

# **Executive Summary**

## **Assessing Green and Efficient Remediation at Waste Sites**

Benjamin Duquette, Christian Anderson, Zonglin Peng

### **The Issue**

Thousands of contaminated properties and industrial waste sites in the United States cause air, water and soil pollution. Waste sites can negatively impact public health through pollution of groundwater, the main source of drinking water for people (Maibach, 2015). Waste sites can range from toxin-ridden soil near abandoned chemical facilities to small oil spills at gas stations. Most potential groundwater contamination sources include gasoline storage tanks, septic systems, landfills, chemicals such as pesticides and fertilizers and other uncontrolled hazardous wastes (The Groundwater Foundation, 2018).

In 1980, the Environmental Protection Agency (EPA) established the federal superfund program, which provides guidelines for classifying the most hazardous waste sites throughout the nation, and enables the EPA to identify and hold accountable the parties responsible for the contamination (United States Environmental Protection Agency, n.d.). Using this as framework, the Commonwealth of Massachusetts created The State Superfund Law which allows the MA government to take designated actions (described in the Massachusetts contingency plan) in response to any site containing a risk of oil or hazardous material release (The General Court of the Commonwealth of Massachusetts, 2018).

The Massachusetts Department of Environmental Protection regulates and monitors cleanup and remediation processes in MA. They have aided in identifying 47,759 hazardous waste sites throughout the state. Through their efforts and regulations, hundreds of these sites have been successfully remediated, leaving only 200 sites left today.

A significant program that MassDEP is responsible for monitoring is the Licensed Site Professional (LSP) Program. LSPs are the individuals who oversee waste site assessments and cleanup processes at specific sites (Sellers, 1998). The LSPs' role is to direct the assessment, characterization, and, to the extent necessary, the cleanup process along with relevant regulations and laws.

Waste site cleanup programs in MA utilize a variety of different remedial technologies in order to reduce or eliminate contamination. One of the most common types is the Pump & Treat process, which is used to hydraulically remove pollutants to restore aquifers (MassDEP, 2009). The Groundwater Remediation (GWR) cleaning method, a specific type of P&T, is commonly used to reduce the amount of pollution and environmental damage by cleaning contaminated underground water (MassDEP, 2009). GWR systems often implement various approaches to treatment, the most common being carbon activation, air stripping, and metals removal (Pump and treat technology, 2007).

The current operation of GWR systems present two key problems that cause an environmental paradox. First, GWR systems require electricity, often generated from fossil fuel-based sources (Massachusetts Department of Environmental Protection, 2012). Significant usage of non-renewable energy directly leads to high material consumption and pollution to the contaminated sites, such as greenhouse gas emission (Sustainable Materials Management, 2013).

Secondly, certain GWR systems are vulnerable to power outages caused by severe weather that is exacerbated by climate change (Massachusetts Department of Environmental Protection, 2012).

In order to reduce the environmental footprint and vulnerability of these sites, MassDEP aims to convince LSPs and Site Managers to consider the usage of energy efficient and renewable practices in GWR processes.

### **Project Goal**

*Assist MassDEP in promoting greener practices through solar power and energy efficient waste site remediation techniques to LSPs and Project Managers in charge of currently contaminated locations that utilize GWR systems.*

We accomplish this goal by fulfilling the following objectives:

- 1) Identified waste sites in MA actively utilizing Groundwater Remediation (GWR) Systems, and the sites vulnerable to flooding and storm surge.
- 2) Investigated how the GWR systems in the selected sites can be more energy efficient.
- 3) Examined the plausibility of using solar power as a renewable energy source for each type of GWR system that is investigated in regards to energy efficiency.

### **Methodology**

We focused on a set of 23 waste sites and determined which sites utilizing GWR systems were vulnerable to flooding or storm surge. We cross searched these waste sites with the vulnerability and waste site activity data sets by utilizing the Route Tracking Number (RTN) of each waste site. Using the Energy & Environmental Affairs Data Portal, we obtained remedial monitoring reports which contained information about each bi-yearly checkup for the 23 waste sites. From these forms we found out when certain unscheduled shutdowns occurred in waste sites due to flooding or storm surge.

To investigate how the current GWR systems can be more energy efficient, we first identified the components that are used in these systems. This was done by collecting and analyzing Phase IV Remediation Implementation Plans (RIPs), Release Abatement Measure (RAM) forms, and Immediate Response Action (IRA) forms for each of the 23 these sites. These forms are LSP-provided documents that provide specifications for the engineering designs of GWR systems, and the manner in which they were implemented. For sites providing detailed component specifications (type, model, make, etc) of system components, we used manufacturer websites and other literature to identify newer or more energy efficient models. To further investigate energy efficiency, we analyzed various suggestions from the Best Management Practices (BMPs) in Standard Guidance of Greener Cleanups (ASTM) provided by MassDEP. We identify energy efficiency practices that can potentially be applied to GWR systems, as well as practices that can be applied to the remediation process as a whole.

To investigate solar power feasibility, we utilized LSP interviews, the B&M Solar PV Feasibility Study, and other online research to identify important considerations for determining if solar energy is an appropriate option to power GWR system operations. The interviews allowed us to focus on understanding the limitations and constraints that LSPs face with regards

to energy usage. The B&M study was used to highlight that solar power was a feasible and financially beneficial option for that particular Superfund site. Additionally, we conducted research through government sources to identify various incentive programs or state funding that can be provided to LSPs who decide to adapt their system to a solar-driven power source. The programs we identified exemplify the types of financial incentives and benefits that are available in the solar power implementation process.

**Findings**

From the data analysis and research, we generated the following conclusions:

1. *BMPs can help to identify opportunities for potential improvements on GWR systems in order to improve energy efficiency, as well as more general opportunities that can be applied to the remedial process as a whole.*

We identified the most applicable BMPs to energy efficiency, listed in Table ES.1.

**Table ES.1:** List of applicable Best Management Practices for LSPs (*United States Environmental Protection Agency, 2017*)

<i>Type of BMP:</i>	<i>BMP Description:</i>
Buildings	Install demand-response mechanisms to reduce power usage while up-keeping with the systems’ needs.
Materials	Introduce a network of piping into the system which would allow for increases or decreases in the extraction and injection rates for treatment.
Power and Fuel	Utilize solar power packs for low-power usage devices such as heating and lighting.
Power and Fuel	Install modular renewable energy system for small scale systems.
Power and Fuel	Utilize a Combined Heat and Power (CHP) system to generate electricity while capturing waste heat.
Power and Fuel	Install variable frequency drive motors to automatically adjust energy usage in blowers, vacuum pumps and aerators.
Power and Fuel	Install amp meters to evaluate energy usage options based on consumption rates.

Power and Fuel	Insulate system pipes and equipment to increase energy efficiency.
Power and Fuel	Install energy efficient lighting fixtures.

In further research, we specifically highlighted the BMP regarding variable frequency drives (VFDs) to exemplify how BMPs can help to improve the energy efficiency in GWR systems. A VFD is a device that is used to control the speed of a motor by means of varying the frequency and voltage of its power source (Danfoss, n.d.). Installation of VFDs in GWR systems can optimize specific components, particularly pumps, to match the energy demand of the system at any time during operation.

We also highlighted the BMP regarding energy efficient lighting, as a way to show that BMPs are available for increasing efficiency in the overall remedial process. From the B&M site visit we identified fluorescent and LED lighting as potential alternatives in order to optimize lighting electricity consumption in remediation site facilities.

2. *Energy efficient pumps and other components are available. Various component manufacturers may also provide incentives for energy efficient products.*

From the B&M site visit we learned that information about new models of system components can be acquired by calling system part manufacturers. Furthermore, these manufacturers may offer various incentives, such as rebates and discounts, for switching to more energy efficient equipment. In addition, new or energy efficient models can be found from manufacturer websites and other supporting literature.

3. *GWR system components are specific to each waste site so it may be hard for MassDEP to identify and recommend which parts to upgrade.*

Each site utilizes different types, models, and arrangements of components. With such variation in the systems and conditions of each site, MassDEP cannot simply recommend all sites to switch to a specific component. Recommending component upgrades or replacements is not a simple task to accomplish; it involves detailed analysis of the specific requirements and needs of each site, as well as the consideration of factors like cost and space. We found that it was difficult for our team to evaluate and compare different component models because we did not have the technical knowledge and expertise needed to assess how energy efficient these parts were.

4. *GWR system component data is incomplete due to the fact that some LSPs are inconsistent in submitting the engineering data that is required by DEP regulations.*

In our research from the Energy & Environmental Affairs Data Portal, we learned that LSPs are either filling out and submitting a Phase IV Report, a Release Abatement Measure (RAM) form, or an Immediate Response Action (IRA) form, all of which are used by these LSPs to report data and specifications about their respective remedial systems. However, from site to site, the data provided was very inconsistent. About half of the sites we analyzed included very detailed and exact specifications for various pumps, blowers, aerators, and other equipment. However, reports from other sites were missing specific data; rather there were only general descriptions of what types of components were installed, or merely statements that a certain part was used. We do not know the reasons why some of these reports seemed incomplete. For future MassDEP work with these sites, it could be difficult to conduct energy efficiency evaluations with only the existing data in the current database.

5. *Renewable energy is applicable to waste sites through state-funded programs that grant rebates on solar installations and for upgrading to more energy efficient components.*

We identified 3 programs:

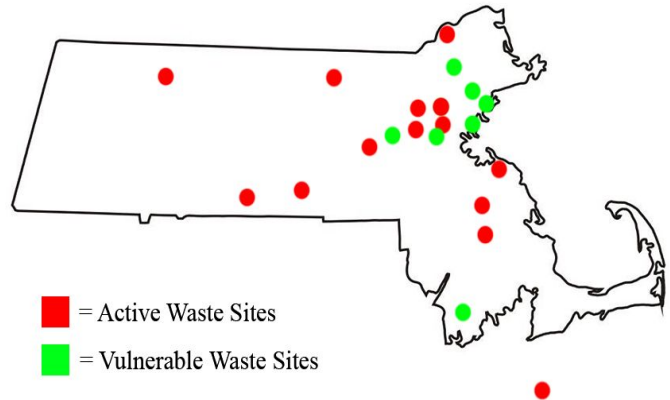
- Solar Massachusetts Renewable Target (SMART) Program- analytical program created to support solar development in MA; sites can apply to get an analysis of solar panel feasibility at their location.
- DSIRE Program- free and open-source platform that has a collection of existing incentives and policies involved with using renewable energy in different states
- RPS Solar Carve-Out Program v1.0 (DOER financial model)- a tool developed by Massachusetts Department of Energy Resources (DOER), that calculates the savings and costs and can help the user to estimate returns from a “optimal” solar project

6. *Solar energy may not be applicable to certain waste sites due to location, time or funding restrictions.*

Solar panel installations may not be an ideal investment for waste sites in smaller areas, where the amount of available space to install a viable amount of solar panels is limited. One of the main concerns with solar power installations for GWR systems is if the investment cost will equal to or less than the energy generated from the panels. Another factor is the return on investment. The amount of time a waste site will remain active is unknown and dependent on each waste sites’ contamination level so it would not seem viable to invest in solar energy if the payback amount is unknown.

7. *Of the 23 waste sites in the dataset, 7 of them are vulnerable to flooding or storm surge.*

The waste sites identified as vulnerable to storm surge or flooding were determined to be closer to bodies of water. This relates to waste sites relying on the power grid to operate even during the event of a storm surge or flood which can cause systems to remain offline. We cannot conclude that all waste sites near bodies of water are vulnerable or if current waste sites will be considered vulnerable in the future.



**Figure i:** Map of the Commonwealth showing the locations Of all active and vulnerable waste sites (*Adobe Photoshop, 2018*)

## Recommendations

1. *MassDEP should utilize available LSP-submitted reports and data from this project to further investigate challenges LSPs may encounter with GWR. MassDEP should promote BMPs to sites, for both GWR systems specifically as well as the overall remediation process to reduce energy use and costs. MassDEP can use the 7 sites we identified to be vulnerable as a starting point.*
2. *MassDEP should utilize available resources and promote existing programs to encourage LSPs to adopt renewable energy and energy efficient methods to LSPs and site managers.*
3. *MassDEP should consider promoting other renewable energy options for particular waste sites with different locations and available spaces.*

By utilizing the recommendations and deliverables we have provided, MassDEP can gain a better understanding of the considerations that are involved in making GWR systems greener. Ultimately, our findings can help MassDEP to achieve the goal of reducing the environmental footprints that GWR processes currently are leaving behind.