ABSTRACT

THE MULTIFACETED NATURE OF CONSULTING: MY EXPERIENCE AS AN ENVIRONMENTAL SCIENTIST AT AMEC FOSTER WHEELER

by Ben Steven Fehr

Throughout the first ten months as a full-time environmental scientist at Amec Foster Wheeler, an international consulting firm, I have been exposed to a multitude of different projects. From conducting building characterization studies to helping with Hurricane Harvey relief efforts, each experience has allowed me to gain new technical and professional skills. This report provides an in-depth discussion of the regulations and methodology associated with Phase I Environmental Site Assessments, asbestos inspections and abatement oversight, and presence and absence bat surveys. At the end of each chapter, case-studies are provided to illustrate how the regulations and methodology are applied in the field. The Institute for the Environment and Sustainability (IES) Master of Environmental Science (M.En.) program at Miami University was invaluable in preparing me for a career as an environmental consultant, and I will continue to use the knowledge gained from the IES program to build relationships with future clients.
THE MULTIFACETED NATURE OF CONSULTING: MY EXPERIENCE AS AN ENVIRONMENTAL SCIENTIST AT AMEC FOSTER WHEELER

An Internship Report

Submitted to the
Faculty of Miami University
in partial fulfillment of
the requirements for the degree of
Master of Environmental Science
by
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Miami University
Oxford, Ohio
2017

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This Internship Report titled

THE MULTIFACETED NATURE OF CONSULTING: MY EXPERIENCE AS AN ENVIRONMENTAL SCIENTIST AT AMEC FOSTER WHEELER

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has been approved for publication by

The College of Arts and Science

and

The Institute for the Environment and Sustainability

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Dedication

This report is dedicated to my late grandmother for her wisdom, compassion, and humbleness.
Acknowledgements

My completion of this project could not have been completed without the guidance from my main advisor, Dr. Sarah Dumyahn. Due to her expertise in environmental law, Sarah was an excellent resource as I wrote and reviewed the regulations section of my report. I also want to thank my other committee members, Dr. Jonathan Levy and Dr. Catherine Almquist, for supporting me along the way and assisting with the review of this report. Last, I want to thank Suzanne Zazycki for helping us all with our Professional Service Projects and making sure we came out of graduate school alive.

This work would also not have been possible without the support from Brad Glisson and Bertisabel Custer, my supervisors at work. They both make it a priority to get me involved in new and exciting projects, and are always available to answer my questions. Most importantly, thank you to my other coworkers for helping me make the transition from the brutally cold Wisconsin winters to the unbearably hot Tennessee summers.

Finally, I would like to extend my thanks to my family and friends for their support and encouragement throughout this project and grad school as a whole. In particular, I wish to thank Keara Pringle, my IES partner-in-crime, for helping me conquer all that graduate school threw our way.
1. INTRODUCTION

The first ten months, March to December 2017, of my full-time position as an environmental scientist at Amec Foster Wheeler (Amec FW) in Nashville, Tennessee served to satisfy my professional experience requirement for the Master of Environmental Science degree (M.En.) with the Institute for the Environment and Sustainability (IES) at Miami University. At Amec FW, I have been primarily involved with conducting due diligence property assessments for properties associated with Phase I Environmental Site Assessments (ESAs), asbestos inspections, and bat surveys. This report provides a detailed discussion of my responsibilities, tasks and projects at Amec FW, as well as a reflection on my experience at IES.

1.1 Amec Foster Wheeler

Amec FW is an international consulting firm, employing over 35,000 people and operating for more than 160 years in over 55 countries (Figure 1). As a leading engineering, project management, and consultancy company, Amec FW’s goal is to deliver profitable, safe, and sustainable projects for customers worldwide. The main vision of Amec FW is “to be the most trusted partner for [their] customers by delivering excellence – bringing together the knowledge, expertise and skills of [their] people from across [their] global network” (Amec FW, 2017a). Amec FW prides itself on using an interdisciplinary approach to develop solutions to complex environmental problems.

One of the main goals of Amec FW is to create a successful, sustainable company for the long-term by balancing economic, social, and environmental issues in their decision-making process. With every project that Amec FW takes on, the goal is to continue to build a more “Resilient World.” Resilient World is the name for Amec FW’s sustainability strategy, and includes investing in a talented workforce, delivering innovative solutions, and ensuring a consistent sustainability standard with every project (Amec FW, 2017b). At the start of 2017, Amec FW created the following sustainability promises:

- Publish and implement a cost effective global carbon reduction strategy with milestone targets that support the need to keep global temperature increase below 2 degrees Celsius;
- Build awareness and technical understanding of what is meant by sustainability; and
- Develop a portal of resources and tools for employees and ambassadors which provide global consistency of approach (Amec FW, 2017c).

Amec FW is committed to adhering to these promises with every project.
Amec FW’s global presence allows them to provide a wide-variety of engineering and environmental services. These services are grouped into four main markets: 1) oil, gas and chemicals; 2) power and process; 3) environment and infrastructure; and 4) mining (Table 1). Some of Amec FW’s major clients include the U.S. Department of Homeland Security, BP, Shell, Exxon Mobil, Honeywell, Duke Energy, Hyundai, and Ontario Power Generation.

**TABLE 1**: Amec FW markets. My responsibilities lie within the Environment and Infrastructure market.

<table>
<thead>
<tr>
<th>Oil, Gas &amp; Chemicals</th>
<th>Power &amp; Process</th>
<th>Environment &amp; Infrastructure</th>
<th>Mining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full life cycle services to offshore and onshore oil and gas development.</td>
<td>Operational support and decommissioning in nuclear, renewables, transmission and distribution, power and bioprocessing.</td>
<td>Consultancy, engineering and project management services in water, transportation/infrastructure, government and industrial/pharmaceutical sectors.</td>
<td>Concept and development through operations and closure of mines, metallurgical processing facilities and associated infrastructure.</td>
</tr>
</tbody>
</table>

1.2 Nashville, Tennessee Office

My office is located in Nashville, Tennessee, founded in 1953, as a small, privately-owned geotechnical engineering firm. Since then, it has grown to offer diverse services and has prospered through several mergers, acquisitions, and transitions. Construction materials testing, mining consulting, and general civil engineering services were added in the mid-1960s. Environmental consulting services were added in the 1970s. Water resources, air quality, and risk assessment services were added in the 1980s. Most recently, GIS services were added in the 1990s and the construction management practice began in 2003 (Amec FW, 2017c).

Today the Nashville office has over 140 employees and serves the clean energy, government, industrial, mining, oil and gas, transportation, and water sectors. The key clients of the office include CSX Transportation (CSXT), Norfolk Southern Corporation, General Electric, U.S. Army Corps of Engineers, the states of Tennessee, Alabama and Mississippi, Natural Resources Conservation Service, Bank of America, and City of Chattanooga.

The Nashville office comprises four main departments which provide consulting services within the environment and infrastructure market: 1) construction management; 2) environmental services; 3) infrastructure services; and 4) water resources. I am employed within the Environmental Services Department. The services offered by my department include:

- Environmental due diligence – Phase I and II ESAs and asbestos inspections and abatement;
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) remedial investigations and feasibility studies;
- Ecological and human risk assessments;
- Resource Conservation and Recovery Act (RCRA) corrective action and remedial design and implementation;
• Environmental and regulatory compliance audits;
• Toxic Substances Control Act (TSCA) facility characterization and remediation;
• Building decommissioning, deconstruction and renovations;
• Underground storage tank (UST) assessment and closures;
• Indoor air quality services;
• Air quality permitting and compliance;
• Environmental, health, and safety management systems; and
• Natural resources.

The Environmental Services Department currently employs 18 people, ranging from staff-level scientists and geologists to senior scientists and biologists to project managers and environmental branch managers. Brad Glisson is the manager of the Environmental Services Department and serves as my direct supervisor. Other senior scientists with whom I interact include Bertisabel Custer, James Hampel, Martha Shirley, Cole Reagan, Todd McFarland, Sara Matthews, and David Carden. I also work alongside other staff-level scientists, including Andrew Foy, Nicholas Smith, Katy Brantley, Thomas Brant, and Robert Singleton.

1.3 Regulatory Framework

Due diligence refers to the steps taken to satisfy a legal requirement, primarily when buying, selling, or altering a property. I have been involved with three main types of due diligence projects while at Amec FW – Phase I ESAs, asbestos inspections and abatement oversight, and presence and absence endangered bat surveys. Phase I ESAs are conducted due to the regulations set forth in CERCLA of 1980 and in the Superfund Amendments and Reauthorization Act of 1986 (SARA). Asbestos is regulated as a hazardous air pollutant, and is thus regulated under the U.S. Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. When asbestos requires abatement, the Occupational Safety and Health Administration (OSHA) requires employers to carry out specific work practices to protect employees. The Endangered Species Act, administered by the U.S. Fish and Wildlife Service (FWS), requires bat surveys to be conducted when a project is assumed to have the potential for suitable summer roosting habitat. Each of these regulations will be discussed in detail in later sections of this report.

The multitude of regulations that I navigate in my position is due to the wide variety of projects that I am involved with as an environmental scientist. Three main projects are described in this report: A Phase I ESA for a site previously used for the manufacture of power generation equipment, an inspection for asbestos on a tract of land owned by the State of Tennessee and provision of oversight of asbestos removal activities, and a presence and absence bat survey to determine if a highway widening project would result in adverse impacts to the Indiana bat and/or the northern long-eared bat.
2. PHASE I ENVIRONMENTAL SITE ASSESSMENTS

Throughout my time at Amec FW thus far, I have been largely responsible for conducting Phase I Environmental Site Assessments (ESAs). Below I explain the purpose of Phase I ESAs through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA).

2.1 CERCLA of 1980

Before environmental laws were enacted in the 1970s and 1980s there were few regulations governing the transportation and disposal of hazardous wastes. The most prominent example of the consequences of unregulated waste dumping is the Love Canal site in Niagara Falls, New York. From 1947 to 1952 the Hooker Chemical Company used the Love Canal section of Niagara Falls as a dumping site for more than 20,000 tons of toxic waste (U.S. EPA, 2017a). In 1953 the landfill was sealed and leased to the local school district, and soon after the area became developed with an elementary school and residential properties (U.S. EPA, 2017a).

In the 1970s, residents began to complain about strange chemical odors and residues seeping up from the ground and into their basements. Increased rates of skin rashes, miscarriages, cancer, and birth defects also started to appear (U.S. EPA, 2017a). President Carter declared two environmental emergencies for the Love Canal site in 1978 and 1980, helping to evacuate families from the area (U.S. EPA, 2017a). In the end, CERCLA was enacted due to the severe contamination of the site and the health effects that surfaced in the surrounding neighborhoods.

CERCLA, passed in 1980, allows the Federal Government to become involved in the management of hazardous waste and to respond to releases or threatened releases of hazardous substances that may endanger the public or the environment. CERCLA imposes a tax on chemical industries, helping to address the cleanup costs of unsafe hazardous waste dumps or spills (U.S. EPA, 2017b). Within five years of CERCLA’s enactment, over 1.5 billion dollars was put into a trust fund, known as Superfund. Superfund is used by the U.S. Environmental Protection Agency (U.S. EPA) for cleaning up abandoned hazardous waste sites when no responsible party can be identified (U.S. EPA, 2017b). In 1986, SARA amended CERCLA to increase the size of the Superfund to $8.5 billion (U.S. EPA, 2017c).

Two types of response actions, short-term and long-term, can be performed by the Federal Government and are funded under CERCLA. Short-term removal actions seek to address the stabilization or cleanup of a hazardous waste site that poses an immediate threat to human health or the environment (U.S. EPA, 2017d). Long-term remedial response actions are meant to reduce risks which are not as time-critical as the risks addressed by removal actions (U.S. EPA, 2017d). Remedial responses can include containment or treatment of toxic chemicals as a permanent solution to a threatened release of hazardous waste.

2.1.1 Liability

When a potentially responsible party (PRP) for the presence of hazardous substances on a site can be identified, CERCLA can impose liability on the PRP (U.S. EPA, 2017d). There are four
different types of PRPs, which include current owners and operators of a facility; past owners and operators of a facility at the time hazardous substances were disposed of; persons who arranged for disposal, treatment, or transport of hazardous substances; and persons who accepted hazardous substances for transport or disposal (CERCLA, 1980).

A PRP may be liable for damages to natural resources, government cleanup costs, and the costs of human health assessments for those living near the site (U.S. EPA, 2017d). In addition, liability under CERCLA is:

1. Retroactive: PRPs can be held liable for actions that occurred before Superfund was enacted in 1980;
2. Joint and Several: when the harm due to hazardous substance release is caused by multiple parties but cannot be separated, any one PRP can be held liable; and
3. Strict: PRPs cannot claim negligence and liability may be assigned solely based on property ownership (U.S. EPA, 2017d).

### 2.1.2 Defenses to Liability

Under CERCLA there are three defenses available to avoid liability: 1) Act of God; 2) Act of War; and 3) third-party defense. Historically, however, each of these defenses have shown to be severely limited and difficult to use. Act of God/Act of War defenses are extremely rare and only are limited to unforeseen circumstances. For instance, they do not apply to events that could be anticipated, such as earthquakes (CERCLA, 1980). Third-party defenses only apply if the PRP can show they “exercised due care” and if they can prove that there was no contractual agreement between the third-party at fault (CERCLA, 1980). For instance, this defense would only apply if an outside party was secretly dumping hazardous substances on the site.

Within the first several years of enactment, CERCLA received large amounts of criticism because of the difficulty to claim defense to liability. First time purchasers of commercial or industrial property were subjected to remediation costs if environmental concerns were identified prior to acquisition, and it was not uncommon for these costs to be significantly more than the actual value of the property being purchased (CERCLA, 1980; Thornhill, 2014). Due to high remediation costs, parties became discouraged to invest in properties known to contain hazardous substances. Among other consequences, this led to the development of brownfields. Defined by the US EPA, a brownfield is “a property, the expansion redevelopment, or reuse of which may be complicated by the potential presence of a hazardous substance, pollutant, or contaminant” (U.S. EPA, 2017d). With no incentive to develop brownfields, contaminated sites around the country sat idle and remained unused for decades.

### 2.1.3 Landowner Liability Protections

To address concerns revolving around CERCLA’s strict liability scheme, liability protections were introduced in 1986 and 2002 which allowed landowners to qualify as innocent landowners, bona fide prospective purchasers, or contiguous property owners (U.S. EPA, 2017d). Qualifying as either an innocent landowner, bona fide prospective purchaser, or contiguous property owner
allows landowners to buy property with knowledge of contamination and not be liable for cleanup costs.

The Superfund Amendments and Reauthorization Act (SARA) of 1986 amended CERCLA’s third-party defense to create the innocent landowner protection (SARA, 1986; U.S. EPA, 2017c). To qualify as an innocent landowner, the landowner must “not know and have no reason to know” that any hazardous substance is present on site when acquiring the property, and also includes those who acquire property through inheritance (CERCLA, 1980; U.S. EPA, 2017d).

In 2002 the Small Business Liability Relief and Brownfields Revitalization Act, more commonly referred to as the 2002 Brownfields Amendments, was enacted by President Bush to clarify CERCLA liability protections as well as provide additional funds to clean up brownfield sites (U.S. EPA, 2017d). The 2002 Brownfields Amendments introduced the bona fide prospective purchaser protection, which only applies to landowners who acquire property after January 11, 2002 (U.S. EPA, 2017d). The contiguous property owner protection was also introduced in the 2002 Brownfields Amendments and pertains to landowners of property that may be contaminated, but where the only source of contamination comes from an adjoining property.

In all cases, landowners who qualify for liability protection must:

- Prove they did not cause or contribute to the release or threatened release of the hazardous substances;
- Prove that hazardous substances were disposed of at the property prior to purchase;
- Comply with specific threshold criteria and ongoing obligations after acquiring the property;
- Not prevent the performance of natural resource restoration or a response action;
- Not have any affiliation with any PRP;
- Take precautions against foreseeable acts or omissions of any previous third party; and
- Conduct all appropriate inquiries prior to purchase (CERCLA, 1980; U.S. EPA, 2017d).

Conducting all appropriate inquiries is a key component to qualifying for CERCLA liability protection. All appropriate inquiries involve the evaluation of a property to identify any environmental contamination, and if contamination is found on the property, to assess potential liability.

### 2.2 Conducting Phase I Environmental Site Assessments

Phase I ESAs are used to conduct all appropriate inquiries and permit landowners to qualify for the innocent landowner, bona fide prospective purchaser, or contiguous property owner under the CERCLA landowner liability protections. The goal of the Phase I ESA process is to identify recognized environmental conditions (RECs). The term REC refers to the presence or likely presence of any hazardous substances or petroleum products in, on, or at a site: (1) due to any release to the environment, (2) under conditions indicative of a release to the environment, or (3) under conditions that pose a material threat of a future release to the environment (ASTM, 2013). De minimis conditions are not RECs. A de minimis condition generally does not present a threat
to human health or the environment, and would generally not be the subject of an enforcement action if brought to the attention of governmental agencies (ASTM, 2013).

Separate and distinct from a REC are two other types of conditions that may be noted in a Phase I ESA: a controlled REC (CREC) or a historical REC (HREC).

A CREC is a REC resulting from a past release of hazardous substances or petroleum products that has been addressed to the current satisfaction of the applicable regulatory authority (ASTM, 2013). For example, as evidenced by a no further action letter or the equivalent, or meeting risk-based criteria established by the regulatory authority, with hazardous substances or petroleum products allowed to remain in place subject to the implementation of required controls. Required controls include site-use restrictions, activity and use limitations, institutional controls, or engineering controls. A HREC is a REC from a past release of any hazardous substances or petroleum products that has occurred in connection with the site and has been addressed to the satisfaction of the applicable regulatory authority (ASTM, 2013).

It is important to note that Phase I ESAs only give an environmental professional’s opinion as to whether the property in question has the potential to be negatively affected by the findings identified in the assessment. If a REC is noted in a Phase I ESA, the client is responsible for deciding if they want to pursue further investigation via a Phase II ESA. Activities during a Phase II ESA can include groundwater and soil sampling to determine the true extent of contamination prior to a property transfer.

2.2.1 Methodology

To adequately assess the presence of hazardous substances while conducting a Phase I ESA, I am responsible for following the American Society for Testing and Materials (ASTM) scope of services outlined in the Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process (ASTM, 2013). The ASTM scope of services, listed below, allow me to conduct all appropriate inquiries into past uses and ownerships of the property, as well as conduct visual observations to determine if there are conditions indicative of releases and threatened releases of hazardous substances on or near the subject property:

- A physical site reconnaissance to identify likely RECs in connection with the site, including cursory observations for asbestos, lead-based paint, and mold;
- Visual observation of adjoining properties or facilities to assess conditions that may indicate RECs on the site or on an adjoining property;
- Review of historical land use of the site back to the first developed use or 1940, whichever is earlier;
- Review of existing published information related to geology, hydrology, and topographical information for the site;
- Review of reasonably ascertainable records and regulatory agency file database searches to identify federal and state-listed properties of known potential environmental concern located within the minimum search distances from the site (as specified in ASTM, 2013);
- Interviews with present and past site owners, operators/managers, or occupants;
• Interviews with representatives of the state, county, or local regulatory agencies with knowledge of the site;
• Evaluation of compiled information and documentation; and
• Preparation of a Phase I ESA report (ASTM, 2013).

My scope of work during a Phase I ESA does not include tasks such as the collection and testing of groundwater samples, surface and drinking water samples, air samples (e.g., radon), or building samples for hazardous materials (e.g., polychlorinated biphenyls [PCBs], asbestos, and lead-based paint). It also does not include the identification of wetlands, endangered plant and animal species, or historical or archeological sites; geotechnical studies; geologic hazards; or potential air quality impacts. These tasks would be conducted during a Phase II ESA.

2.3 Project Case Study

During my time as an environmental scientist at Amec FW I have had experience conducting Phase I ESAs for several different clients. In May 2017, I conducted a Phase I ESA for a site developed with multiple manufacturing, office, and ancillary buildings. The client for this project wanted to identify the extent of environmental contamination before they purchased the site. Below I describe the specific methodology used, as well as the findings discovered, while performing each of the services listed above in Section 2.2.1.

Review of Existing Published Information for the Site

Before conducting the physical site reconnaissance, I reviewed information pertaining to the site in general, as well as geologic, hydrologic, and topographic information of the site. This allowed me to identify what to investigate prior to visiting the site. Sources of this information included internal documents with the client, Google Earth, and the United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) websoil survey.

Site Description

The site was located west of downtown Chattanooga, Tennessee and east of the Tennessee River, and was the largest industrial development in the area. The site was developed with multiple high bay structures, office buildings, and ancillary structures and was utilized for the manufacture of tubing panels for boilers and power generation facilities (Figures 2 and 3). Using Google Earth, I determined the site was developed with around 532,000 square feet of industrial structures and around 95,000 square feet of office space.

FIGURE 2: The site consisted of multiple high bay structures (Fehr, Amec FW, 2017).
Along with investigating the current uses of the property, it was also important to identify the adjoining properties and their uses. Located near the eastern portion of the site was public housing residential development. The site was surrounded by industrial and commercial development to the north, south, and east. As will be discussed later, the adjoining industrial and commercial properties were investigated in detail to determine if their uses had resulted in hazardous substances being present on the site.

Physical Setting

Assessing the physical setting of the site was important to understand how past releases of hazardous substances may have moved, or how threatened releases may move. Review of a topographic map for the site area indicated that the natural lay of the land sloped towards the Tennessee River. If any hazardous substances were present on the surface of the site, it was expected that they would have traveled west and potentially discharged into the Tennessee River. According to the topographic map, it was also determined that there were no surface-water bodies located on the site.

To assess the soil types of the site, I used the USDA NRCS online websoil survey (USDA, 2017). This tool allows users to outline an Area of Interest (AOI) on a Google Earth map, and then order a report that describes the soils present in the AOI. Soils at the site were characterized as urban land complex according to the report. This description is used for areas where urban structures cover more than 85% of the surface, and the soils have been altered by the installation of utilities and excavation for building and streets. Based on this classification, it was expected that surface contamination would runoff the site, rather than seep into local groundwater.

The characteristics of the local groundwater were also investigated. The general direction of groundwater flow can be inferred from surficial expressions of groundwater identified on topographic maps for the area around the site in question. Surficial groundwater occurrences can include permanent lakes, streams, and wetland areas. In this case, no surficial groundwater expressions were visible on the site. Based on my review of the topographic maps and from observations during my site visit, described later, the groundwater direction was inferred to be
generally to the south from the eastern portion of the site, and to the west from the western portion of the site.

**Review of Historical Land Use of the Site**

While preparing for the site reconnaissance, I also reviewed the historical land use of the site area by examining historical street directories, aerial photographs, topographic maps, and fire insurance maps. The historical documents were provided by an independent data research company, Environmental Data Resources (EDR), Inc., of Shelton, Connecticut. Reviewing the historical documents allowed me to develop a history of the previous uses of the site and surrounding area to help identify the likelihood of past uses that could have led to RECs in connection with the site.

**Historical Street Directories**

Local street directories were used as a screening tool to assist in evaluating potential liability resulting from past activities on or near the site. For this Phase I ESA, street directory listings were provided for the site area from 1964 to 2013. Listings for addresses in the vicinity of the site primarily included car dealerships, United States Postal Service Facilities, banks and credit unions, residential properties, and family-owned businesses. After a thorough review of the listings, I did not identify any historical usage that would have been considered a REC in connection with the site.

**Historical Aerial Photographs**

I reviewed available aerial photographs of the site and the surrounding area from 1942 to 2012 and summarized the information in a table. The table described what was shown in each photograph for the target site, as well as for the adjoining properties. As an example, Figure 4 illustrates the aerial photographs from 1942 and 2012, along with their corresponding table entries.

Reviewing the historical aerial photographs allowed me to identify development and activities of areas encompassing the site. Activities observed in the photographs included the construction and demolition of buildings, the clearing of land, and the presence of small structures resembling semi-trailers. No activity in the photographs represented a REC in connection with the site. Examples of RECs identified in aerial photographs from other Phase I ESAs that I have worked on include train derailments and fill of unknown origin.

**Historical Topographic Maps**

Historical topographic maps of the site and surrounding area from 1888 to 2013 were reviewed and again summarized in a table. For each map, information worth noting included water bodies, roads, railroad tracks, and buildings. Figure 5 illustrates topographic maps from the years 1888 and 1958 along with relevant information. No RECs were identified from the topographic maps.
FIGURE 4: Example of aerial photographs from 1942 and 2012, along with the corresponding descriptions that I included in the Phase I ESA report (EDR, 2017). I examined both the target site and the adjoining properties for any historical use that could be classified as an REC. The site is outlined in red. None of the aerial photographs presented any concern for the site.
Fire insurance maps, or Sanborn maps, have been produced for many urban areas since the late 1800’s and have been used to assess fire hazards. Sanborn maps include detailed information about building addresses, heights, and footprints, street names, number of stories per building, building construction materials, and building use. I reviewed Sanborn maps of the site location from 1885 to 1969 and identified five RECs: 1) from at least 1955 to 1969, there was a switch room and transformer yard on the northern portion of the site; 2) from 1955 to 1969, there was a transformer yard on the north-central portion of the site; 3) there is a furnace house and switch house on the northern portion of the site; 4) from at least 1950 to 1969, there were fuel oil tanks,
a pump house, and a 4-foot earth dike on the northern portion of the site; and 5) since at least 1950, there was a substation and transformer yard east of the site.

The former switch and transformer yards on and around the site represent concerns due to the possible presence of PCBs. PCBs don’t burn easily and are good insulators, and as a result, they have been used as lubricants and coolants in transformers, capacitors, and other electrical equipment (U.S. EPA, 2017e). The production of PCBs was halted in 1977 when it was discovered that they cause harmful health effects. However, due to their persistence, they are still found in the environment today (U.S. EPA, 2017e). The Sanborn maps don’t indicate whether any PCB spills occurred, but to be conservative, all switch rooms and transformer yards were classified as RECs. The furnace house, fuel oil tanks, and the pump house also present concerns due to the possibility of petroleum impacts (Figure 6). The 4-foot earth dike was classified as an REC due to the unknown nature of the materials used for its construction. For instance, soil contaminated with PCBs could have been used.

**FIGURE 6:** Example of the Sanborn map from 1950 for the site (EDR, 2017). Note the former locations of the transformer yard, oil tanks, and pump house, which all present concerns due to the possibility of PCB impacts on the site. The 4-foot earth dike is not shown on this map.

**Review of Environmental Records**

EDR provided the results of a regulatory agency database search for the site. These records were reviewed for information pertaining to storage and/or reported releases of hazardous substances and petroleum products on the site and on surrounding properties that may have affected the site. The site was identified on six standard environmental record sources databases, described in Table 2 (EDR, 2017).
TABLE 2: The site was listed on six different environmental databases. However, based on the regulatory status of the site within each database, none of the listings presented a concern for the site (EDR, 2017).

<table>
<thead>
<tr>
<th>Database</th>
<th>Database Description</th>
<th>Why was Site Identified?</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCB Transformer Registration Database</td>
<td>Database of PCB transformer registrations that includes all PCB registration submittals.</td>
<td>Three PCB transformers were listed for the site address. No leaks or spills had been reported.</td>
</tr>
<tr>
<td>Voluntary Remediation Sites</td>
<td>Sites involved in the Voluntary Remediation Program (VRP).</td>
<td>The site had an active status in the VRP.</td>
</tr>
<tr>
<td>Site Remediation Program (SRP)</td>
<td>Sites involved in the SRP.</td>
<td>The site had an active status in the SRP.</td>
</tr>
<tr>
<td>National Pollution Discharge Elimination System (NPDES)</td>
<td>A listing of wastewater discharge permits.</td>
<td>The site had an active permit associated with manufacturing turbines.</td>
</tr>
<tr>
<td>Corrective Action Report (CORRACTS)</td>
<td>Identifies hazardous waste handlers with RCRA corrective action activity.</td>
<td>The site was assigned a low corrective action priority for the manufacturing of turbines and turbine generators.</td>
</tr>
<tr>
<td>RCRA-Treatment, Storage and Disposal</td>
<td>Includes information on sites which generate, transport, store, and/or dispose of hazardous waste as defined by RCRA.</td>
<td>The site was classified as a generator of hazardous waste in 2000, 2004, 2008, and 2010.</td>
</tr>
</tbody>
</table>

Although identified on six environmental record databases, the site was found to be in compliance for each listing. As a result, no RECs were identified after the review of the environmental database records. If, however, violations were found for the site within any of the databases, and corrective actions were never taken, RECs would have been identified.

The database search information was also reviewed for facilities found within the recommended ASTM search distances around the site (ASTM, 2013). Of the 88 total facility listings within the ASTM search distances, 26 listings were noted for adjoining properties. For each facility that was listed, the elevation relative to the site, mapped distance and direction from the site, assumed groundwater flow direction, and regulatory status was noted (Figure 7). This information was used to determine if any of the facilities classified as an REC in connection with the site. Based on the environmental records for nearby facilities, I concluded that none of the properties listed in the EDR search report was likely to have a negative impact on the site based on actual distances from the site boundary, the presumed direction of groundwater flow, and/or regulatory status.
A physical site reconnaissance was conducted to identify any likely RECs. During this visit, I made observations that pertained to the general conditions of the physical land, including but not limited to, the location and presence of any ponded water, wetlands, stained and stressed vegetation, monitoring wells, and solid or liquid waste. Accessible common areas, and manufacturing facilities used by occupants or the public were also observed.
Observations during Site Reconnaissance

Several plastic totes and drums were located within the waste storage building located on the southeast portion of the site (Figure 8). The plastic totes contained cleaning soaps, and the drums contained non-hazardous, solid wastes. The totes and drums appeared in good condition, and no leaks or spills were observed in the surrounding area. There was a single steel commercial waste dumpster at the northern side of the building, and two steel commercial waste dumpsters in the waste storage building. The dumpsters were all in good condition and were only used for recycling and general debris. The totes, drums, and dumpsters, did not present concerns for the site.

I did not observe any USTs and associated dispensers or piping on the interior or exterior portions of the site, nor did I note any unusual odors. I also did not find any pools, catchment structures, or sumps containing liquids or oily sheen likely to be hazardous substances or petroleum products on the site. I saw no hazardous substances or petroleum products nor any electrical or hydraulic equipment known to contain PCBs. Last, I did not observe any wastewater or other liquids, including stormwater that discharges into a drain, ditch, underground injection system, or stream on or near the site. For these reasons, no REC’s were found while making observations at the site.

Interview during Site Reconnaissance

I interviewed the current Health and Safety Manager concerning on-site environmental conditions at the site. I first asked basic background information. The Health and Safety Manager had been working at the site since December 2013. The site underwent a redevelopment in 2010 and 2011 where modifications were completed for the site buildings and subsurface including excavations for new building floors, tunnels under the buildings, and new buildings.

Concerning environmental conditions, the site had no USTs, no wastewater treatment plant, no oil/water separators, and no transformers containing PCBs. The Health and Safety Manager did not mention any spills or releases of petroleum products associated with the site or the surrounding area, and the site was currently in compliance with RCRA regulations.
However, the Health and Safety Manager made me aware of an area of soil containment located on the northwest portion of the site, which was used to relocate soil from the site with elevated lead and arsenic levels. He showed me the exact location of the area, which I observed as a mound with higher elevation than the surrounding area, covered with a circular sidewalk. Due to the potential elevated lead and arsenic levels in the soil, I classified this soil containment area as a REC.

The Health and Safety Manager also told me about a non-reportable spill of PCBs from a capacitor which happened in January 1992, at the northern portion of the site. The spill occurred in a metal storage building on a concrete floor with no drains, and the building where the spill occurred was demolished in 2008. All waste materials were properly disposed during demolition, but no sampling of the spill area was conducted. Consequently, the spill area represents a REC, as we do not know the extent of PCB contamination.

While the Health and Safety Manager was not legally required to share this information with me, it was in his best interest since he was classified as a PRP in association with the site. If he had not told me about the soil containment area or about the PCB spill, but contamination was later discovered in these locations, the current owner would be held liable for the cleanup costs under CERCLA.

Future Actions Based on Phase I Environmental Site Assessment

There were several RECs in connection with the site, which all represented the likely presence of hazardous substances or petroleum products in, on, or at the site. Based on my opinion of the RECs, the historical uses of the site and adjoining properties had the potential to negatively impact the site. To determine the true extent of soil and groundwater contamination, I recommended a Phase II ESA to be conducted. The Phase II ESA was still in progress at the time of this report.
3. ASBESTOS INSPECTIONS AND ABATEMENT OVERSIGHT

During my first several months at Amec Foster Wheeler (Amec FW) I have been responsible for conducting inspections for asbestos-containing materials (ACM) on properties owned by the Tennessee Department of Transportation (TDOT) prior to scheduled repairs or demolition. If ACM is identified, I am responsible for providing oversight during the asbestos removal, referred to as abatement. Below I provide an explanation of what asbestos is and why it is regulated, followed by a discussion of a project that involved both inspection and abatement activities.

3.1 Asbestos

Asbestos refers to a group of naturally occurring fibrous minerals that are mined from the earth, which include amosite, chrysotile, tremolite, actinolite, anthophyllite, and crocidolite (META, 2017). Of these six types of asbestos, chrysotile, amosite, and crocidolite are used commercially. Chrysotile, commonly called white asbestos, is the most common type and accounts for roughly 95% of all asbestos in the United States (META, 2017) (Figure 9, left). Amosite, commonly called brown asbestos, consists of fibers which are hard to control with water (META, 2017) (Figure 9, middle). Crocidolite, also known as blue asbestos, has a high resistance to acids and causes cancer at a higher rate than all other asbestos types (META, 2017) (Figure 9, right). Tremolite, actinolite, and anthophyllite are the three less common types of asbestos, and are usually found as contamination in certain products, rather than an additive.

![Image of asbestos types](image-url)

**FIGURE 9:** The three most-common forms of asbestos found in commercial products include chrysotile (left), amosite (middle), and crocidolite (right) (META, 2017).

Asbestos is highly resistant to corrosion, abrasion, heat, and chemicals, is extremely flexible, does not dissolve in water, does not conduct electricity, and is very stable in the environment. Consequently, asbestos has been added to over 3,000 common building products for both exterior and interior use (META, 2017). Examples of products containing asbestos include: sprayed-on fire proofing and insulation in buildings; insulation for pipes and boilers; wall and ceiling insulation; ceiling and floor tiles; putties, caulks, and cements; roofing shingles; siding shingles on old residential buildings; wall and ceiling texture in older buildings and homes; drywall and joint compound in older buildings and homes; and brake linings.

**Health Hazards of Asbestos Exposure**

Asbestos is most hazardous when it is friable. Friable materials are those which can be crumbled, pulverized, or reduced to powder by hand pressure when dry (U.S. EPA, 1973). Non-friable
materials cannot be crumbled, pulverized, or reduced to powder by hand pressure (U.S. EPA, 1973). For example, vinyl asbestos floor tile in good condition is considered non-friable; however, if it is crushed and disturbed, it can become friable and raise health concerns. Further, damage and deterioration will increase the friability of asbestos-containing materials. Water damage, continual vibration, aging, and physical impact such as drilling or sawing can break the materials down, making fiber release more likely.

When materials containing asbestos are disturbed, individual asbestos fibers are released into the air. Fibers may be up to 700 times smaller than a human hair, and as a result, they can remain suspended in the air for up to 80 hours once released (META, 2017). These tiny fibers can then enter the body through inhalation and ingestion. Many of the fibers will become trapped in the mucous membranes of the nose and throat where they can be removed. However, some fibers may pass deep into the respiratory and digestive tissues and cause serious health problems.

Asbestos is classified as a carcinogen by the U.S. Department of Health and Human Services, the U.S. Environmental Protection Agency (EPA), and the International Agency for Research on Cancer (Agency for Toxic Substances and Disease Registry, 2001; IARC, 2012; National Toxicology Program, 2016; U.S. EPA, 1984). Three main conditions can arise from prolonged asbestos fiber and dust exposure: asbestosis, lung cancer, and mesothelioma.

Asbestosis is a chronic, non-cancerous respiratory disease. Inhaled asbestos fibers aggravate lung tissues, which then causes the tissue to scar (META, 2017). Symptoms of asbestosis include shortness of breath and a dry crackling sound in the lungs when breathing, and in its advanced stages, the disease may cause cardiac failure (META, 2017). There is no effective treatment for asbestosis, and the disease is usually disabling or fatal. The risk of asbestosis is minimal for those who do not work with asbestos, but those who renovate or demolish buildings that contain asbestos may be at a significant risk.

Lung cancer causes the largest number of deaths related to asbestos exposure (META, 2017). The incidence of lung cancer in people who are directly involved in the mining, milling, and manufacturing of asbestos and its products is much higher than in the general population (META, 2017). The most common symptoms of lung cancer are coughing and a change in breathing. Other symptoms include shortness of breath, persistent chest pains, hoarseness, and anemia (META, 2017).

Mesothelioma, the most serious condition, refers to cancer of the thin membrane lining the chest and abdomen. Approximately 200 cases are diagnosed each year in the U.S. (META, 2017). Symptoms of mesothelioma include shortness of breath, pain in the chest and abdomen, muscle weakness, and dry coughing/wheezing (Mott, 2012). These symptoms may not appear for up to 40 years after exposure to asbestos, and once diagnosed, the life expectancy of mesothelioma patients ranges from just twelve to 21 months (Mott, 2012).

### 3.2 Asbestos Regulations

Contrary to common belief, it is still legal to add asbestos in most building products. There has never been a complete ban on asbestos products in the United States, and chrysotile may be
found in new and imported products. However, several regulations do exist to minimize asbestos exposure during asbestos abatement activities. The U.S. EPA focuses on minimizing fiber release during the removal of ACM, and the Occupational Safety and Health Administration (OSHA) focuses on protecting workers from asbestos exposure during removal activities.

U.S. EPA National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants (NESHAP) was developed in accordance with Section 112 of the Clean Air Act (CAA) (CAA, 1970). Section 112, part of the air toxic provisions of the CAA, requires the U.S. EPA to enforce regulations that protect the public from hazardous air pollutants (U.S. EPA, 2017f). Asbestos was identified as a hazardous air pollutant by the U.S. EPA on March 31, 1971, and the Asbestos NESHAP regulations were created on April 6, 1973 (U.S. EPA, 1973).

Significant definitions related to the regulation of asbestos under the Asbestos NESHAP regulations include:

- **Friable ACM**: any material containing more than 1 percent asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR Part 763 Section 1, Polarized Light Microscopy (PLM) that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

- **Non-friable ACM**: any material containing more than 1 percent asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR Part 763 Section 1, PLM that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

- **Category I non-friable ACM**: asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR Part 763, Section 1, PLM.

- **Category II non-friable ACM**: any material, excluding Category I Non-friable ACM, containing more than 1 percent asbestos as determined using the methods specified in Appendix A, Subpart F, 40 CFR Part 763, Section 1, PLM, that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure (U.S. EPA, 1973).

Non-friable ACM that will not be made friable during removal or disposal is not regulated by the Asbestos NESHAP regulations. However, the NESHAP regulations require that all regulated asbestos-containing materials (RACM) be removed prior to any renovation or demolition activities that will disturb them. The regulations define RACM as:

- Friable ACM;
- Category I non-friable ACM that has become friable;
• Category I non-friable ACM that will or has been subject to sanding, grinding, cutting, or abrading; and
• Category II non-friable ACM that has a high probability of becoming, or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations (U.S. EPA, 1973).

Further, during the demolition or renovation of buildings containing RACM, the Asbestos NESHAP regulations require:

• A thorough inspection where RACM will be disturbed;
• The operator of the renovation or demolition to contact the relevant state agency prior to the start of work;
• The implementation of work practice standards that are designed to control releases of asbestos fibers, such as wetting all RACM prior to disturbance and sealing asbestos waste in leak tight containers;
• Vehicles, bags, and dumpsters used to transport RACM waste be marked with an asbestos danger sign during loading and unloading and be lined with plastic sheeting to avoid cross contamination; and
• Landfills be covered with six inches of material within 24 hours of receiving the RACM waste (U.S. EPA, 1973; U.S. EPA, 2016).

Overall, the Asbestos NESHAP regulations are designed to minimize asbestos fiber release and contamination of adjoining areas during the removal, transport, and disposal of RACM.

OSHA Asbestos Construction Standard

The OSHA Asbestos Construction Standard provides regulations intended to protect employees from asbestos exposure during asbestos abatement activities. Several different protections for workers exist under the Asbestos Construction Standard, described below.

Permissible Exposure Limit

A Permissible Exposure Limit (PEL) is a legal limit set by OSHA to protect employees from the adverse effects of hazardous substances, and is usually expressed as a time-weighted average (TWA). A TWA is the average exposure workers have to a hazardous substance, over an eight-hour day or a 40-hour week, before they experience adverse health effects. Further, OSHA also sets an Excursion Limit (EL), which is the maximum exposure an employee may have to a certain substance over a short sampling period, such as 30 minutes.

For asbestos, the PEL is 0.1 fiber per cubic centimeter (cm$^3$) of air over an eight-hour TWA (U.S. DL, 1996; OSHA, 2014). Further, the EL for asbestos is 1.0 asbestos fibers per cm$^3$ of air over a 30-minute sampling period (U.S. DL, 1996; OSHA, 2014). In order to comply with the OSHA Asbestos Construction Standard, employers must make sure that employees are not exposed to asbestos in excess of these limits during asbestos abatement activities.
Assessment

Before any asbestos removal can begin, OSHA requires an assessment to be conducted by a licensed asbestos inspector to determine the locations and types of asbestos present (OSHA, 2014). For example, the inspector must determine if the proposed work practices will generate airborne fibers based on whether the asbestos onsite is non-friable or friable.

Monitoring

Any employer performing asbestos abatement is required to conduct air quality testing to determine if workers are exposed to asbestos concentrations at or above the PEL and EL.

Engineering Controls and Work Practices

If the results of the air monitoring reveal that workers may be exposed to asbestos concentrations above 0.1 cm$^3$ for 8-hours (PEL) or 1.0 cm$^3$ for 30 minutes (EL), OSHA requires the employer to use proper work practices to maintain worker exposure below the PEL and EL (OSHA, 2014). One proper work practice includes the use of wet methods during the asbestos removal process (U.S. DL, 1996). This involves misting the air to reduce fiber counts and wetting the material during disturbance to prevent the release of fibers. If visible emissions (i.e., dust) are observed coming from the removal of ACM, then the material has not been adequately wetted.

A second OSHA requirement is to use High Efficiency Particulate Air (HEPA) vacuums on asbestos abatement projects, if vacuums are being used (U.S. DL, 1996). HEPA filtered vacuums are unlike standard vacuums in that the exhaust air is filtered to remove very small particles. As a result, any asbestos fibers that are collected by the HEPA vacuum are not released through the exhaust air, helping to reduce worker exposure.

Along with HEPA filtered vacuums, OSHA also requires the use of HEPA filtered exhaust units, or negative air machines (NAMs) during asbestos abatement projects (U.S. DL, 1996). Under the Asbestos Construction Standard, four air changes are required per hour (U.S. DL, 1996). An air change means that a volume of outdoor air, equal to the volume of the room or area where abatement is occurring, is pumped through the NAM. This helps to continually replace the contaminated air with “clean” air, again reducing worker exposure to asbestos fibers. Negative air machines must be ducted directly outdoors to prevent the distribution or disruption of dusts in work areas (U.S. DL, 1996).

In some cases, asbestos abatement is only conducted in one area of the project site. When this occurs, OSHA requires the use of work area enclosures to isolate the work area from the clean area (U.S. DL, 1996). A common practice is to use 6-mil polyethylene (poly) sheeting to construct floor-to-ceiling curtain walls or wall-to-wall curtain barriers. This minimizes the tracking and distribution of dusts and asbestos fibers from soiled areas into clean areas. Examples of such work area enclosures will be discussed in Section 3.3.

Finally, when workers are exposed to asbestos fibers above the PEL and EL, OSHA requires employers to provide proper personal-protective-equipment (PPE) (U.S. DL, 1996). This
includes the use of respirators and Tyvek coveralls to provide protection against asbestos fibers, as well as to ensure that any asbestos encountered in the workplace is not tracked home.

Miscellaneous Requirements

The Asbestos Construction Standard includes several additional requirements that employers must follow to protect workers from asbestos. For example, asbestos warning signs must be posted at any jobsite where asbestos is disturbed. In addition, employers must provide asbestos awareness training to any worker exposed at the PEL before work begins, and yearly medical surveillance needs to be provided to workers to ensure their health is not being compromised by asbestos abatement activities (U.S. DL, 1996; OSHA, 2014).

3.3 Project Case Study

In April 2017, I conducted an inspection for ACM on a tract of land owned by TDOT. The property consisted of a one-story, brick veneer residential building (Figure 10). The house was located in an area where a Tennessee highway was scheduled for widening, and as a result, required demolition. However, before demolition could occur, my office was hired by TDOT to determine if any ACM would be disturbed in the process. If ACM was discovered, it would have to be properly abated by a licensed asbestos abatement contractor.

FIGURE 10: Residence owned by TDOT slated for demolition (Fehr, Amec FW, 2017). An inspection for ACM was required to determine if asbestos would be disturbed during the demolition process.

3.3.1 Asbestos Inspection

The asbestos inspection and sampling activities were performed James K. Hampel, a Professional Engineer and an accredited State of Tennessee Asbestos Management Planner, and me. At the time of this project I was still being trained in asbestos work, and so Mr. Hampel accompanied me during the inspection to answer any of my questions.
Methodology

Visual Survey

The asbestos survey began with a walk-through and visual survey of the residence. The visual survey consisted of: sketching the structure, photographing and verifying the floorplans provided by TDOT; locating and identifying suspect materials that might have contained asbestos fibers; and determining applicable sampling locations.

Sampling

The identification of ACM was performed by collecting bulk samples of suspect materials (i.e., floor tiles, roof shingles, vinyl flooring, etc.) and having those samples analyzed by a laboratory. Bulk sampling is a procedure in which representative homogeneous sampling areas (HAs) in a structure are identified and then sampled. A homogeneous sampling area is an area that contains material of the same type (uniform in color and texture) and that was applied during the same general time period.

Once the HAs were identified throughout the residence, samples of suspect materials were obtained based on my discretion. Three total samples of each HA were collected. A unique identification number was assigned to each asbestos sample collected during the survey, which identified the site, HA, and sample sequence (Figure 11).

![Figure 11: Example of a unique identification number assigned to an asbestos sample while out in the field. This unique identification system helped to provide consistency between laboratory reports, photo logs, and the inspection report (Amec FW, 2017d).](image)

Samples were collected by carefully removing small portions of the suspect material with a clean, sharp knife or other hand tool suitable for the material being sampled. Each sample was placed in a labeled plastic container immediately after collection, labeled with the unique identification number. A photograph was taken of each sample next to the sample location (Figure 12). Sample containers were then placed in a large re-sealable plastic bag for transportation to the laboratory.

The sampling instrument was wiped with a clean moist cloth to decontaminate the tool and minimize the potential release of asbestos fibers or cross-contamination of subsequent samples. Data pertinent to each sample (e.g., date, sample number, material description, and material category) was recorded on a field data sheet.
FIGURE 12: Examples of samples collected and photographs taken during the April 2017 asbestos inspection (Fehr, Amec FW, 2017). The photographs were used to create a photolog for the client, as well as to help me identify the specific types of suspect materials back in the office.
Asbestos Analysis

The samples were sent to an Amec FW laboratory in Atlanta where they were analyzed using PLM in accordance with EPA Method 600/R-93/116 (U.S. EPA, 1993). Polarized Light Microscopy is an analytical method for asbestos identification, which identifies the specific asbestos mineral fibers by their unique optical properties. The optical properties are a result of the mineral’s chemical composition, physical atomic structure, and visual morphology (U.S. EPA, 1993).

Samples from each HA were analyzed on a “first positive stop” basis (U.S. EPA, 1993). “First positive stop” means that if one sample from a HA of material was found to contain greater than one percent asbestos, the remaining samples from that same HA were not analyzed and the material was assumed to contain asbestos.

Asbestos Inspection Results

A total of 30 samples were obtained from the residence, and it was discovered that the drywall and joint compound material contained asbestos (Table 3).

Table 3:

<table>
<thead>
<tr>
<th>Material</th>
<th>HA No.</th>
<th>% Asbestos</th>
<th>Friable</th>
<th>Estimated Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray Architectural Roof Shingles, Residence</td>
<td>01</td>
<td>Not detected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roofing Felt, Roofs</td>
<td>02</td>
<td>Not detected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Shingle, Shed (Bottom Roof)</td>
<td>03</td>
<td>Not detected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Window Glazing Compound, Front &amp; Laundry &amp; Kitchen</td>
<td>04</td>
<td>Not detected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White &amp; Gray Loose Insulation, Attic</td>
<td>05</td>
<td>Not detected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloth Covered Electrical Wire, Attic</td>
<td>06</td>
<td>Not detected</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drywall &amp; Joint Compound, Den &amp; Living Room</strong></td>
<td>07</td>
<td><strong>10% - Chrysotile</strong></td>
<td>Friable</td>
<td><strong>3,500 sq. ft.</strong></td>
</tr>
<tr>
<td>Tan Cushion Vinyl w/ Yellow Mastic, Bath &amp; Kitchen</td>
<td>09</td>
<td>Not detected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood Grain Vinyl, Laundry</td>
<td>10</td>
<td>Not detected</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since asbestos was identified in the residence during our inspection, the residence could not be demolished without first properly, and legally, removing the asbestos.
3.3.2 Asbestos Abatement Oversight

My office subcontracted with a local mold and asbestos abatement company to perform the asbestos removal. As part of the abatement process, I was responsible for remaining onsite and verifying that the subcontractor was complying with the Asbestos NESHAP regulations and with the requirements laid out in the OSHA Asbestos Construction Standard. The results of the air monitoring on the first day of the abatement revealed that workers would be exposed to asbestos fibers exceeding the PEL and EL. Consequently, the OSHA Asbestos Construction Standard was relevant. Along with enforcing the regulations, I was also onsite to provide guidance if the subcontractor had any questions while removing the drywall and joint compound.

Daily Field Reports

Field work occurred for four days in August 2017, and each day I was responsible for completing daily field reports (DFRs). Each DFR contained the following information: onsite Amec FW personnel; onsite contractors; equipment and supplies onsite; description of tasks performed; project notes; waste hauling; and the next day’s planned activities. Photographic documentation of each day of fieldwork was also included in each DFR.

Asbestos Abatement: Day 1

The first day of the abatement involved prepping the work area for the removal of the walls and ceiling, all of which contained drywall and joint compound. To comply with the OSHA Asbestos Construction Standard, 6-mil poly sheets were installed throughout the residence in order to isolate the work area, a NAM was located in the living room to ensure four air changes per hour, and an asbestos warning sign was placed on the front door (Figures 13-14). In addition, the kitchen cabinets were removed and disposed as regular construction and demolition waste.

FIGURE 13: View of the living room with 6-mil poly sheets installed, the NAM, and the exhaust tube from the NAM (Fehr, Amec FW, 2017).
Asbestos Abatement: Day 2

On the second day of the abatement, workers started to remove the interior walls and ceilings. As the abatement was occurring, I was responsible for entering the residence twice per hour to verify that the subcontractor was adhering to the Asbestos NESHAP regulations and the OSHA Asbestos Construction Standard. The workers were always using a HEPA vacuum, and wet methods were constantly being employed. However, I would often have to remind the workers to wear their respirators, as well as the hood on their Tyvek coveralls (Figure 15). At the end of the day, the asbestos-containing drywall materials were properly bagged and stored in the living room for future disposal (Figure 16).

FIGURE 14: View of the front of the residence with the asbestos warning sign and the exhaust tube from the NAM (Fehr, Amec FW, 2017).

FIGURE 15: View of a worker wearing his respirator and Tyvek coveralls after my reminder (Fehr, Amec FW, 2017).
Asbestos Abatement: Day 3

Workers finished removing and bagging the interior walls and ceilings on the third day of abatement. Throughout the day I noted that the subcontractor complied with all regulations and standards – the workers were always wearing their PPE, the HEPA vacuum and wet methods were employed, and all of the 6-mil poly sheets remained intact (Figure 17).

FIGURE 16: View of sealed bags of asbestos waste that were stored in the living room after the second day of abatement (Fehr, Amec FW, 2017).

FIGURE 17: View of workers wearing their respirators and Tyvek coveralls (Fehr, Amec FW, 2017). The worker on the left was using an air mister to reduce the airborne asbestos fiber counts.
Asbestos Abatement – Day 4

The fourth and final day of the abatement involved transferring the bagged asbestos from inside the residence to a roll-off dumpster located outside the residence for disposal. Per the Asbestos NESHAP regulations, I made sure that the subcontractor lined the dumpster with 6-mil poly sheets in order to avoid cross contamination, and placed an asbestos warning sign on the outside of the container (Figure 18). Last, it was required that the subcontractor seal the dumpster with an additional layer of plastic sheeting prior to it being transported off site (Figure 19). Before leaving the site, I took photographic documentation that the asbestos abatement had been completed throughout the residence (Figure 20).

FIGURE 18: View of the properly lined roll-off dumpster containing the bagged asbestos waste (Fehr, Amec FW, 2017).

FIGURE 19: Once all of the bagged asbestos waste was transferred to the dumpster, the top was sealed with an additional layer of 6-mil poly (Fehr, Amec FW, 2017).
Asbestos Abatement Final Report

When the fieldwork was completed, I was responsible for completing the final asbestos abatement report back in the office. The report included copies of the DFRs, photographic logs, as well as documentation that the subcontractor followed the Asbestos NESHAP regulations and the OSHA Asbestos Construction Standard through the project’s entirety. In the end, our report served as written approval that TDOT was allowed to demolish the residence and move forward with their highway widening project.

FIGURE 20: View inside the residence with all interior walls and ceilings removed. The asbestos abatement was considered complete at the time of this photo (Fehr, Amec FW, 2017).
4. PRESENCE AND ABSENCE BAT SURVEY

For two weeks in July 2017 I conducted a presence and absence bat survey to determine if a highway widening project would result in adverse impacts to the endangered Indiana bat (*Myotis sodalis*) and/or the threatened northern long-eared bat (NLEB) (*Myotis septentrionalis*). My client for this project was the Tennessee Department of Transportation (TDOT). Before describing the project in detail, below I explain the Endangered Species Act and provide background information on the Indiana bat and the NLEB.

4.1 Endangered Species Act

The Endangered Species Act was signed into law in 1973 by President Richard Nixon (USFWS, 1973). Overseen by the United States Fish and Wildlife Service (USFWS), the purpose of the Act is to provide for the protection of critically imperiled species from extinction, their ecosystems on which they depend, and the enforcement of all treaties related to wildlife preservation (USFWS, 2013).

Under the Endangered Species Act, species may be listed as either endangered or threatened. An endangered species is defined as “any species which is in danger of extinction throughout all or a significant portion of its range” (USFWS, 1973). Endangered species are in danger of becoming extinct. A threatened species is defined as “any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range” (USFWS, 1973). Threatened species are in danger of becoming endangered in the near future.

Section 4: Determination of Endangered Species and Threatened Species

Section 4 of the Endangered Species Act outlines how species in need of protection are identified and prioritized and the actions needed to recover those species and conserve their habitats (USFWS, 2013). Section 4(a) lists five factors to be considered when evaluating whether a plant or animal should be listed under the Act:

1) The present or threatened destruction, modification, or curtailment of its habitat or range;
2) Overutilization for commercial, recreational, scientific, or educational purposes;
3) Disease or predation;
4) The inadequacy of existing regulatory mechanisms; or
5) Other natural or manmade factors affecting its continued existence (USFWS, 1973).

These five factors are based on the best scientific data available about population health and habitat quality for the species in question. When any one of these factors is having an impact on the survival of a species, the USFWS develops a proposed rule to list the species as endangered or threatened (USFWS, 2013). However, if the listing of the species is precluded by other species with a higher priority for listing, the species becomes a “candidate” for listing until the USFWS has time or enough budget to prepare a rule (USFWS, 2013). Candidate species are not protected under the Act, but are still subjected to conservation measures by the USFWS (USFWS, 2013).
When “prudent and determinable,” Section 4(a) of the Endangered Species Act also requires the designation of “critical habitat” for species listed as endangered or threatened (USFWS, 1973). As defined in the Act, “critical habitat” refers to the:

“specific areas within the geographic area occupied by the species…on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species at the time it is listed…that such areas are essential for the conservation of the species” (USFWS, 1973).

When a species is listed, the USFWS must consider whether there are areas that are essential to the species’ conservation. Critical habitats affect Federal agency actions, as they are required to avoid “destruction” or “adverse modification” of the critical habitat (USFWS, 1973; USFWS, 2013).

Section 4(d) of the Endangered Species Act directs the USFWS to enact regulations to conserve threatened species (USFWS, 1973; USFWS, 2014). Threatened species automatically are subjected to the protections laid out in Section 9 for endangered species, discussed below. However, a 4(d) rule can be issued if specific types of “take” need to be clarified or simplified for a threatened species (USFWS, 2014). For instance, section 4(d) rules can allow certain activities to continue if they do not harm the threatened species, while placing higher priority on the specific threats that are impacting the species’ recovery (USFWS, 2013). The NLEB is associated with a 4(d) rule, described in Section 4.3.

Section 4(f) of the Endangered Species Act is geared towards recovering listed species through the development of recovery plans. Recovery plans are developed by the USFWS, and outline the path and conservation measures required to restore a wild population (USFWS, 2013). For example, captive breeding programs may be created to help a species achieve a population size large enough to allow for reintroduction into the wild. Once a species has recovered to the point where they no longer need protection, they are removed from the list.

Section 9: Prohibited Acts

Under Section 9 of the Endangered Species Act, it is prohibited to “take” listed endangered or threatened species (USFWS, 1973). As defined in the Act, “take” means to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct” (USFWS, 1973). Through additional regulations in 1999, “harm” was defined to include significant habitat modification or degradation where it actually kills or injures wildlife and impairs essential behavior patterns, such as feeding and sheltering (USFWS, 2013). These actions, known as take prohibitions, apply to any public or private entity (USFWS, 2013).

Section 7: Interagency Cooperation

Under Section 7(a) of the Endangered Species Act, Federal agencies must consult with the USFWS if the projects they authorize, fund, or carry out may jeopardize the survival of endangered and threatened species, or result in the adverse modification of an endangered or
threatened species’ critical habitat (USFWS, 1973). To determine if a Federal action is likely to adversely affect a listed species, Section 7(b) directs the USFWS to conduct a biological assessment, followed by the issuance of a biological opinion.

A biological assessment is meant to document the rationale behind the USFWS’s opinion as to whether the Federal action in question will negatively impact a listed species. Elements included in a biological assessment are as follows:

1) Description of the project, including what the project involves, where the project is located, how will the project be performed, and who is carrying out the project;
2) Description of the habitat type, including if the geographic area of the project encompasses critical habitat;
3) Identification of endangered or threatened species which may be present in the project area; and
4) Description of how the Federal action may affect listed species (i.e., biological opinion) (USFWS, 2017a).

If the USFWS determines that the Federal action is likely to adversely affect an endangered or threatened species, the USFWS will include a list of alternatives within the biological assessment. The alternatives must be reasonable and prudent, and are meant to allow the project to proceed in a manner which will not jeopardize the survival of the listed species (USFWS, 1973). The USFWS can also cooperate with state agencies for assistance with developing the biological assessment (USFWS, 1973).

For the project that I worked on in July 2017, TDOT received federal funds to widen the highway. As a result, Section 7 consultation was required to determine if the federally funded highway widening project would result in adverse effects to the Indiana bat and NLEB. My office was hired by TDOT to determine if the Indiana bat or NLEB was present in the project area via a presence/absence bat survey. Using our findings from the field, TDOT was then responsible for preparing the official biological assessment to be submitted to the USFWS for review.

4.2 Indiana Bat

The Indiana bat is classified as an endangered species under the Endangered Species Act. Indiana bats are known for clustering together in large numbers during hibernation, and have relatively small, mouse-like ears (USFWS, 2006). After hibernating in the winter, Indiana bats migrate to wooded areas and roost under loose tree bark (USFWS, 2006). Indiana bats forage along the edges of wooded areas, and mainly feed on insects found near rivers or lakes (USFWS, 2006). While almost half of all Indiana bats are found in southern Indiana, a significant number of Indiana bats are also found in Tennessee.

There are several factors which makes the Indiana bat an endangered species. Since Indiana bats hibernate in such large numbers in only a few caves, up to 500 bats per square foot in some cases, they are extremely vulnerable to disturbance (USFWS, 2006). Opening caves to tourists in...
the winter, for example, eliminates the ability for Indiana bats to hibernate. In addition, even installing a gate at the entrance to a cave known to contain Indiana bats can prove harmful. Gates can change the temperature in a cave, which can make hibernation unsuitable (USFWS, 2006).

In the summer, habitat loss and degradation reduce the Indiana bat’s ability to forage. To help the Indiana bat recover, the USFWS is aimed at making sure there is a sufficient supply of dead and dying trees that Indiana bats can use as roosting sites (USFWS, 2006).

### 4.3 Northern-Long Eared Bat

The NLEB is listed as a threatened species under the Endangered Species Act. Northern long-eared bats are distinguished by their elongated ears, especially as compared to Indiana bats (USFWS, 2015). During hibernation in the winter, NLEBs are found within small cracks in caves, with only the nose and ears typically visible (USFWS, 2015). In the summer, NLEBs roost underneath bark or in cavities of live and dead trees (USFWS, 2015). Like the Indiana bat, NLEBs forage along the understory of forested areas and are found throughout Tennessee (USFWS, 2015).

The main reason why the NLEB is listed as threatened is due to the emergence of white-nose syndrome (WNS). White-nose syndrome is caused by a fungus which infects the ears, muzzle, and wings of NLEBs during hibernation (USGS, 2017). Northern long-eared bats infected by WNS have white fungal growth on their muzzle or wings, and they also experience physiologic changes involving weight loss, electrolyte imbalances, dehydration, and ultimately death (USGS, 2017). Symptoms of WNS were first observed in 2006 in New York, but the disease has spread rapidly from the Northeast to the Midwest and Southeast (USFWS, 2015).

The USFWS published a section 4(d) rule for the NLEB in 2016, which is focused on protecting the life stages of the NLEB in areas affected by WNS (USFWS, 2016). The primary focus of the 4(d) rule is to protect bats when and where WNS makes them the most vulnerable – simply applying the general take prohibitions outlined in Section 9 would not help to recover the NLEB (USFWS, 2016). In addition, research is ongoing by organizations to control the spread of WNS and to reduce the impact WNS has on the NLEB.

### 4.4 Project Case-Study

The project I worked on in July 2017 entailed the widening of approximately 6.75 miles of State Route (SR) 18 in Jackson, Tennessee. The project’s preliminary plans indicated proposed right-of-way (ROW) widths along SR 18 that varied from 75 feet to 300 feet along both sides of the highway. In order for construction to occur, TDOT was required to report to the USFWS that no Indiana bats or NLEBs were present throughout the proposed ROW extensions. As a result, TDOT hired Amec FW to conduct a presence and absence bat survey.

The project team included myself, two senior biologists, and one permitted biologist. The permitted biologist had extensive experience in conducting emergence surveys for Indiana bats and NLEBs, and was authorized by the USFWS to capture and release engendered and
threatened bats. Only the permitted biologist, with assistance from the two senior biologists, was allowed to handle any captured bats.

4.4.1 Methodology

The scope of work was to conduct a presence and absence bat survey according to the USFWS Range-Wide Indiana Bat Summer Survey Guidelines (Summer Survey Guidelines). The Summer Survey Guidelines outline methodology to be used by surveyors to determine whether Indiana bats or NLEBs are present at any given site during the summer months (USFWS, 2017b). More specifically, the objectives of the Summer Survey Guidelines are to:

1) Standardize range-wide survey procedures;
2) Maximize the potential for detection/capture of Indiana bats and NLEBs at a minimum level of effort;
3) Make accurate presence/absence determinations; and
4) Aid in conservation efforts for the species by identifying areas where the species is present (USFWS, 2017b).

The following sections provide the project-specific details regarding methodology that were used during the July 2017 survey, based upon the Summer Survey Guidelines.

Habitat Assessment

Before heading out into the field, a desktop review was conducted to determine the habitat types throughout the project area. Based on a desktop review of available aerial photographs along with a set of city plans provided by TDOT, it was determined that the project area consisted of the following habitats: residential, light commercial, upland hardwood forests, riparian areas, roads, agricultural fields, and open pastures/fields. Keeping the roosting habits of the Indiana bat and NLEB in mind, twelve potential net site locations were identified within the upland hardwood forests and riparian areas.

On the first two days in the field, a site visit was conducted to verify or adjust the potential net site locations identified during the desktop review. During the site visit, we determined that only four, not twelve, suitable net locations existed throughout the project area. The project area was largely surrounded by residential areas, and few forested corridors were present (Figure 21). Further, few standing trees with cracks, crevices, hollows, etc. providing potential maternity habitat were observed.

FIGURE 21: Typical view of a residential area observed along SR 18 (Fehr, Amec FW, 2017). Nets were not deployed in residential areas since they do not provide adequate canopy cover for bats.
Mist Netting

Mist netting was used as a presence/probable absence survey method. According to the Summer Survey Guidelines, any capture of reproductive adult females and/or young of the year during May 15 – August 15 via mist netting confirms the presence of a maternity colony in the vicinity of the project area (USFWS, 2017b).

Mist nets six-meters in length, with 38-mm mesh, were used during the survey. Based on the characteristics of each site in the project area, either single-high (12 feet) or double-high (24 feet) nets were used (Figures 22-23).

Per the Summer Survey Guidelines, linear projects (i.e., highway widening projects) located in Tennessee are required to be evaluated with a minimum of four net nights per 0.6-mile of suitable summer roosting habitat (USFWS, 2017b). Single-high nets account for one net night, and double-high nets account for two net nights. For example:
Based on our project length of 6.75 miles, we were required to evaluate the site with a minimum of 45 net nights:

\[
[6.75 \text{ miles} \div 0.6 \text{ mile}] \times 4 \text{ required net nights} = 45 \text{ total net nights}
\]

**Survey Nights**

Mist-net surveys were conducted between July 18 and July 29, 2017. Netting began at dusk and continued for at least five hours. Each night before dusk, a minimum of two, double-high nets, located at least 100 ft. apart (unless survey areas restricted placement) were deployed each night. When a site allowed, two additional single-high mist nets were deployed. Net locations at each site were recorded using a handheld Global Positioning System (GPS) unit. One site was surveyed per night, and each site (four total) was surveyed for two consecutive nights.

Best professional judgement by myself and the project team was used to select the net site locations at each site. Nets were placed along travel corridors such as streams and small roads, and the nets were placed perpendicular across the corridors. If applicable, the nets filled the corridors from side to side and from ground level up to the overhanging canopy. When no corridors were present, nets were placed along forested edges, perpendicular to the edge, to catch bats that were foraging.

The first net site (Site 1) was adjacent to a stream that flowed beneath the highway (Figure 24). Adjacent to the stream was a narrow forest of trees and shrubs, and a pasture with tall grasses. This riparian vegetation provided a moderate canopy cover for any bats in the area.

The second net site (Site 2) was adjacent to an emergent wetland and stream (Figure 25). A few scattered shrubs and grasses were present, and a forested tree line was located adjacent to the net locations.

The third net site (Site 3) was a grassy road with scattered shrubs and trees that provided marginal canopy cover (Figure 26). A young successional forest was located next to the site, and a water source was located within 500 feet.

The fourth net site (Site 4) was located along a stream channel, which was lined with trees and shrubs (Figure 27). A mowed residential yard with scattered trees was located next to the site.
FIGURE 24: Site 1 with an example of a double-high net located along the forest canopy (Fehr, Amec FW, 2017).

FIGURE 25: Site 2 with an example of a double-high net located along the wetland. A whiteboard was used to identify the specific net locations (Fehr, Amec FW, 2017).
FIGURE 26: Site 3 with an example of a single-high net located along the forest edge (Fehr, Amec FW, 2017).

FIGURE 27: Site 4 with an example of single-high and double-high nets located along the stream (Fehr, Amec FW, 2017).
To minimize disturbance of the bats around the area, nets were only checked every 20 minutes with a dim flashlight. Any captured, non-listed bats that were caught were identified, measured, and released immediately by the permitted biologist. All data, including GPS location, date, weather, site description, biologists’ names, bat captures, and bat measurements were recorded on field data forms.

To minimize the transmission of WNS between captured bats, all hard, non-porous netting equipment was sanitized with Lysol® prior to arrival and after each survey night. All other equipment, including the mist nets, was submersed in boiling water for a minimum of 20 minutes. The permitted biologist wore disposable latex gloves over sanitized handling gloves while handling any captured bats. Last, all nondisposable equipment, such as rulers, contacting any captured bats was sanitized immediately following the handling of the bat.

4.4.2 Project Findings

A total of 45-net nights was successfully achieved during the study period. Table 4 illustrates additional information from each survey night.

**TABLE 4:** Information gathered during each survey night. One bat was captured on the first night of surveying. On July 23 and July 27, the survey night was not completed due to unsuitable weather for the majority of the survey night.

<table>
<thead>
<tr>
<th>Date</th>
<th>Site ID</th>
<th># of Nets</th>
<th>Begin Time</th>
<th>End Time</th>
<th>Duration</th>
<th>Captures</th>
</tr>
</thead>
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<tr>
<td>7/18/2017</td>
<td>Site 1</td>
<td>4</td>
<td>8:46 p.m.</td>
<td>1:50 a.m.</td>
<td>5 hrs. 4 min.</td>
<td>1</td>
</tr>
<tr>
<td>7/19/2017</td>
<td>Site 1</td>
<td>4</td>
<td>8:19 p.m.</td>
<td>1:30 a.m.</td>
<td>5 hrs. 11 min.</td>
<td>0</td>
</tr>
<tr>
<td>7/20/2017</td>
<td>Site 2</td>
<td>4</td>
<td>8:10 p.m.</td>
<td>1:13 a.m.</td>
<td>5 hrs. 3 min.</td>
<td>0</td>
</tr>
<tr>
<td>7/21/2017</td>
<td>Site 2</td>
<td>4</td>
<td>8:15 p.m.</td>
<td>1:21 a.m.</td>
<td>5 hrs. 6 min.</td>
<td>0</td>
</tr>
<tr>
<td>7/22/2017</td>
<td>Site 3</td>
<td>5</td>
<td>8:11 p.m.</td>
<td>1:20 a.m.</td>
<td>5 hrs. 9 min.</td>
<td>0</td>
</tr>
<tr>
<td>7/23/2017*</td>
<td>Site 3</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>7/24/2017</td>
<td>Site 3</td>
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<td>8:10 p.m.</td>
<td>1:23 a.m.</td>
<td>5 hrs. 13 min.</td>
<td>0</td>
</tr>
<tr>
<td>7/25/2017</td>
<td>Site 4</td>
<td>6</td>
<td>8:19 p.m.</td>
<td>1:40 a.m.</td>
<td>5 hrs. 11 min.</td>
<td>0</td>
</tr>
<tr>
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<td>1:23 a.m.</td>
<td>5 hrs. 15 min.</td>
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<td>9:00 p.m.</td>
<td>2 hrs. 3 min.</td>
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</tr>
<tr>
<td>7/28/2017</td>
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<td>1:35 a.m.</td>
<td>5 hrs. 28 min.</td>
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</tbody>
</table>

Only one bat species, evening bat (Nycticeius humeralis), was captured over the 45-net night survey effort (Figure 28). Other bats were observed flying in the vicinity of the project area and in some cases, near the mist-nets. However, we were unable to identify these bats and are thus not included in the results.

**Final Conclusions and Report**

Throughout the survey period, the SR-18 corridor was consistently active with automobile traffic that produced light and noise. These factors likely limited the presence of common bat species in the project area, as well as the presence of Indiana bat or NLEB maternity colonies. Since no Indiana bats or NLEBs were captured during the survey period, absence was assumed for the project area.
Our findings were submitted to TDOT within one week after the fieldwork was completed, who then completed the entire biological assessment. Soon after receiving the assessment from TDOT, the USFWS issued a biological opinion and determined that the SR 18 highway widening project would not jeopardize the continued existence of the Indiana bat and the NLEB. As a result, TDOT was approved to begin the project.

**FIGURE 28**: The permitted biologist holding the evening bat (*Nycticeius humeralis*) captured on the first survey night at Site 1 (Fehr, Amec FW, 2017).
5. MULTIFACETED NATURE OF ENVIRONMENTAL CONSULTING

My position as an environmental scientist at an international consulting firm gives me the opportunity to work on a multitude of different projects. From the projects discussed throughout this report, to building characterization surveys and to indoor air quality testing, each project I work on presents me with a unique set of challenges. I must meet strict deadlines, be responsible for conducting projects with little previous training, and work efficiently under heavy workloads. Along with these challenges, however, I am also able to gain significant experience with not only technical report writing and field methodology, but also with forming relationships with clients and subcontractors. In addition, having such a large variety of projects often allows me to travel out of state and experience different areas of the country.

Below I describe two projects that I have particularly enjoyed working on, including a reflection regarding the specific challenges I faced and the main skills I learned during each project. The Institute for the Environment and Sustainability (IES) Master of Environmental Science (M.En.) program provided me with the foundation needed to work on such a wide-variety of projects. I obtained numerous technical skills through my graduate coursework which I have found to be useful in every project I work on, namely analyzing quantitative data and writing concise and detailed field notes. Most importantly, owing to the IES program’s emphasis on professional development, I also acquired the skills needed to interact well with others and work efficiently within an interdisciplinary setting.

5.1 Building Characterization Survey

In September 2017, I conducted a building characterization survey to assist a client with facility decommissioning and demolition preparations. The site, located in Goldsboro, North Carolina, consisted of an approximate 110,000 square-foot manufacturing building that formerly manufactured industrial lighting products (Figure 29). Our survey was meant to evaluate environmental conditions at the site to provide the client with information for future building deconstruction.

![FIGURE 29: Views of the manufacturing building that was slated for decommissioning and demolition (Fehr, Amec FW, 2017).](image)
Site Surveys

To fully characterize the site, the site surveys included the following: an equipment inventory; a universal waste/regulated material inventory; an asbestos-containing materials survey; paint sampling; concrete sampling; and equipment wipe sampling. Each of these surveys and their respective findings are briefly described below.

**Equipment Inventory**

An inventory of equipment was conducted at the site and included the equipment dimensions, location in the building, and general characteristics. Equipment observed onsite included cranes, drill presses, sanders, forklifts, and wire spoolers (Figure 30). Based on our inventory, the client understood what equipment was still present, and based on the type and condition, the client could decide if it would be more cost-effective to sell or reuse the equipment at a different site.

**Universal Waste/Regulated Materials**

I was responsible for conducting an inventory of universal wastes and other regulated materials for the building, which included an assessment of PCB-containing devices such as transformers, circuit breakers, and fluorescent light ballasts. Equipment suspected to contain refrigerants and mercury were also inventoried. In general, the materials identified included mercury-containing devices such as fluorescent lamps, thermostats, and manometers and materials with batteries including exit signs and emergency lights. In addition, fire extinguishers and dry-type transformers were observed throughout the building. This inventory helped the client to understand the different types and amounts of materials which needed to be properly disposed of during the decommissioning of the facility.

**Asbestos Building Survey**

As part of site closure activities, an asbestos-containing material (ACM) survey was conducted to understand potential environmental liabilities in connection with the building and property. The asbestos survey identified the presence, location, and quantity of ACM and satisfied the requirements of the Asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations for the renovation or demolition of a facility. Results of the survey indicated that ACM was identified throughout the building, primarily in floor tiles (Figure 31). Prior to demolition, all ACM was required be properly abated.
Paint Chip Sampling

Based on the poor condition of the building’s interior painted surfaces, sampling of flaking paint was conducted for analysis of PCBs and lead (Figure 32). The PCB analytical results were compared to the bulk PCB remediation waste cleanup standard set by the Toxic Substances Control Act (TSCA), and the lead analytical results were compared to the EPA Regional Screening Level (RSL) for lead. It was found that each paint chip sample exceeded the TSCA standard for PCBs. As a result, all flaking paint was required be properly removed, transported, and disposed of to a TSCA permitted facility certified to receive waste with elevated PCB concentrations.
Concrete Sampling

Samples were collected from the concrete floor surfaces at the site to characterize concrete disposal during demolition activities. The locations of the concrete samples were focused on areas of activities and facility processes or visible staining or impacts to the concrete. Concrete samples were collected from the upper three inches of the floor surface and were submitted to the laboratory for PCB and mercury analysis. Similar to the paint chip samples, the PCB results were compared to the TSCA’s bulk PCB remediation waste cleanup standard, and the mercury results were compared to the mercury RSL. Each of the concrete samples were found to exceed the TSCA standard, which were in areas of visible staining. As a result, all of the concrete flooring had to be sent to a TSCA permitted landfill.

Wipe Sampling

Wipe sampling was conducted to determine if equipment and building materials inside the building contained elevated PCB concentrations. For each sample location, a template was used to delineate the area to be wiped (Figure 34). The wipe medium consisted of a gauze pad saturated with hexane. Following the collection of the wipe sample, the gauze pad was allowed to air dry and was then placed into a glass vial to be sent to the laboratory. Several samples were shown to trigger TSCA waste disposal requirements for PCBs.

5.1.1 Reflection

This building characterization survey presented me with a wide variety of challenges, but with these challenges I was also able to gain a great deal of experience. Before arriving onsite, I had never been involved with concrete, paint, and equipment wipe sampling, and I had no experience with inventorying large pieces of industrial equipment. However, my supervisor accompanied me throughout the fieldwork to train me in the different sampling procedures. After roughly two days of training, I felt comfortable to perform the sampling by myself, and I can now take the technical skills I learned here to similar projects in the future.

With all the different kinds of sampling came a significant amount of reporting back in the office. I was responsible for compiling the lab results into tables, meeting with the GIS team to create figures that illustrated the sampling locations, creating photo logs, and writing the final report. In addition, on top of the quick turnaround required for these deliverables, I was also juggling two separate projects at the same time. While it was a stressful process, I was able to
meet each deadline by working efficiently and delegating tasks to some of my coworkers – skills that I obtained during my time in the IES master’s program.

Along with the technical experience obtained during this project, I was also responsible for completing tasks related to project management. Even before my office was awarded the work I assisted with bidding for the project. This involved writing the proposal, developing the timeline and budget, and attending conference calls with the prospective client. Once our office was awarded the project, I was then responsible for calling around and obtaining quotes from several different laboratories to analyze the samples we would be collecting. This required me to be familiar with the specific sampling procedures and understand what analysis methods were required, and I was responsible for making sure the quotes aligned with the project budget.

Similar to finding a laboratory, I was tasked with finding a concrete company to help with collecting the concrete samples. However, finding a company that was willing to travel to Goldsboro, NC for a relatively small project quickly proved difficult. In addition, I had trouble finding a company that could meet Amec Foster Wheeler’s (Amec FW) and the client’s high insurance requirements. As a result, I was further tasked with communicating with my supervisor and with our client to lessen the insurance requirements for this specific project. Once the contract was finalized, I was responsible for communicating with the subcontractor and making sure they performed the work according to the sampling procedure.

Thanks to this project, one of my goals as an environmental consultant is to now eventually work my way up to become a project manager. I found budgeting and tracking project progress to be both challenging and fascinating, and I really enjoyed the managerial roles that I was assigned. Further, I realized that to be an effective project manager, one needs to be familiar with the technical background of the project as well – not with just budgeting and managing the different pieces behind a desk. I look forward to continuing to obtain the technical experience early in my career in order to become a successful project manager.

5.2 Hurricane Harvey – Mold and Moisture Remediation

From September to December 2017, I was relocated to Houston to assist with remediation efforts at a large apartment complex severely damaged by Hurricane Harvey. Our client for this project was the insurer of the complex, and hired Amec FW to provide a floodwater, mold, and moisture remediation work plan, provide guidance to the remediation contractor during cleaning, and conduct post remediation verification (PRV) testing.

**Project Background**

The complex contained eighty apartment buildings which were all flooded as Hurricane Harvey passed through the Houston area at the end of August 2017. Based on investigations of water stains on the apartment buildings in the complex, water levels ranged from six inches to seven feet above floors in the first-floor residential units. Combined with Houston’s high humidity, the flood resulted in extensive colonies of suspect visible mold growth (SVG) on moisture affected materials throughout the first-floor residential units of each building (Figure 35).
As part of the remediation, all known building materials that were affected by SVG and moisture were required to be removed. The remediation scope of work included the removal of all carpeting and padding; all moisture and SVG impacted walls, ceilings, cabinetry, insulation, and entry doors; all exterior pressboard siding; all ductwork; all toilets and bathtubs; and any personal belongings and furniture left behind during the flood. In general, each first-floor residential unit had to be completely gutted to remove all flood-related SVG and moisture (Figure 36).

Once all the impacted building materials were removed, the remediation contractor was responsible for cleaning each unit. Cleaning involved the removal of visible construction debris, settled dusts, soils, and SVG from materials and surfaces that remained in the work area. Materials that remained in the work area included wood studs, concrete floors, windows, sliding glass doors, and electrical wiring. The contractor used a sanitizer certified by the EPA as appropriate for sanitizing surfaces affected by floodwaters.

**FIGURE 35:** Combined with the region’s high humidity, floodwaters from Hurricane Harvey resulted in extensive mold growth throughout the first-floor apartment units (Fehr, Amec FW, 2017).

**FIGURE 36:** To completely remove all flood-related mold growth, the remediation contractor was required to gut each apartment unit (Fehr, Amec FW, 2017).

**Post Remediation Verification (PRV) Testing and Mold Air Sampling**

Once apartment units were deemed clean by the remediation contractor, I was responsible for conducting final PRV testing prior to the installation of new building materials. The PRV involved assessing the condition of exposed building finishes, wall and ceiling cavities, and floors exposed by demolition and remediation to assess the cleanliness of surfaces. If visible dust/debris or remaining SVG was observed, or if excess moisture was detected, then I directed the contractor to perform additional cleaning, followed by a second PRV.
After the completion of remediation work and the PRV testing, I conducted mold spore trap indoor and outdoor air sampling to confirm that the buildings were successfully remediated. This involved pumping air through Air-O-Cell® spore trap sampling cassettes, which collect mold spores on a small slide coated with an adhesive collection media (Figure 37). Apartment units “passed” when the results indicated that indoor mold spore concentrations were less than or equal to outdoor, and indoor mold taxa were similar to outdoors. However, units “failed” if indoor mold spore concentrations were greater than outdoors, or if the indoor mold taxa were different than outdoors. If an apartment unit failed, the contractor was required to reclean the unit, followed by me conducting an additional round of mold air sampling.

FIGURE 37: Spore trap sampling cassettes were used to confirm whether each apartment unit was adequately cleaned by the remediation contractor. Note the water line on the patio door (Fehr, Amec FW, 2017).

5.2.1 Reflection

Out of all the projects I have worked on thus far at Amec FW, this project was the most challenging. The remediation work was originally scheduled to only last for one month. It was expected that once each apartment building was cleaned, it would only take one sampling event to confirm the building had been successfully remediated. However, throughout the first month not one building passed the mold air sampling. The indoor mold spore concentrations consistently exceeded the outdoor concentrations, and buildings still did not pass after three or four additional rounds of cleaning.

As the only hygienist onsite, the contractor often demanded answers as to why the buildings were not passing. Prior to this project I had little experience with mold remediation work, and at times I felt stressed since I could not answer the questions I was asked. Additionally, the project manager was in Seattle, and it was often difficult to contact him due to his busy schedule and to the time difference. After spending numerous hours investigating the units that had been cleaned, I worked with the remediation contractor to develop a new cleaning scheme. I also talked with other consultants familiar with mold and moisture remediation techniques, who assisted me with directing the contractor to use a different EPA-approved sanitizer. Once revisions to the cleaning practices were made, the buildings started passing, and the remediation work was completed in mid-December.
It was very rewarding to be able to work alongside the remediation contractor to finally pass all eighty apartment buildings, but it could not have been done without establishing effective communication. Every morning I was responsible for communicating the lab results from the previous day’s sampling to the contractor. If a unit failed the mold air sampling test, I worked with the remediation team to point out additional materials to clean before I conducted an additional sampling event. Along with communicating with the contractor, I was also responsible for sending daily updates to the project manager in Seattle for him to use to update the client.

Even with the challenges that I faced while I was onsite, I truly enjoyed being involved in this project. Conducting mold and moisture assessments for three months gave me tremendous experience with work related to industrial hygiene, and I am looking forward to pursuing similar opportunities in the future. I enjoyed the fieldwork that came with this project, but I also enjoyed looking over the lab reports each day back in the Houston office to see which units passed or failed from the day before.

Last, it was truly eye opening to see the devastation that was caused by Hurricane Harvey throughout the apartment complex and Houston as a whole. Residents at the apartment complex were forced to be rescued by boat, and most residents were forced to leave their personal belongings behind, only for them to be destroyed in the flood (Figure 38). I befriended several different families both onsite and in my hotel, and each of them had stories to tell of how they were impacted by the flood. It was rewarding to know that my work on this project helped residents to eventually move back into their homes.

![Image](image_url)

**FIGURE 38:** Tenants at the apartment complex were forced to abandon their personal belongings while escaping the flood caused by Hurricane Harvey. Shown here is a large pile of debris that was removed from the apartment units before cleaning could begin (Fehr, Amec FW, 2017).
5.3 The IES Experience

Looking back, I cannot stress enough how valuable the IES M.En. program was in preparing me for my career as an environmental consultant. From installing seepage meters to quantify surface water and groundwater interactions, to calculating Indices of Biotic Integrity to assess stream water quality, I obtained a diverse set of technical skills through my graduate coursework. Due to my time as a teaching assistant for Environmental Law, I am well-versed in how environmental regulations are applied in the field. In addition, the Willeke Wheel and my experience with the oral comprehensive exam helps me to develop clear solutions to complex environmental problems.

The IES master’s program also gave me the professional skills necessary for excelling in the field of environmental consulting. My Professional Service Project (PSP) involved working with other graduate students to assist the Hueston Woods State Park Golf Course in obtaining certification as a cooperative sanctuary. During this project, I was responsible for maintaining regular communication with our client, making sure deliverables were given to our client on time and free from errors, and acting as the chief editor of our team’s final report. Through these responsibilities I developed competence in oral and written communication as well as in handling quantitative information – skills which I have found to be essential to succeed as an environmental consultant.

Perhaps most importantly, through PSP I gained experience working closely with people who have different personalities and values. So far at Amec FW I have worked alongside biologists, engineers, technicians, contractors, state and local officials, and local landowners, among others. Conflicts often arise due to differences in opinions between each stakeholder, but through my experience with PSP, I had practice developing ways to manage conflict. The interpersonal skills I learned while in PSP and in IES proved to be invaluable. I will be able to use the knowledge and skills gained from the IES program to continue to build long-lasting relationships with coworkers and clients.
REFERENCES


Fehr, Amec FW (2017). Personal/internal photographs.


