package
Operable Units 2, 3, and 4
Charles George Landfill Reclamation Trust Landfill Superfund Site
Tyngsborough, Massachusetts
May 2015

Introduction

The attached folders contain the operations and maintenance manuals, guidelines, and plans for Operable Units 2, 3, and 4 at the Charles George Landfill Reclamation Trust Landfill Superfund Site in Tyngsborough, Massachusetts. These documents have been incorporated into a combined folder for ease of identification and use. The documents provided in the comprehensive package will be updated as necessary given changes in operation and maintenance protocols. Each Operable Unit is described below followed by an index of the available O&M documents.

Operable Unit 2

The OU2 Record of Decision provided a cap for the Site consisting of a synthetic membrane and soil cover, a surface water management system, a passive landfill gas venting system, and a leachate collection system. The landfill cover minimized storm water infiltration which reduces leachate generation. The leachate collection system minimized impacts to off-site surface water and groundwater. Construction of a synthetic landfill cap and appurtenant systems was begun in early 1989 and completed in October 1990.

Operations and maintenance activities are performed on the landfill cap which includes semi-annual inspections and maintenance as needed, site access controls, landfill gas vents, and vegetation control. Nearby land use activities are monitored for changes that could impact the protectiveness of the remedy. Soil gas concentrations are screened at the site boundary. MassDEP will also begin annual groundwater monitoring the fall of 2015.

Operable Unit 3

The OU3 Record of Decision provided for landfill gas thermal oxidation by flaring and groundwater extraction at the southwest area of the landfill. Five extraction wells were installed in a trenched system which limits off site migration. The flare reduced ambient emissions of methane and landfill gases. Also public water supply lines were installed to impacted areas that were currently only serviced by private wells. Construction of the groundwater collection trenches were completed in 1995, and construction of the current enclosed flare was completed in 1998

Operation and maintenance activities are performed on the flare and the groundwater collection trench. Also, every five years the off gases from the flare are sampled and analyzed for TO15 compounds to assured proper destruction. The water lines were turned over the local water utility which now owns and maintains them.

Operable Unit 4

The Operable Unit 4 Record of Decision provided for collection of groundwater in the eastern portion of the site and the combined discharge of groundwater from the east and southwest portions of the site, and landfill leachate to the public sewer system. OU4 includes the construction of a sewer line from the site to the existing system. Construction of the OU4 remedy components was completed in 1998. From there, it is piped to the Cummings Road Pumping Station for discharge to the Lowell Regional Wastewater Utility (LRWU) for treatment and disposal. This discharge is regulated by an LRWU industrial discharge permit.

Operations and maintenance activities are performed on the eastern groundwater extraction system, combined flow pump stations, and include all permit compliance activities.

O&M Responsibility

The Massachusetts Department of Environmental Protection has taken over operation and maintenance activities for of the site remedy components. Operation and maintenance is performed using the guidance provided in the O&M plans and guidance documents provided at the completion of each operable unit. Each applicable document has been converted to an Acrobat Adobe format and provided in the CG Comprehensive O&M Package. Documents are arranged according to remedy component and not operable unit.

Folder Index:

Folder 1, Landfill Cap O&M:

1.A Charles George Landfill Site, Tyngsborough, Massachusetts, Operations and Maintenance Plan for Post Closure Period, January 1992, provided by US. Army Corps of Engineers.

1.B. Massachusetts Department of Environmental Protection, Charles George Landfill Superfund Site, Landfill/Security/Site Maintenance Inspection Checklist, August 1999, MassDEP.

1.C. Long Term Groundwater Monitoring Plan, May 2015, MassDEP

Folder 2, Gas Collection and Monitoring:

2.A. Sampling Procedures for Perimeter Probes/Wells, date unknown, MassDEP

2.B. Charles George Landfill Superfund Site, Soil Gas Probe Monitoring Results, 1999. MassDEP

2.C. Massachusetts Department of Environmental Protection, Charles George Landfill Superfund Site, Gas Collection System Inspection Checklist, January 2001, MassDEP

Folder 3, Flare O&M:

Folder 3.1 John Zink Operating Manual

- 3.1.A. Operating Manual for 5' OD x 40 OAH, Enclosed ZTOF, Biogas Flare System, April 1999, John Zink, Part 1
- 3.1.B. Operating Manual for 5' OD x 40 OAH, Enclosed ZTOF, Biogas Flare System, April 1999, John Zink, Part 2
- 3.1.C. Operating Manual for 5' OD x 40 OAH, Enclosed ZTOF, Biogas Flare System, April 1999, John Zink, Part 3

3.A. Supplemental Flare Manual, 2009, US Corp of Engineers

3.B. Massachusetts Department of Environmental Protection, Charles George Landfill Superfund Site, Flare Inspection Checklist, August 1999, MassDEP

Folder 4, SW Trench O&M:

4.A. Submersible Well Pumps and Motors (II) Submittal, Operating and Maintenance Instructions, February 1994, Tricil Environmental

4.B. Massachusetts Department of Environmental Protection, Charles George Landfill Superfund Site, Southwest Groundwater Collection Trench Checklist, January 2001, MassDEP

Folder 5, Pump Station, East Wells, Discharge, PLC

5.A. Charles George Landfill Superfund Site, Operable Unit IV, Tyngsborough, Massachusetts, Final Operation and Maintenance (O&M) Manual, August 1999, Roy F. Weston, Inc.

5.B. Charles George Landfill Superfund Site, Operable Unit IV, Tyngsborough, Massachusetts, Final Operation and Maintenance (O&M) Manual, Appendix B, August 1999, Roy F. Weston, Inc.

Folder 5.1. OU4, O&M Misc. Figures, Tables, Plan

- 5.1.A. Figure 2-1, On-Site Process Flow Diagram
- 5.1.B. Figure 7-1, Daily Log Form
- 5.1.C. Figure 8-1, Equipment Record Card
- 5.1.D. Figure 9-1, Fire Extinguisher Maintenance Card
- 5.1.E. Table 5-1, Alarm Summary Table
- 5.1.F. Site Plan

Commonwealth of Massachusetts
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DRAFT LONG TERM GROUNDWATER MONITORING PLAN
CHARLES GEORGE RECLAMATION TRUST LANDFILL SUPERFUND SITE
TYNGSBOROUGH, MASSACHUSETTS

MassDEP RTN No. 3-2000136

Prepared by
Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup
One Winter Street
Boston, MA 02108

May 2015

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DRAFT LONG TERM GROUNDWATER MONITORING PLAN
CHARLES GEORGE RECLAMATION TRUST LANDFILL SUPERFUND SITE
TYNGSBOROUGH, MASSACHUSETTS
MassDEP RTN No. 3-2000136
May 2015

Table of Contents

1. INTRODUCTION

This Long Term Groundwater Monitoring Plan (LTGMP) is developed in anticipation of the Massachusetts Department of Environmental Protection (MassDEP) taking responsibility of groundwater monitoring from the U.S. Environmental Protection Agency (EPA) at the Charles George Reclamation Trust Landfill Superfund Site in Tyngsborough, Massachusetts (the Site).

1.1 Project Overview

Project consists of evaluating groundwater quality from 14 sampling points in the vicinity of the Site. Groundwater monitoring for Site contaminants will be used for evaluating the overall effectiveness of the landfill remedy.

1.2 Site Description

The Site is a former mixed industrial, municipal, and hazardous waste landfill located approximately one mile southwest of the center of Tyngsboro, Massachusetts. The Site comprises approximately 60 acres, and is bordered by U.S. Route 3 to the east, Cannongate Road to the south, Dunstable Road to the west, and Cummings Road to the north. The CGLF Site was operated from the mid 1950s until its closure in 1983. Based on available information, the landfill was primarily used as a disposal site for municipal wastes. However, industrial and hazardous wastes were accepted for disposal between 1973 and 1976 under a license from the Commonwealth of Massachusetts.

Disposal activities resulted in the release of hazardous materials to groundwater. Nearby private water supplies were impacted and the U.S. EPA and then MassDEP extended public water to those areas. The landfill has been capped and includes a leachate collection system and two groundwater extraction systems to control off site migration.

2. SCOPE AND DATA USAGE

2.1 Scope

The long term groundwater monitoring program is designed to collect data to be used in determining whether the management of migration remedy components remain effective. Groundwaters monitoring sampling points were chosen to represent downgradient and upgradient groundwater quality. In addition, MassDEP proposes to include a residence which is immediately upgradient and north of the site as an additional monitoring point. This property is serviced by a private well for potable water. A total of 13 monitoring wells and the one residential supply well will be incorporated into the program for a total of 14 monitoring points. The points will represent both the unconsolidated and bedrocks aquifers. Groundwater will be monitoring for general groundwater chemistry, volatile organic compounds, metals on an annual basis; and semi volatile organic compounds and mercury once every five years.

2.2 Data Usage

Groundwater analytical data will be used to assess current site conditions and to compare with prior site data to evaluate contaminant concentration trends and migration. Comparisons will be accomplished through the use of charts and trend graphs. Concentrations will be compared to MassDEP RCGW-1 concentrations. The contaminants of concern are taken from the Operable Unit Two Record of Decision.

3. MONITORING AND SAMPLING ACTIVITIES

3.1 Well Headspace and Groundwater Level Measurements

Prior to sampling, the well headspace will be screened for volatile organic compounds and methane utilizing appropriate screening tools. This data will be logged and used for comparison purposes in subsequent long term groundwater monitoring events.

Prior to sampling, the depth to water will be measured in the monitoring wells with respect to the top of the well casing using either an electronic water level indicator. All groundwater level measurements will be reported as elevations referenced to mean sea level and will be compared to historical data. Well construction details are provided in the attachment at the end of this document.

3.2 Groundwater Sampling

Groundwater samples will be collected using a Monsoon low-flow submersible pump, peristaltic pump, or bailer (depending on depth to groundwater and well recharge rates). The groundwater will be purged from the monitoring wells using the low stress or "low flow" sampling technique. The Region 1 Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells will be used as guidance.

Water quality parameters (D.O., pH, ORP, turbidity, temperature, and conductivity) will be monitored approximately every 5-10 minutes during well purging with a YSI Model 6 Series Sonde and a Hach turbidity meter. The well purge rate (ml/min.) and water level/depth (ft.) will also be measured. All field and in-situ data collected during the sampling event will be documented on field data sheets.

3.3 Residential Well Groundwater Sampling

Groundwater from the resident will be taken directly from the kitchen tap if access into the structure is available. Otherwise a sample will be taken from an outside tap if available and upon homeowner approval.

Based on the above criteria, the following groundwater monitoring points will be incorporated into the long term groundwater monitoring program:

Sample point I.D.	Relative Gradient to Plume	Formation Setting
MW-1	Upgradient - north	Bedrock - shallow
GEI-MW-1A	Upgradient - north	Overburden - shallow
MW-5	Downgradient - east	Bedrock - shallow
MW-5A	Downgradient - east	Overburden - shallow
CDM-5S	Downgradient - east	Overburden - deep
CDM-5B	Downgradient - east	Bedrock - shallow
MW-6	Downgradient - southeast	Bedrock – shallow
MW-8	Downgradient - south	Bedrock – shallow
MW-8A	Downgradient - south	Overburden – shallow
MW-9	Downgradient - southwest	Bedrock – shallow
MW-9A	Downgradient - southwest	Overburden – deep
MW-12	Downgradient - south	Bedrock – deep
MW-12A	Downgradient - south	Overburden - shallow
Residence	Upgradient – north	Unknown

See Figures 1 and 2 for monitoring point locations. Monitoring points may be adjusted as necessary based on access, recharge capacity, and well condition.

1. 3.4 Target Compound List

Groundwater will be analyzed annually for volatile organic compounds utilizing EPA Method 8260B and metals utilizing EPA Method 6010C. In addition, every five years semi volatile organic compounds will be analyzed by EPA Method 8270D and mercury by EPA Method 7470A. The constituents of concern based on the Operable Unit Two Record of Decision are:

OU2 ROD COC	MassDEP MCP-RCGW-1 (mg/L)	EPA Method	Reporting Limit (µg/l)
Acetone	6.3	8260B	10
Arsenic	0.01	6010C	5-10
Benzene	0.005	8260B	2
Benzoic acid	10.0	8270D	5-10
2-butanone	4.0	8260B	10
1,1-dichloroethene	0.007	8260B	2
1,4-dioxane[1]	0.0003	8260B	250-500
Cadmium	0.004	6010C	5-10
Copper	10.0	6010C	20
Ethyl Benzene	0.7	8260B	2
4-methyl-2-pentanone	0.35	8260B	10
Mercury	0.002	7470A	0.2
4-methylphenol	5.0	8270D	5-10
2-methylphenol	5.0	8270D	5-10
Phenol	1.0	8270D	5-10
Toluene	1.0	8260B	2
Tichloroethene	0.005	8260B	2

[1]1,4-dioxane added as COC after ROD.

Semi volatile organic compounds and mercury sampling schedules are reduced to once every five years based on historic data which shows concentrations are stable.

3 STANDARD SAMPLING PREPARATION AND CUSTODY

3.5 Sample Handling and Preparation

MassDEP will require its contractor to meet the requirements of the BWSC's Compendium of Quality Control Requirements and Performance Standards for Selected Analytical Protocols. The compendium provides for presumptive certainty for data collected, analyzed, and reported if the protocols established in it are met. Details can be found at:

http://www.mass.gov/eea/agencies/massdep/cleanup/regulations/wsc10-320-compendium--quality-control-reqs.html

3.6 Documentation

All information will be recorded in a site-specific logbook and field data sheets. Sampling teams will also complete sample container labels, chain of custody forms, etc.

3.7 Data Reporting

Analytical data will be presented in separate reports for each parameter. Reports will be delivered electronically to the MassDEP Project Manager. When all analyses are completed and approved, a compilation of analytical data will be available for download in Excel spreadsheet format. Any limitations on the use of data will be documented and explained. Field data will be compiled and reviewed by the Sampling Leader.

4 DATA REPRESENTATIVENESS

4.5 Data Comparability

Sampling and analytical data will be compared to previous analytical results from groundwater sampling as provided by EPA. The same field procedures and analytical methods will be used for each of the sample locations throughout the sampling event so that data can be compared. Samples must be representative of the current groundwater within the study area. Data will be used to assess if contaminants are present within the groundwater well interval. Field duplicates will be used to measure the precision of the method and heterogeneity of the sample matrix.

10.2 Data Completeness

The target requirement of valid data for completeness is 90%, however an evaluation of critical samples will determine if data are incomplete, and the MassDEP Project Manager will determine if additional sampling is needed.

5 ACCESS

Seven of the proposed groundwater sampling locations are outside the area MassDEP has access. Therefore access will need to be granted by the owner(s) prior to sampling activities. EPA will assist MassDEP with this effort.

6 SCHEDULE

Groundwater sampling events will be performed during the late fall months of September through November. The first round will begin late 2015. For years 1 through 4, VOCs and metals will be analyzed. Year 5 will include SVOCs and mercury. If any changes in groundwater quality are observed, the frequency and/or monitoring constituents will be reevaluated.

7 IMPLEMENATION

MassDEP will implement the long term groundwater monitoring program utilizing its Site Assessment and Remediation Site Support Contractors or Immediate Response Contractors selected by competitive bid. The selected contactor will be required to submit a Quality Assurance Project Plan and a Sampling and Analysis Plan which will be approved by the MassDEP Project Manager prior to field activities. The QAPP and SAP will provide details on the sampling program and quality program.

FIGURE 1

EAST WELL LOCATIONS

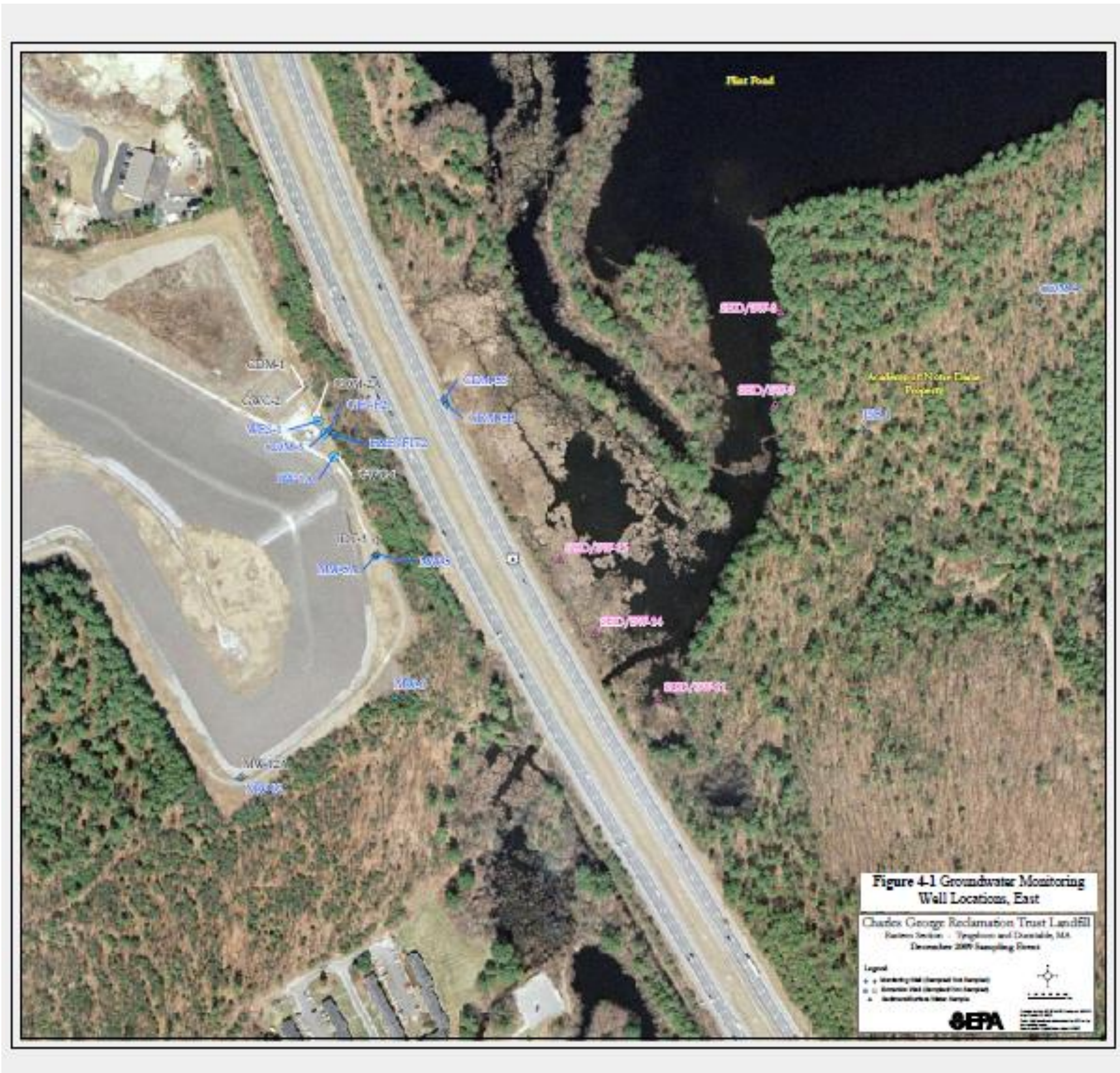
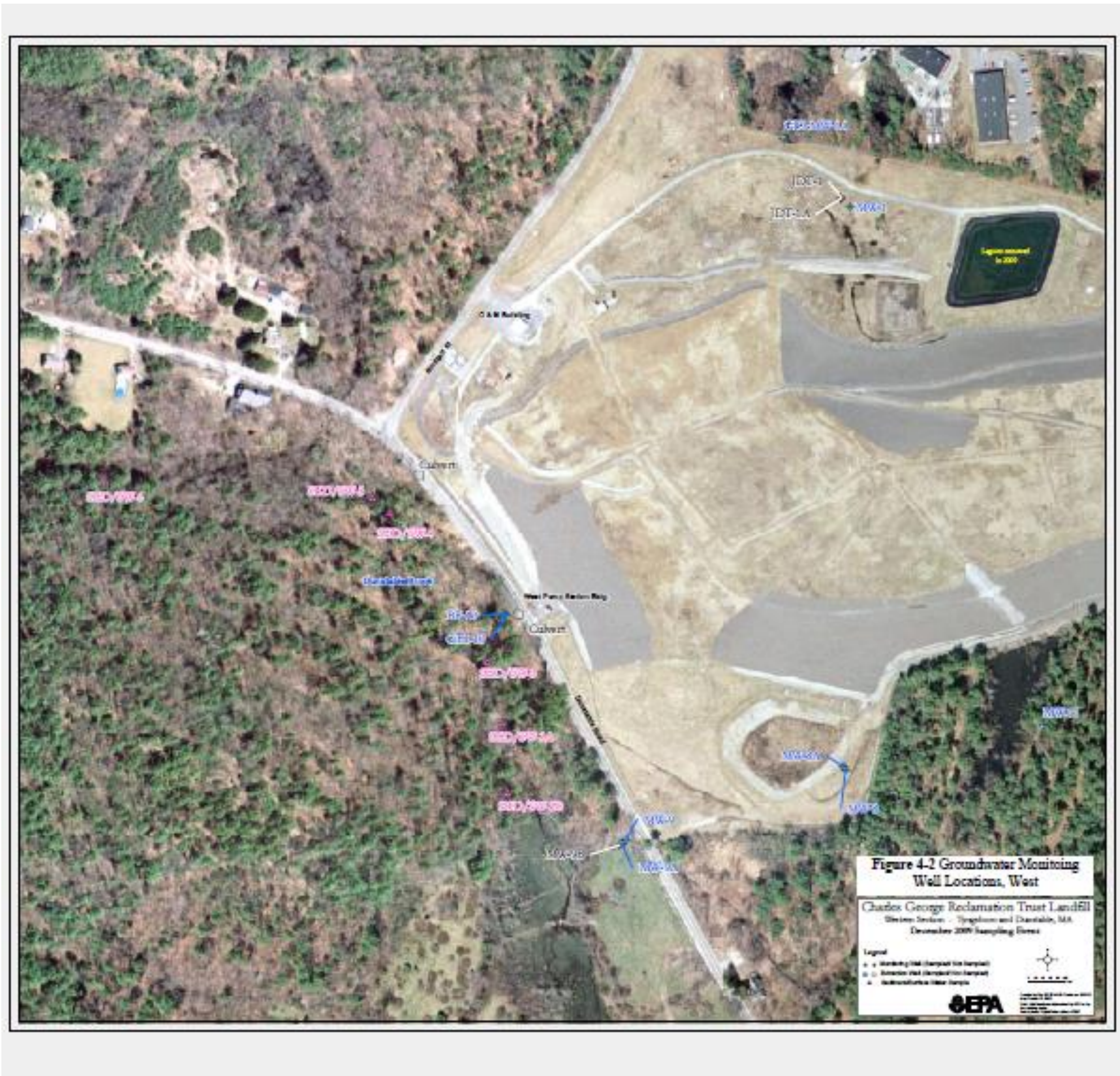


FIGURE 2

WEST WELL LOCATIONS



ATTACHMENT

WELL CONSTRUCTION DETAILS

Table 4-1: Monitoring Well Geometry Data & Ground Water Elevation Data
Charles George Landfill
Tyngsborough, Massachusetts
Groundwater Measurements Taken 11/3/09 through 12/7/09

WATER TABLE WELLS

Well Number	Well Material	Well Type	Well ID (in)	Total Depth(ft)	Grd. Surf. Elev. (ft)	Top of Casing Elev. (ft)	Top of Riser Elev. (ft)	Depth to Top Scr. (ft below bgs)	Depth to Bot. Scr. (ft below bgs)	Elev. Top Scr. (ft)	Elev. Bot. Scr. (ft)	Elev. Head (ft)	Longitude	Latitude	Ground Water Elev. (ft)	Depth to Water From Ref. Elev.
BF-10	PVC	OB	2	10.00	153.5	154.90	154.20	4.5	9.5	149.00	144.00	146.50	-71.4489177950	42.6680159550	153.50	0.70
E&E FIT2	PVC	OB	1.5	45.30	154.1	157.03	156.75	21.0	45.0	133.10	109.10	121.10	-71.4377913290	42.6694554060	127.83	28.92
GEI-MW1A	PVC	OB	2	24.60	215.3	219.87	216.69	10.6	19.6	204.70	195.70	200.20	-71.4460695360	42.6715718920	209.89	6.80
MW-5A	PVC	OB	2	22.30	157.2	158.40	158.32	16.0	21.0	141.20	136.20	138.70	-71.4373690230	42.6685535360	141.62	16.70
MW-8A	PVC	OB	2	11.50	180.5	180.60	180.07	6.0	11.0	174.50	169.50	172.00	-71.4454640250	42.6668694610	177.82	2.25
MW-12A	PVC	OB	2	9.20	184.1	186.32	184.44	5.0	9.0	179.10	175.10	177.10	-71.4387191840	42.6669212640		DRY
CDM-4	PVC	OB	2	50.00	139.2	142.63	142.44	30.0	40.0	109.20	99.20	NA	-71.4305778110	42.6704337860	122.73	19.71

DEEP OVERBURDEN WELLS

Well Number	Well Material	Well Type	Well ID (in)	Total Depth(ft)	Grd. Surf. El.(ft)	Top of Casing Elev. (ft)	Top of Riser Elev. (ft)	Depth to Top Scr. (ft below bgs)	Depth to Bot. Scr. (ft below bgs)	Elev. Top Scr. (ft)	Elev. Bot. Scr. (ft)	Elev. Head (ft)	Longitude	Latitude	Ground Water Elev. (ft)	Depth to Water From Ref. Elev.
MW-9A	PVC	OB	2	46.50	159.0	162.22	162.13	36.0	46.0	123.00	113.00	118.00	-71.4477244020	42.6662989820	151.52	10.61
CDM-5S	PVC	OB	2	56.00	130.99	133.34	133.11	51.00	56.00	79.99	74.99	NA	-71.4366630917	42.6697119951	124.61	8.50

SHALLOW BEDROCK WELLS

Well Number	Well Material	Well Type	Well ID (in)	Total Depth(ft)	Grd. Surf. El.(ft)	Top of Casing Elev. (ft)	Top of Riser Elev. (ft)	Depth to Top Scr. (ft below bgs)	Depth to Bot. Scr. (ft below bgs)	Elev. Top Scr. (ft)	Elev. Bot. Scr. (ft)	Elev. Head (ft)	Longitude	Latitude	Ground Water Elev. (ft)	Depth to Water From Ref. Elev.
JSB-1	PVC	BR	4	65.0	NA	136.18	TBD	59.0	64.0	-59.00	-64.00	-61.50	-71.4323837100	42.6694813990	121.38	14.80
MW-1	SC/OH	BR	5 5/8	60.0	215.40	217.62	NONE	19.0	60.0	196.40	155.40	175.90	-71.4453905180	42.6710595070	213.90	3.72
MW-5	SC/OH	BR	5 5/8	100.0	157.40	158.21	NONE	30.7	100.0	126.70	57.40	92.05	-71.4373459490	42.6685644090	142.16	16.05
MW-6	SC/OH	BR	5 5/8	75.0	167.50	169.51	NONE	12.7	75.0	154.80	92.50	123.65	-71.4371680713	42.6675124572	153.98	15.53
MW-8	SC/OH	BR	5 5/8	64.0	180.00	180.24	NONE	19.0	64.0	161.00	116.00	138.50	-71.4454413570	42.6668494250	179.84	0.40
MW-9	SC/OH	BR	5 5/8	100.0	158.80	161.09	NONE	55.7	100.0	103.10	58.80	80.95	-71.4476828670	42.6663239830	154.29	6.80
GEI-10	PVC	BR	2	62	153.00	157.28	157.20	17.5	62.0	135.50	91.00	113.25	-71.4488922010	42.6680065610	157.20	0.00
GEI-F2	PVC	BR	2	144.6	152.80	154.87	154.39	49.3	114.6	103.50	38.20	70.85	-71.4378344050	42.6694843170	129.17	25.22
MW-11	SC/OH	BR	5 5/8	55.0	191.60	193.28	NONE	9.0	55.0	182.60	136.60	159.60	-71.4434269660	42.6671796600	188.08	5.20
CDM-5B	PVC	BR	2	83.5	131.43	133.52	133.15	78.5	83.5	52.93	47.93	NA	-71.4366348530	42.6696767070	125.25	7.90

DEEP BEDROCK WELLS

Well Number	Well Material	Well Type	Well ID (in)	Total Depth(ft)	Grd. Surf. El.(ft)	Top of Casing Elev. (ft)	Top of Riser Elev. (ft)	Depth to Top Scr. (ft below bgs)	Depth to Bot. Scr. (ft below bgs)	Elev. Top Scr. (ft)	Elev. Bot. Scr. (ft)	Elev. Head (ft)	Longitude	Latitude	Ground Water Elev. (ft)	Depth to Water From Ref. Elev.
MW-12	SC/OH	BR	5 5/8	425	185.0	186.48	NONE	19.4	425.0	165.60	-240.00	-37.20	-71.4387440360	42.6669113510	139.77	46.71

Notes:
SC/OH - Steel Casing/Open Hole
DC/OH - Double Cased/Open Hole
PVC - Poly Vinyl Chloride
SS - Stainless Steel
OB - Overburden
BR - Bedrock
TBD - To Be Determined
NA - Not Applicable/Unknown
None - No Steel Casing Present

Source: TRC 2006

Weekly O&M Maintenance Logs

CHARLES GEORGE LANDFILL

5/5/2015 3:12:05 PM

WEEKLY INSPECTION DATA

Process Overview

Reports

Ctrl + P to Print

Effluent Monitoring Station

Record Effluent Temperature and Total Flow Amount from EMS Panel				
Effluent pH	6.76	Units	Total Effluent	Gals
Effluent Flow	13.0	GPM	Effluent Temp	Deg C

East Extraction Wells

WES-1	5376.	Hrs.	28	83617	Gals	1.4	GPM
CDM-3	29150	Hrs.	3	599703	Gals	0.0	GPM
PW-1A	27778	Hrs.	23	307612	Gals	0.0	GPM

East Pump Station Equipment

P-17A Wet Well	25358.	Hrs.
P-17B Wet Well	18353.	Hrs.
East Total Flow Amount	85 453379	Gallons
East Effluent Flow	23.0	Gallons Per Minute
East Discharge Pres.	23.5	Pounds Per Square Inch

East Pump Station Complexing Agent

P-18A Complex	17499.	Hrs	(Measure Drum Level at EPS)
P-18B Complex	16735.	Hrs.	Inches

East Pump Station Biocide

P-19A Biocide	5518.3	Hrs	(Measure Drum Level at EPS)
P-19B Biocide	6227.7	Hrs.	Inches

West Extraction Wells

MH-1	P-21	8275.2	Hrs.
MH-2	P-22	14972.1	Hrs.
MH-3	P-23	10732.6	Hrs.
MH-4	P-24	5617.6	Hrs.
MH-5	P-25	7533.4	Hrs.
Total Flow Amount		273, 453941	
Current Flow Rate		50.0	GPM

West Pump Station Equipment

P-26A Wet Well	15920.	Hrs.
P-26B Wet Well	14637.	Hrs.
West Total Flow Amount	27, 332573	Gallons
West Effluent Flow	13.1	Gallons Per Minute
West Discharge Pres.	24.0	Pounds Per Square Inch

West Pump Station Complexing Agent

P-27A Complex	12706.	Hrs	(Measure Drum Level at WPS)
P-27B Complex	12805.	Hrs.	Inches

West Pump Station Biocide

P-28A Biocide	4164.5	Hrs	(Measure Drum Level at WPS)
P-28B Biocide	4305.6	Hrs.	Inches

WEEKLY PUMP STATION LOG

Time: [illegible] Date: [illegible] Operator: B. Lareau

EAST PUMP STATION

East Extraction Wells

ID No.	Current Run Time	Previous Run Time	Hours Run	Current Flow (total)	Previous Flow (total)	Gallons Pumped	Current Flow Rate (gpm)	
WES-1	5,245.0	5,178.0	167.0	28,081,154	28,066,861.0	14,292	1.4	
CDM-3	29,150.0	29,150.0	0.0	3,598,703	3,598,703.0	0	0.0	
PW-1A	27,778.0	27,778.0	0.0	23,307,512	23,307,512.0	0	0.0	
						14,293		
					Total (gpm):	[illegible]		

East Pump Station Equipment

ID No.		Previous Run Time	Hours Run	Current Flow (total)	Previous Flow (total)	Gallons Pumped	Flow Rate (gpm)	Pressure (psi)
P-17A	[illegible]	26,319.0	48.0	85,442,522	85,379,960	62,562	15.2	28.0
P-17B	[illegible]	18,591.0	38.0					
Comments:					Total (gpm)	[illegible]	[illegible]	[illegible]
					[illegible]	[illegible]		

Citric Acid

ID No.	Current Run Time	Previous Run Time	Hours Run	Stroke Setting	Ratio Setting	Comments:
P-18A	17,497.0	17,451.0	46.0	48	1.0	
P-18B	[illegible]	16,882.0	41.0	48	1.0	

Drum Level (inches)	Previous Level (inches)	Inches Used	Conversion Factor	Gallons Used	No. of Days	Average Gallons Used/Day
23.0	24.50	1.5	1.6	2.4	7.0	0.3
Comments:				0.028 gals per hour	0.038 gals per 1000 gals	

Biocide BT-20

ID No.	Current Run Time	Previous Run Time	Hours Run	Stroke Setting	Speed Setting	On Time Period	Off Time Period	Ratio
P-19A	[illegible]	5,508.0	8.1	60	27	1 hour	24 hour	
P-19B	[illegible]	5,219.9	7.8	60	27	1 hour	24 hour	

Drum Level (inches)	Previous Level (inches)	Inches Used	Conversion Factor	10628.2	No. of Days	Average Gallons Used/Day
22.0	19.00	-3.0	1.6	-4.8	7.0	-0.69
Comments:	Added [illegible] inches on [illegible]			-0.318 gals per hour	-0.076 gals per 1000 gals	

WEEKLY PUMP STATION LOG

Time: 11:30:00 PM Date: 05/04/15 Operator: B. Lareau

WEST PUMP STATION

West Extraction Wells

ID No.	Current Run Time	Previous Run Time	Hours Run	Current Flow (total)	Previous Flow (total)	Gallons Pumped	Current Flow Rate (gpm)	
MH-1	8,275.2	8,275.2	0.0	[illegible]	272,867,176.0	495,894	50.0	[illegible]
MH-2	14,972.0	14,972.0	0.0					
MH-3	10,732.8	10,538.5	194.3					
MH-4	5,816.2	5,808.5	7.7					
MH-5	7,532.7	7,531.2	1.5					
					Total (gpd)	[illegible]		

West Pump Station Equipment

ID No.		Previous Run Time	Hours Run	Current Flow (total)	Previous Flow (total)	Gallons Pumped	Flow Rate (gpm)	Pressure (psi)
P-26A	16,915.0	16,904.0	11.0	27,324,365	27,301,735	23,630	0.0	37.0
P-26B	14,533.0	14,516.0	17.0					
Comments:					Total (gpd)	3,376	Ratio	7%
					Variance	-67,490		

Citric Acid

ID No.	Current Run Time	Previous Run Time	Hours Run	Stroke Setting	Ratio Setting	Comments:
P-27A	12,706.0	12,689.0	17.0	82	1.0	
P-27B	12,797.0	12,785.0	12.0	82	1.0	

Drum Level (inches)	Previous Level (inches)	Inches Used	Conversion Factor	Gallons Used	No. of Days	Average Gallons Used/Day
9.5	10.5	1.0	1.6	1.6	7.0	0.2
Comments				0.095 gals per hour	0.068 gals per 1000 gals	

Biocide

ID No.	Current Run Time	Previous Run Time	Hours Run	Stroke Setting	Speed Setting	On Time Period	Off Time Period	Ratio
P-28A	4,161.4	4,155.1	6.3	60	75	1 hour	24 hour	
P-28B	4,305.6	4,297.2	8.4	60	75	1 hour	24 hour	

Drum Level (inches)	Previous Level (inches)	Inches Used	Conversion Factor	Gallons Used	No. of Days	Average Gallons Used/Day
13.5	15	1.5	1.1	1.65	7.0	0.2
Comments:				0.117 gals per hour	0.070 gals per 1000 gals	

Massachusetts Department of Environmental Protection
CHARLES GEORGE LANDFILL SUPERFUND SITE (RTN-2-0136)
SOUTHWEST GROUNDWATER COLLECTION TRENCH INSPECTION CHECKLIST

Brendan Lareau 5/4/2015

900
1500

At the beginning of the inspection groundwater collection trench was: (Highlight One) **Operating** Not Operating In Alarm

If the trench was not operating, explain status# off at arrival due to west wet well alarms

Weekly: *Inspect and record condition of water level sensors, pump support cables, and hoses*

	Water Level Sensors			Pump Hoses/Cables	
	Acceptable	Unacceptable* (See Note Below)	Significant Buildup or Bacterial Growth	Acceptable	Unacceptable* (See Note Below)
Well No. 1	yes		no	yes	
Well No. 2	yes		no	yes	
Well No. 3	yes		no	yes	
Well No. 4	yes		no	yes	
Well No. 5	yes		no	yes	

Monthly: *Inspect and record condition of pump and pump connections. One pump per month should be taken apart and inspected/cleaned if necessary.*

	Pumps				
	Acceptable	Unacceptable* (See Note Below)	Significant Buildup or Bacterial Growth	Operating Amperage	Condition of hose/Support Cable/Electrical Cable Connection
Well No. 1	yes			off	
Well No. 2	yes			5.4	
Well No. 3	yes			5.2	
Well No. 4	yes			5.3	
Well No. 5	yes			5.4	

Note: All conditions identified as "unacceptable" should be detailed below or under separate cover

Flow Meter
Flow Meter Totalizer Reading: __Inoperative____ Gallons
Average Flow was: __n/a________ GPM with ___n/a______ Pumps Operating

Comments/General Maintenance Requirements:
Troubleshooting SW Extraction wells

Site Security Fence Inspected:	YES	NO

Detail Fence Maintenance Requirements:

UNUSUAL OR EMERGENCY CONDITIONS
Unusual or emergency conditions identified during busines hours should be reported immediately to the DEP Project Manager. During weekend, holiday, or evening hours, the DEP 24-Hour Emergency Response Program should be contacted by calling the State Police Dispatch at 1-888-304-1133, ask them to page DEP, ER.

Massachusetts Department of Environmental Protection
CHARLES GEORGE LANDFILL SUPERFUND SITE (RTN-2-0136)
FLARE INSPECTION CHECKLIST

Inspector(s):	Brendan Lareau	Date:	5/4/15
		Time In:	900
		Time Out:	1500

I. The Flare was *operating* / ***not operating*** at the beginning of the inspection.
(Highlight as appropriate)
If the Flare was not operating, describe alarm condition:
The flare is off due to oxygen sensor power problem

II. ***Flare Control Building:***

1. Instrumentation Readings (weekly):

Gas Volume (SCFM)	Blower Speed (Hz)	Landfill Pressure (Inches H2O)	Operating Temperature (F)	Gas Totalizer Reading (Cu. Ft.)	Oxygen Concentration (%)
inoperative	0ff	inoperative	53	n/a	0

2. Oxygen Sensor Calibrated (weekly):	**Yes**	No
Span Settings Prior to Calibration:	na	
Span Settings Following Calibration:	na	
Oxygen Concentration Following Calibration:	0	
Oxygen Sensor Replaced (as required):	Yes	**No**
Date Last Replaced: 5/30/2014 N/A		
3. Air Compressor/Refulator Drained (weekly):	**Yes**	No
4. Air Compressor Drain Bucket Emptied (as required):	Yes	**No**
5. Chart Recorder Paper Replaced (weekly):	Yes	**No**
Describe Previous Weeks Operation (based on chart): Chart recorder not operational.		

6. Comments/General Maintenance Requirements for System Control Building:

Date: 5/4/2015

III. *Blower Building*

1. Inlet Reading:	0	Inches H2O
Outlet Reading:	0.0	Inches H2O
2. Nitrogen Line Pressure:	85	PSI
2a. Nitrogen Tank Pressure	2100	PSI
3. Blower/Motor Bearings Lubricated: Date Last Lubricated: 12/30/2014	Yes	No
4. Blower/Motor Bushing Checked for Alignment: Date Last Checked: 12/30/2014	Yes	No
5. Knock-out Pot and Blower Drained: Date Last Drained: 12/30/2014	Yes	No
6. Drain traps under Knock-Out Pot/Blower Filled with Water: Date Last Filled: 12/30/2014	Yes	No
7. Comments/General Maintenance Requirements for Blower Building Components:		

IV. *Flare*

1. Flare Arrestor Inspected and Cleaned: Date Last Inspected 6/3/2014	Yes	No
2. Infrared Flame Detector Inspected and Cleaned: Date Last Inspected: 12/30/2014	Yes	No
3. Damper Flap Bearings Lubricated (weekly):	Yes	No

4. Comments/General Maintenance Requirements for Flare:

No flare data being recorded at SCADA system, have no ability to track flare run-time.
Ran Flare while on site while monitoring O2 and LEL levels.

UNUSUAL OR EMERGENCY CONDITIONS

Unusual or emergency conditions identified during busines hours should be reported immediately to the DEP Project Manager. During weekend, holiday, or evening hours, the DEP 24-Hour Emergency Response Program should be contacted by calling the State Police Dispatch at 1-888-304-1133, ask them to page DEP, Emergency Response.

Flare Inspection

Massachusetts Department of Environmental Protection
CHARLES GEORGE LANDFILL SUPERFUND SITE (RTN-2-0136)
FLARE INSPECTION CHECKLIST

Inspector(s): Brendan Lareau   Date: 5/26/15
Time In: 830
Time Out:

Stack Testing should be performed every five years.
Last Test Performed: 2010   Next Test Due: 2015

I. The Flare was *operating* ***/ not operating*** at the beginning of the inspection.
(Highlight as appropriate)
If the Flare was not operating, describe alarm condition:
The flare is off due to oxygen sensor loop error.

II. ***Flare Control Building:***

1. Instrumentation Readings (weekly):

Gas Volume (SCFM)	Blower Speed (Hz)	Landfill Pressure (Inches H2O)	Operating Temperature (F)	Gas Totalizer Reading (Cu. Ft.)	Oxygen Concentration (%)
inoperative	0ff	inoperative	Off	n/a	0

2. Oxygen Sensor Calibrated (weekly):	**Yes**	No
Span Settings Prior to Calibration:	na	
Span Settings Following Calibration:	na	
Oxygen Concentration Following Calibration:	0	
Oxygen Sensor Replaced (as required):	Yes	**No**
Date Last Replaced: 5/30/2014 N/A		
3. Air Compressor/Refulator Drained (weekly):	**Yes**	No
4. Air Compressor Drain Bucket Emptied (as required):	Yes	**No**
5. Chart Recorder Paper Replaced (weekly):	Yes	**No**
Describe Previous Weeks Operation (based on chart): Chart recorder not operational.		

6. Comments/General Maintenance Requirements for System Control Building:

Date: 5/26/2015

III. *Blower Building*

1.	Inlet Reading:	0	Inches H2O
	Outlet Reading:	0.0	Inches H2O
2.	Nitrogen Line Pressure:	85	PSI
2a.	Nitrogen Tank Pressure	2100	PSI
3.	Blower/Motor Bearings Lubricated: Date Last Lubricated: 12/30/2014	Yes	**No**
4.	Blower/Motor Bushing Checked for Alignment: Date Last Checked: 12/30/2014	Yes	**No**
5.	Knock-out Pot and Blower Drained: Date Last Drained: 12/30/2014	Yes	**No**
6.	Drain traps under Knock-Out Pot/Blower Filled with Water: Date Last Filled: 12/30/2014	Yes	**No**
7.	Comments/General Maintenance Requirements for Blower Building Components:		

IV. *Flare*

1.	Flare Arrestor Inspected and Cleaned: Date Last Inspected 6/3/2014	**Yes**	No
2.	Infrared Flame Detector Inspected and Cleaned: Date Last Inspected: 12/30/2014	**Yes**	No
3.	Damper Flap Bearings Lubricated (weekly):	**Yes**	No

4. Comments/General Maintenance Requirements for Flare:

No flare data being recorded at SCADA system, have no ability to track flare run-time.
Ran Flare while on site while monitoring O2 and LEL levels.

UNUSUAL OR EMERGENCY CONDITIONS

Unusual or emergency conditions identified during busines hours should be reported immediately to the DEP Project Manager. During weekend, holiday, or evening hours, the DEP 24-Hour Emergency Response Program should be contacted by calling the State Police Dispatch at 1-888-304-1133, ask them to page DEP, Emergency Response.

Semi-Annual Inspection

Massachusetts Department of Environmental Protection
CHARLES GEORGE LANDFILL SUPERFUND SITE
GAS COLLECTION SYSTEM INSPECTION CHECKLIST

Date of Inspection: 12/15/14 **Barometric Pressure:** 29.79

Name of Inspectors: B. Lareau, R. Garrison **Monitoring Equipment:** Landtec GA 90

Vent No.	O_2 (%)	CO_2 (ppm)	H_2S (ppm)	CH_4 (%)	Pressure (Inches H_2O)	Gas Temperature (F)	Valve Position (open full, 3/4, 1/2, 1/4, closed)	Detail Maintenance Requirements
1	0.4	27.3	0	41.7			1/4	Missing ball valve handle
3	1.2	31.5	0	58.5			1/4	Missing ball valve handle
4	0.6	27.9	0	45.3			1/4	None
5	0.7	27.6	0	49.4			1/4	None
6	1.0	24.8	0	53.8			1/4	None
8	1.5	25.2	0	39.2			1/4	Broken ball valve handle
9	0.1	33.4	1.0	66.5			1/4	Missing ball valve handle
10	0.7	29.0	0	54.8			1/4	Broken ball valve handle
11	1.6	25.4	0	52.1			1/4	None
12	0.2	26.4	0	38.2			1/4	Missing ball valve handle
14	2.8	20.9	0	46.4			1/4	None
15	2.4	22.8	0	46.8			1/4	None
16	4.7	19.2	0	39.1			1/4	None
17	0.2	25.0	0	67.1			1/4	Missing ball valve handle
18	3.0	23.5	0	34.9			1/4	None
21	2.6	21.3	0	34.3			1/4	None
22	0.6	25.2	0	54.3			1/4	None
23	12.8	10.7	0	16.0			1/4	Missing ball valve handle

Date: 12/15/2014

Vent No.	O_2 (%)	CO_2 (ppm)	H_2S (ppm)	CH_4 (%)	Pressure (Inches H_2O)	Gas Temperature (F)	Valve Position (open full, 3/4, 1/2, 1/4, closed)	Detail Maintenance Requirements
24	4.0	17.6	0	40.0			1/4	None
25	0.7	20.5	0	31.0			1/4	Rodent hole near collection point
26	15.1	7.7	0	12.8			1/4	None
28	7.2	16.5	0	29.3			1/4	None
29								Closed
30								Closed
31								Closed

Monitoring Well Number	O_2 (%)	CO_2 (ppm)	H_2S (ppm)	CH_4 (%)	Pressure (Inches H_2O)	Gas Temperature (F)	Valve Position (open full, 3/4, 1/2, 1/4, closed)	Detail Maintenance Requirements
JLF 1	1.2	25.2	0	53.7			1/2	Needs to be resealed
JLF 1A	1.4	23.4	0	48.1			1/4	None
JLF 2	1.9	22.8	0	49.9			open full	None

	O_2 (%)	CO_2 (ppm)	H_2S (ppm)	CH_4 (%)	Gas Temperature (F)	Detailed Maintenance Requirements
Flare Sample Port						Not Running

	Detailed Maintenance Requirements
Gas Collection Pipeline	No maintenance required at time of inspection.

UNUSUAL OR EMERGENCY CONDITIONS

Unusual or emergency conditions identified during busines hours should be reported immediately to the DEP Project Manager. During weekend, holiday, or evening hours, the DEP 24-Hour Emergency Response Program should be contacted by calling the State Police Dispatch at 1-888-304-1133, ask them to page DEP, Emergency Response.

Massachusetts Department of Environmental Protection
CHARLES GEORGE LANDFILL SUPERFUND SITE
LANDFILL/SECURITY/SITE MAINTENANCE INSPECTION CHECKLIST

I. GENERAL INFORMATION

DATE: 12/16/2014
TIME BEGAN: 800
TIME COMPLETED: 1500

INSPECTORS (Include Name and Organization):

1) Brendan Lareau Watermark
2)
3)

WEATHER:
(Describe both current conditions and significant conditions during previous 72 Hours):
Current conditions: Sun 30-40s
No significant weather during the previous 72 hours.

GENERAL COMMENTS/OBSERVATIONS/AMBIENT AIR CONDITIONS (Unusual Odor, Site Activities, Changes Since Last Inspection):
The landfill appears to be in good condition. No odors were detected during the inspection.

GENERAL COMMENTS REGARDING CHANGES IN LANDUSE ON SITE AND AT ADJACENT PARCELS
(Note changes in use, new structures, or activities)
There are no changes in uses, activities on site or at adjacent properties. There are no new structures.

II. SITE SECURITY

Feature	Condition	Describe Maintenance Requirements
Front Access Gates (Blodgett Rd)	Good	
Back Gate Access (Dunstable Rd)	Good	
Perimeter Fence/Gates/Locks/Chains	Good	100' SW of Blodgett Road. The top rail of the fence needs to be straightened.
Barbed Wire	Good	
Warning Signs (Every 50 feet)	Good	

Vegetation Growth around Fence	Good	
Evidence of Unauthorized Access: If Yes, Describe Evidence and Location	**NO**	

Date: 12/16/2014

III. LANDFILL COVER

A. Synthetic Membrane & Seams

Observation Port Number	Visual Appearance of Membranes & Seams	Describe Maintenance Requirements
1	Good / Some wrinkles	None
2	Good / Material above membrane is cut to allow viewing of membrane	None
3	Good	None
4	Good	None
5	Good	None
6	Good	None
7	Good	None
8	Good	None
9	Good	None
10	Good	None
11	Does not Exist	NA
12	Good	None
13	Good	None
14	Good	None
15	Good / Seam is also Good	None
16	Good	None
17	Good	None

18	Good	None
19	Good	None
20	Good	None

Date: 12/16/2014

B. Landfill Cover Materials

	Cap Component	Condition/Describe Maintenance Requirements
1)	**VEGETATION:** **Areas of Stress** **Estimate Vegetation Height** **Presence of Woody Plants**	The vegetation cover is approximately 4-6 inches tall with no signs of stress or woody plants.
2)	**SOIL BASE:** **Holes and Cracks** **Erosion/Gullies**	 None None
3)	**GRAVEL COVER:** **Depth of Coverage** **Exposed Areas** **Gravel Slippage**	The gravel cover appears to be in good condition with no exposed areas or slippage.
4)	**CAP INTEGRITY/SUBSIDENCE:** **Significant Holes** **Significant Bulges** **Water Ponding** **Leachate Seeps**	 None None Some ponding noticed 15' SE of Gas Collection Point 6 None

IV. SURFACE DRAINAGE FACILITIES

A. Drainage Swales & Culverts

	Drainage Swale Component	Condition/Describe Maintenance Requirements
1)	**LANDFILL CAP SWALES/CULVERTS:** **Significant Vegetation Growth** **Blockages** **Significant Debris Buildup**	No significant vegetative growth, blockages or debris buildup was present during the inspection.

2)	**PERIMETER SWALES/CULVERTS:** **Significant Vegetation Growth** **Blockages** **Significant Debris Buildup**	No significant vegetative growth, blockages or debris buildup was present during the inspection.

Date ______________ 12/16/2014

B. Sediment Basins

	Sedimentation Basin	Condition/Describe Maintenance Requirements
1)	**WEST SED. BASIN:**	
	Inlet Clear of Debris	Yes
	Riser Pipe/Outlet Culvert Debris	No Debris
	Sidewall Integrity	Good
	Evidence of Landfill Erosion/Siltation	No evidence of Landfill Erosion or Siltation
2)	**SOUTHWEST SED. BASIN:**	
	Inlet Clear of Debris	Yes
	Riser Pipe/Outlet Culvert Debris	No Debris
	Sidewall Integrity	Good
	Evidence of Landfill Erosion/Siltation	No evidence of Landfill Erosion or Siltation
3)	**EAST SED. BASIN:**	
	Inlet Clear of Debris	Yes
	Riser Pipe/Outlet Culvert Debris	No Debris
	Sidewall Integrity	Good
	Evidence of Landfill Erosion/Siltation	No evidence of Landfill Erosion or Siltation

V. ROADWAYS

	Feature	Condition/Describe Maintenance Requirements
1)	**PERIMETER ROAD:**	
	Potholes/Ruts **Vegetative Growth**	No maintenance required.

2)	**LANDFILL ACCESS ROAD:** **Potholes/Ruts** **Vegetative Growth**	No maintenance required.
3)	**ACCESS/PARKING AREA/EAST & WEST PUMP STATION/SW TRENCH:** **Potholes/Ruts** **Vegetative Growth**	No maintenance required.

Date 12/16/2015

VI. LEACHATE COLLECTION SYSTEM

Clean Out Number	H_2S (ppm)	O_2 (%)	CH_4 (%)	VOCs by PID (ppm)	Leachate Flow Conditions	Detailed Maintenance Requirements
1	0	0.8	0.7	1.8	Standing Water	None
2	0	22.1	0	0	Standing Water	Iron buildup
3	0	4.1	1.1	1.5	Good Flow	Interior of riser pipe is purple
4	0	16.4	0.6	1.8	Trickle Flow	None
5	0	19.2	0.1	0	Some Debris	See photo
6	Inspect Only - Sampling Not Applicable				No Flow	None
7	Cleanout No. 7 - Was buried during installation of West Force Main - No Inspection Possible					
8	0	14.4	0	0.7	Trickle Flow	Debris, See photo
9	0	18.4	0.1	0.2	Standing Water	Iron buildup, See photo
10	0	3.4	17.2	0	No Flow	None
11	Inspect Only - Sampling Not Applicable				No Flow	Crushed stone bottom
12	0	7.4	8.2	1.3	Standing Water	None
13	0	20.5	0	0.6	Standing Water	None
14	0	1.2	5.9	1.1	No Flow	None
15	0	4.5	3.0	4.3	No Flow	Iron buildup

Evidence of Toe Drain Subsidence (Highlight One): **YES** **NO** (YES highlighted)
If Yes, Describe and Identify Location: Possible subsidence at 8 and 9.

Evidence of Leachate Breakout (Highlight One): **YES** **NO** (NO highlighted)

If Yes, Describe and Identify Location:

UNUSUAL OR EMERGENCY CONDITIONS

Unusual or emergency conditions identified during busines hours should be reported immediately to the DEP Project Manager. During weekend, holiday, or evening hours, the DEP 24-Hour Emergency Response Program should be contacted by calling the State Police Dispatch at 1-888-304-1133, ask them to page DEP, Emergency Response.

Massachusetts Department of Environmental Protection

CHARLES GEORGE LANDFILL SUPERFUND SITE

SOIL GAS PROBE MONITORING RESULTS

Date of Inspection: 12/15/2014
Name of Inspectors: B. Lareau, R. Garrison
Equipment Calibration: Landtec, PID

Barometric Pressure: 29.78
Weather Conditions Sun 30's
Date/Time of Calibration: 12/15/14

Vent No.	O_2 (%)	CO_2 (ppm)	H_2S (ppm)	CH_4 (%)	VOCs (ppm)	Monitoring Type	Comments
SG-1	21.4	0.1	0	0	0	Stabilized	Needs tube cap
SG-2	21.5	0.2	1.0	0	0	Stabilized	Needs tube cap
SG-5	21.7	0.1	1.0	0	0	Stabilized	Needs tube cap
SG-7	21.3	0.6	0	0	0	Stabilized	Needs tube cap
SG-9	21.9	0.1	0	0	0	Stabilized	Needs tube cap
SG-20	21.9	0.1	0	0	0	Stabilized	Needs tube cap
SG-22	22.1	0.1	0	0	0	Stabilized	Needs tube cap
SG-29	21.4	0.1	0	0	0	Stabilized	None
SG-30	21.5	0.1	0	0	0	Stabilized	Needs tube cap
SG-31	21.5	0.1	0	0	0	Stabilized	Needs tube cap
SG-32	21.7	0.1	0	0	0	Stabilized	Needs tube cap
SG-32-I	21.6	0.1	0	0	0	Stabilized	Needs tube cap
SG-32D	21.5	0.1	0	0	0	Stabilized	Needs tube cap
SG-6	21.9	0.1	0	0	0	Stabilized	Needs tube cap
SG-8	21.6	0.4	0	0	0	Stabilized	Needs tube cap
SG-16	21.5	0.1	0	0	0	Stabilized	None
SG-16I	21.5	0.1	0	0	0	Stabilized	None

SG-16D	21.2	0.2	0	0	0	Stabilized	None
Right of Front Gate	20.4	0.8	0	0	0	Stabilized	None
Left of Front Gate	21.2	0.2	0	0	0	Stabilized	None

<u>Notes:</u>

1. Field measurements for CH_4, CO_2, H_2S and O_2 were made using a LANDTEC Model GA-90 direct-reading instrument
2. Field Measurements for VOCs were made using a Photovac 2020 Photoionization Detector
3. Field measurements were recorded approximately after two minutes (stabilized)

APPENDIX H

Lowell Regional Wastewater Utility (LRWU) Discharge Permit Information

Watermark

Engineering • Construction • Operations

Environmental
Infrastructure
Buildings & Facilities

April 14, 2015

Ms. Amy Daigneault
Lowell Regional Wastewater Utility
First Street Boulevard (Rt. 110)
Lowell, Massachusetts 01850

Subject: **Quarterly Effluent Monitoring Report – 1st Quarter 2015**
Industrial Sewer User Permit No. 085
Charles George Landfill, Tyngsborough, MA

Dear Ms. Daigneault:

On behalf of the Massachusetts Department of Environmental Protection (MassDEP), Watermark Environmental, Inc. (Watermark) is pleased to submit the attached sampling results regarding the wastewater discharge testing for the Charles George Landfill, located in Tyngsborough, Massachusetts. The report is for the 1st Quarter of 2015, which is defined as January 1 through March 31, 2015.

This submittal includes samples taken during the month of March 2015. The Quarterly/Semi-Annual composite/grab samples were taken on March 5 and 6, 2015 for all parameters. All samples were analyzed by Con-test Analytical. The following effluent wastewater samples were collected in accordance with the Sites Industrial Sewer User Permit:

- Flow-paced composite samples for COD, TSS, Total Nitrogen and Metals.
- Discrete grab samples for Acidity, VOC's, SVOC's, Pesticides and PCB's.

The completed Industrial Sewer User Self-Monitoring Report Summary Sheet is included as Attachment A.

The laboratory analytical report is included as Attachment B.

The effluent flow and pH data for this monitoring period are included as Attachment C.

We hope that you will find the information included herein complete. If you have any questions or require additional information regarding this submittal, please contact Mr. Mark E. Augustyniak at (978) 452-9696 or the MassDEP Project Manager, Mr. David Buckley, at (617) 556-1184.

Sincerely,
WATERMARK

Mark E. Augustyniak
Project Manager

cc: David Buckley (MassDEP)
File 14030/WLC2736

175 Cabot Street • Lowell, MA 01854 • Office 978.452.9696 • Fax 978.453.9988 • www.watermarkenv.com

LOWELL REGIONAL WASTEWATER UTILITY
Industrial Sewer User Self-Monitoring Report Summary Sheet

Facility Information: Company Name Watermark Environmental, Inc. (Contractor for MassDEP)

Facility Address 70 Cummings Road, Tyngsborough, MA Permit No. 085

Facility Contact Mark Augustyniak Telephone (781) 258-1727

———————Use A Separate Summary Sheet For Each Monitoring Point———————

Monitoring Report: Monitoring Point Site 001 Submittal Date 4/14/15

Reporting Period (circle one): Baseline Annually [Semi-Annually] [Quarterly] Monthly Re-Sample

Reporting Period Start Date 1/1/15 Reporting Period End Date 3/31/15

Sample Analysis: Certified Analytical Lab Con-test Analytical Laboratory

Authorized Rep. Meghan E. Kelley Certification No. M-MA 100

Analytical Sub-Contractor New England Testing Certification No. MA M-R1010

Sample Collection: Sampler (Lab/Self/Other) Brendan Lareau, Watermark Environmental, Inc.

Sample Type(s) (circle all that apply): [Grab] Time Composite [Flow Composite]

Grab Sampling: Sample Date 3/5/15 Sample Time 11:30

pH (Standard Units) 6.58 Temperature (° F) 40.06 Instant Flow Rate (GPM) 10.68

Composite Sampling: Start Date/Time 3/5/15 – 11:30 Stop Date/Time 3/6/15 – 12:10

No. Aliquots 58 Aliquot Volume 150 ml Sample Volume 8.7 L

Flow Data: Sampling Event Interval Volume (Gal) 5,867 Daily Flow Rate (GPD) 5,867

Flow Monitoring Period Average Daily Flow (GPD) 15,185.54 [x] Meter [ ] Estimate

Monitoring Period Start Date 1/1/15 Monitoring Period End Date 3/31/15

Refer to Self-Monitoring Report Instructions for details on completing this SMR Summary Sheet

N/A = Not Applicable

Submit All Chains of Custody and Laboratory Result Sheets With SMR Summary Sheet

LOWELL REGIONAL WASTEWATER UTILITY

Industrial Sewer User Self-Monitoring Report Summary Sheet

Analytical Results: **Site 001**

Parameter	Analysis Date	Result (mg/L)	Parameter	Analysis Date	Result (mg/L)
Acidity	3/13/15	249	VOCs (Method 624)		
COD	3/11/15	94	Acetone	3/9/15	0.11
TTO **	3/9/15	0.24	Benzene	3/9/15	0.0012
			Tetrahydrofuran	3/9/15	0.0075
Arsenic	3/11/15	0.064	1,4-Dioxane	3/9/15	0.13
Copper	3/11/15	0.024			
Lead	3/11/15	ND	SVOCs (Method 625)	3/13/15	ND
Nickel	3/11/15	0.019			
TSS	3/9/15	11			
Total Nitrogen	3/9, 3/11 & 3/13/15	30	PCBs (Method 608)	3/12/15	ND
			Pesticides (Method 608)	3/14/15	ND

BOD = Biochemical Oxygen Demand COD = Chemical Oxygen Demand O & G = Oil & Grease TSS = Total Suspended Solids TTO = Total Toxic Organics

NR = Not Required NA = Not Analyzed ND = Not Detected TOC = Total Organic Carbon

*** TTO's = Summation of all quantifiable values greater than 0.01 mg/L for toxic organics listed in 40 CFR 413.02(i). TTO's include PCB's (Poly-Chlorinated Biphenyls), VOC's (Volatile Organic Compounds), SVOC's (Semi-Volatile Organic Compounds). PCB's, VOC's and SVOC's shall be analyzed using EPA Methods 608, 624, and 625, respectively.*

Zero Discharge / Self-Monitoring (initial if applicable):

______________ No industrial wastewater from permitted processes has been discharged to sewer during the monitoring period

______________ No sampling has been conducted on permitted sewer discharges during the monitoring period

Certification Statement:

"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Mark E. Augustyniak	Project Manager
Printed Name of Authorized Representative	*Title*
[signature]	4/14/2015
Signature of Authorized Representative	*Date*