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Metal Remediation of the Zinc Site

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ABSTRACT

This work assignment involved the performance of a remedial investigation/feasibility study (RI/FS) at the Zinc Site in the state of Illinois. The RI/FS will study the nature and extent of contamination in soil, groundwater, sediment, surface water, and building materials from former onsite buildings and storm sewers/catchments. Also, the potential risks this contamination could have for human health and the environment will be evaluated. The RI/FS will provide sufficient data to support the selection of the best approach for performing the remediation of the site in order to eliminate, reduce, or control risks to human health and the environment. Moreover, it will support the Record of Decision (ROD).

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INTRODUCTION

A remedial investigation/feasibility study (RI/FS) is being performed for the Zinc Site in Illinois. The Zinc Site is surrounded on the east and south by open agricultural land. A vacant parcel of land with vegetation and trees bound the area from the west side. Railroad tracks are located at the north side of the site. Even further north from the railroad track, agricultural land, wetlands and property currently owned by the village can be found.

Inside the Zinc Plant area, there are no buildings, but only the remaining foundations of the former facility. However, there is a furnace structure in the northeastern portion of the former facility. Furthermore, there are three (3) large building foundations in the center of the site. The thickness of the foundations ranges from 3-4 feet. Also, several piles of trash, construction debris, slag, and cinders can found across the site. The eastern portion of the site is covered by grasses and spindly tress. Central and western portions of the site are moderately infertile with cinder, slag, and the concrete foundations.

Water features at the site include a large farm pond and a smaller oval shaped pond. The farm pond is approximately 200 feet (approx. 61 meters) in diameter, located on the eastern side of the site. The oval-shaped surface water body is about 40 feet (approx 12 meters) long by 20 feet (approx 6 meters) wide and 2 feet (0.6 meters) deep. The residential area is located approximately 1,200 feet west of the site. This residential area comprises of roughly 500 homes from which 96 were sampled by the EPA Field Environmental Decision Support (FIELDS) team in 2010. By 2011, five of the sampled properties were scheduled for removal action due to elevated lead concentration levels.

EXECUTIVE SUMMARY

This research work has been supported by the DOE-FIU Science & Technology Workforce Initiative, an innovative program developed by the US Department of Energy's Environmental Management (DOE EM) and Florida International University's Applied Research Center (FIU ARC). During the summer of 2012, a DOE Fellow intern (Elicek Delgado Cepero) spent 10 weeks doing a summer internship at Sullivan International Consulting in Chicago, IL, under the supervision and guidance of Dr. Jennifer Knoepfle. The intern's project was initiated on June 4, 2012, and continued through August 10, 2012, with the objective of assisting in the performance of a remedial investigation/feasibility study (RI/FS) at the Zinc Site.

The RI/FS will study the nature and extent of contamination in soil, groundwater, sediment, surface water, and building materials from former onsite buildings and storm sewers/catchments. The RI/FS will provide sufficient data to support the selection of the best approach for performing the remediation of the site in order to eliminate, reduce, or control risks to human health and the environment. Moreover, it will support the Record of Decision (ROD).

SITE HISTORY

The Zinc Site smelter started operating in 1885 as a primary zinc smelter. After being destroyed by a fire in 1914, the smelter began operating as a secondary zinc smelter. In 1971, the Illinois Environmental Protection Agency (IEPA) started investigating the facility due to potential violations. Later on, by 1976, due to complaints regarding excessive emissions at the facility, a site inspection was conducted by the Illinois Department of Pollution Control. Finally, after EPA submission of a federal report, the Zinc Site was classified as a hazardous waste site. Compounds of interest that were fed into the kilns included pure zinc, zinc oxide, zinc chloride, aluminum chloride and other trace metals. The site functioned as a second smelter until 1985 when it was closed. By 1986, the Zinc Company was officially dissolved and declared bankruptcy.

Meanwhile, between 1974 and 1977, field work was conducted in order to support further studies. The Illinois State Water Survey (ISWS) and the Illinois State Geological Survey (ISGS) conducted both geological and groundwater studies during the abovementioned time frame. As part of this study, forty-nine (49) monitoring wells were installed in thirty-six (36) different locations inside the site. The study report was completed by 1982 and the site was added to CERCLA the following year.

IEPA completed a CERCLA Preliminary Assessment in 1986 followed by a CERCLA Site Inspection completed by 1988. By 1990, during a site inspection, it was discovered that the site was used by a salvage company for storing recyclable materials such as glass, cardboard, newspaper, and aluminum, as well as a location for dumping of demolition debris. Another field investigation was conducted, collecting sediment samples from the pond and stream; elevated concentrations of lead and other metals were found.

At the beginning of 1991, a seal order was placed on the abandoned facility by the IEPA. A fuel oil spill from an aboveground storage tank made IEPA respond with removal actions by the end of 1991. The spill ran off-site and into the western drainage way. EPA and a private contractor responded to the spill using a vacuum truck, installed fences around the site, removed drums and other containers, containerized hazardous and non-hazardous wastes inside and outside the buildings, pressure washed, and finally demolished and removed some of the buildings.

In April 1993, an IEPA subcontractor completed a Draft Feasibility Study for the site; a Final Feasibility Study was never completed. The draft study revealed that the lead levels found were greater than 10,000 ppm. Also, elevated levels of copper, nickel, and zinc were found at the site.

Supplementary cleanup activities were performed in 1998 including repairing and replacing fencing and conducting a site inventory of the waste materials to be removed (drums and other containers and spills on the ground). Other cleanup activities included proper abandonment and sealing of monitoring wells and appropriate removal and storage of hazardous and non-hazardous substances found inside the buildings. Hazardous wastes such as zinc oxide waste and fuel oil contaminated soils were removed as well. Finally, cleanup, demolition and disposal of the two above-ground fuel oil storage tanks was performed.

Around mid-1999, IEPA notified EPA of a list of the Possible Responsible Parties (PRPs) followed by a Resource Conservation and Recovery Act (RCRA) inspection in 2005 [1]. In 2009, an expanded site investigation was completed on sediment and surrounding farms, finding high levels of inorganic substances such as antimony, copper, lead, and zinc.

Finally, by 2010, the EPA FIELDS Team conducted XRF residential soil sampling on 93 properties near the site. In 2011, the Zinc Site was listed on the National Priority List (NPL) with a hazard ranking system (HRS) score of 30, which is above the minimum requirement for surface water migration pathways to qualify for the NPL. These results were collected by a private contractor Site Assessment Report in 1999.

Table 1 shows the chemicals of interest from prior site investigations.

Table 1. Chemicals of Interest

Chemical of interest	Surface Soil [mg/kg]	Sediment [mg/kg]	Groundwater [µg/L]	Surface Water [µg/L]
Arsenic	58	NA	NA	NA
Cadmium	67	21	45	370
Copper	5,850	1,010	64	90
Lead	41,000	2,200	34	NA
Nickel	3,460	490	41	100
Silver	210	46	450	120
Zinc	360,000	150,000	280	4,200

By 2011, Sullivan International Group took on the task of performing the RI/FS on the Zinc Site since the private contractor hired in 1999 only offered a draft FS report. Therefore, the necessary procedure for performing a RI/FS under CERCLA is being applied.

RI/FS UNDER CERCLA

EPA has protocols for performing cleanup tasks. These procedures are updated periodically and include lessons learned and recommended methods for successfully cleaning up contaminated sites. Figure 1 shows the CERCLA flowchart.

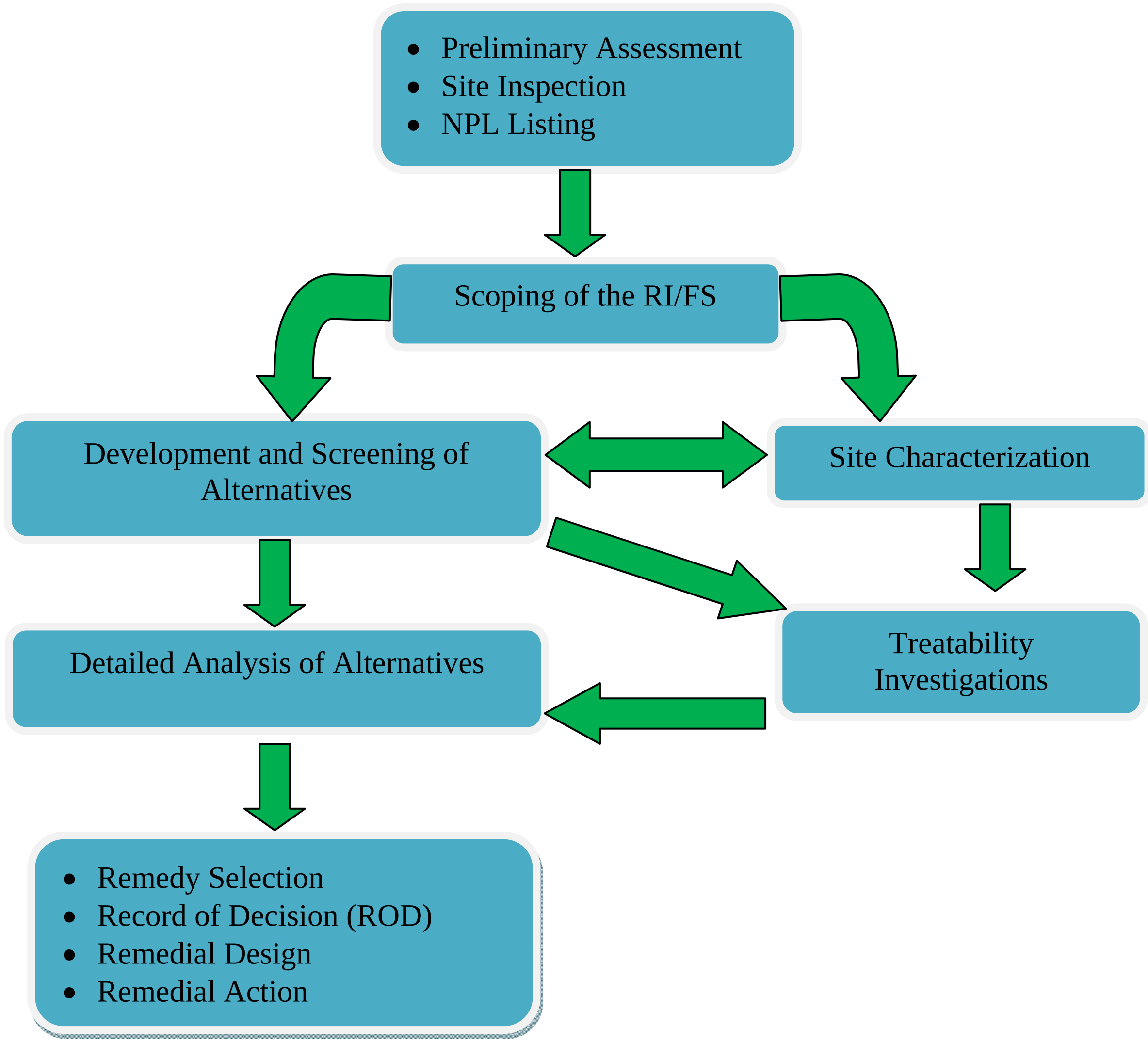

Figure 1. CERCLA Flowchart.

After reviewing the documents for the Zinc Site, it was determined that the preliminary assessment and site inspection were already performed. There are multiple documents with historic data of the site, and previous private contractors' reports were evaluated. Currently, the work plan was proposed and is in the process of being approved. Multiples reviews will be performed until a final RI/FS is accepted.

GENERAL REQUIREMENTS

After the work is assigned to a contractor, the contractor is required to gather proper documentation that will support the Record of Decision (ROD). This ROD will determine the remedial action that will be used for eliminating, reducing, or controlling risks to human health and the environment.

The contractor proposes an approach and cost estimate based on the work breakdown structure (WBS) for the requirements of the scope of work (SOW). It is expected by EPA that the contactor proposes the most appropriate and cost-effective procedures and technologies using accepted engineering practices and controls. In addition, the contractor must continue doing technical and cost tracking and reporting throughout the work assignment term.

Additionally, the contractor should submit major deliverables and a proposed schedule based on the planned deliverables to EPA. The contactor should maintain at least monthly communication with the EPA contracting office representative via either face-to-face meetings or conference calls.

Throughout the RI/FS process, EPA oversees and reviews the contractor's deliverables, which is helpful for fulfilling EPA's responsibility of providing protection for the public health, welfare, and the environment. Also, by overseeing the RI/FS, EPA ensures the compliance of the performance and operations requirements and the achievement of established goals.

Furthermore, the contractor must perform proper recordkeeping, maintaining all financial and technical records for the RI/FS according to the contract. At the end of the work assignment, the contractor must provide an official record of the RI/FS in both hard copy and electronic copy to the client.

WORK BREAKDOWN STRUCTURE (WBS)

Following the guide for RI/FS under CERCLA, the following tasks were added to the WBS for this project. At the completion of the work assignment, it is mandatory for the contractor to perform a project closeout according to the contract. These are the WBS stages:

1. Project Planning and Support
    - 1.1. Work Plan
    - 1.2. Site-Specific Plans
    - 1.3. Project Management and Reporting
    - 1.4. Subcontractor Procurement and Support Activities
2. Community Involvement
3. Field Investigation/ Data Acquisition (FI/DA)
4. Analytical Support/ Data Validation
5. Data Evaluation
6. Risk Assessment
7. Remedial Investigation Report
8. Remedial Alternatives Screening
9. Remedial Alternatives Evaluation
10. Feasibility Study Report
11. Post RI/FS Support
12. Work Assignment Closeout

The WBS is currently in the initial project planning and support stage. Recently, the work plan was approved and the project is ready to start the field investigation/data acquisition (FI/DA) stage.

Project Planning and Support

This first task covers the planning of the execution and overall management of the work assignment. It comprises the technical and managerial activities needed for properly implementing the RI/FS work plan and cost estimate. The contractor prepares and submits a RI/FS work plan including a detailed description of the implementation activities, performance monitoring, overall management strategy, and optimization for the RI/FS. Some of these tasks are: (1) the contractor must schedule a kickoff meeting with the client representative of EPA within five calendars days; (2) if the contractor is unfamiliar with the site, background documents (e.g., Preliminary Site Characterization Summary) must be reviewed and the documents considered relevant to the RI/FS will be used to support the work plan preparation; also, the contractor should have all background documents about RI activities performed by the Possible Responsible Parties (PRP); and (3) the contractor must conduct a site inspection in order to understand the site and its logistics.

On these tasks, EPA's contractor performed the following efforts related to the project initiation:

- ✓ **Kickoff Meeting:** Contacted EPA within 5 calendar days after receiving the Work Assignment (WA) to schedule the kickoff meeting.
- ✓ **Review Background Documents:** Procured and reviewed 78 existing site background documents.
- ✓ **Conduct Site Visit:** Visited the Zinc Site with EPA and State Agency representatives.
- ✓ **Prepare Work Plan (WP):** Prepared a RI/FS work plan with the following elements:
    - To-be performed individual task descriptions, and proposed technical approach for each task. It also included assumptions and a description of the work products that will be submitted to EPA.
    - Assumptions used to estimate hours required to complete each task and subtask.
    - Revised schedule with specific dates for completing each task and submitting each deliverable required in the SOW.
- ✓ **Revise Work Plan:** Conducted a work plan fact finding/negotiation with EPA and implemented these recommendations.
- ✓ **Conflict of Interest Disclosure:** Prepared and submitted a conflict-of-interest disclosure to EPA.

Project Management and Reporting

EPA's contractor will perform general WA management activities such as communicating with the WAM, giving general coordination, managing and tracking costs, preparing monthly progress reports, attending project meetings, attending EPA held training and audits, preparing and submitting invoices, and accommodating any external audits or review mechanisms as required.

Subcontractor Procurement and Support Activities

EPA's contractor will identify, procure and administer the necessary subcontracts. The hiring of the following 8 subcontractors is anticipated in order to implement and complete the scope of work proposed:

1. Subcontractor 1: Drilling company for the following tasks:
    a. Drilling monitoring wells,
    b. Monitoring well installation and development,
    c. Soil boring via direct push,
    d. Trenching for fill depths onsite, and

    e. Onsite utility location and clearance.

2. Subcontractor 2: Site surveyors
3. Subcontractor 3: Fence construction and repair
4. Subcontractor 4: Laboratory services providing specialized analytical tests such as:
    a. Acid volatile sulfide simultaneously extracted metal (AVS-SEM) in sediments,
    b. Asbestos samples in soils,
    c. Full suite of polyaromatic hydrocarbons (PAHs) in sediments, and
    d. Hexavalent chromium analyses in all matrices.
5. Subcontractor 5: Equipment rental for the following types of field work:
    a. Geological,
    b. Hydrogeological,
    c. Ecological, and
    d. Geophysical downhole survey.
6. Subcontractor 6: Sewer inspection with robotic camera,
7. Subcontractor 7: Waste disposal,
8. Subcontractor 8: Onsite security during active field work events (evenings and weekends)

It must be highlighted that the use of the services of the above mentioned subcontractors are subject to change based on the location, cost, schedule and/or scope of work activities. Therefore, the use of more than 8 subcontractors to execute the proposed scope of work is possible. For example, it is ideal to find a laboratory that performs all the needed analytical testing; however, it may not be feasible in regards to cost. Also, it is expected that the services of the same subcontractors will be used for both Phases I and II. Nevertheless, since Phase II depends on Phase I results, these subcontractors may vary.

Field Investigation/ Data Acquisition (FI/DA)

At the kickoff meeting, it was discussed with EPA that the RI/FS task will be performed in two (2) phases. The exact number, types and locations of samples that will be collected in the Phase II field investigation will be determined partly based on the results from Phase I.

The proposed approach for the Zinc Site requires two phases of work for the field investigation (Task 3). Phase II depends on the results of Phase I based on RI/FS experience with similar sites. As the project progresses, EPA's contractor will communicate to EPA all of the results and possible changes to the assumptions.

Field investigation Phase I comprises of the following steps:

1) Identify the sources of contamination at the site,
2) Investigate the nature and extent of contamination in soil, groundwater, surface water, and sediment within the area of interest,

3) Examine the nature and extent of contamination in building materials from former onsite building foundations, and
4) Collect updated groundwater quality data including additional background water quality data and flow data.

Field investigation Phase II will likely focus on addressing any data gaps from Phase I. Therefore, the same procedure from Phase I will be used in Phase II. Any changes will be detailed in the Phase II description.

The following field activities will likely take place:

1) Mobilization:
    a. Initial mobilization,
    b. Field screening, which includes identification of field support equipment, supplies, and facilities, and
    c. Site set-up, which includes utility clearance, construction of a staging area, construction of a decontamination area, site security, set-up of a field laboratory, site-trailer set-up, clearing of the site to facilitate transportation of equipment and vehicles.
2) Perform Site Reconnaissance: Using an Illinois-registered land surveyor, a site survey will be conducted in order to construct a site base map that will include property boundaries, well inventory, utility rights-of-way, topographic information, and other features considered important. Also, if possible, the Illinois-registered surveyor will identify sampling locations such as monitoring wells and soil borings. Otherwise, EPA's contractor will conduct site surveys using global positioning system (GPS) technology for identifying and recording sampling locations. These GPS coordinates will be integrated into the base map. Since the work site will involve access and utilities clearance in multiple areas on public right of ways and private property within the residential areas of the site, it is expected to conduct several visits.
3) Conduct Geological Investigations (Soils and Sediments): In order to perform the RI/FS, the soils of the site must be analyzed as well. The understanding about the Zinc Site assumes that the surficial materials are generally fill (cinder, ash, slag, construction debris, etc). Glacial drift underlies the fill material with a thickness of 60 feet on the east side, increasing to 75 feet on the west side of the site. This glacial drift includes the following from youngest to oldest:
    - Peoria Loess,
    - Roxana Silt,
    - Berry Clay Member,
    - Hagarstown Member (aquifier unit roughly 20 feet bgs),
    - Glasford Till Member,
    - Lierle Clay Member,

- Banner Formation Till, and
- Bond Formation.

The depth to water is typically around 4 to 7 feet below ground surface. Due to the geological nature of the overlying fill and glacial drift, it is expected that there may be thin discontinuous perched groundwater zones above the more substantial water bearing Hagerstown unit. Based on the chemicals of interest, samples will be analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), polychlorinated biphenyls (PCBs), pesticides, metals, toxicity characteristic leaching procedure (TCLP), and synthetic precipitation leaching procedure (SPLP).

During Phase I, ecological investigations will be conducted including wetland and habitat delineation/function and value assessment, wildlife observation, benthic reconnaissance/community characterization, and identification of endangered species and other species of special concern. This ecological investigation does not require sending samples to a lab.

Data Evaluation

Upon completion of the data evaluation task related to Phase I, EPA's contractor will meet with EPA to confirm the remaining data collection activities. The contractor will provide a Field Sampling Plan (FSP) Addendum after the approval of the Work Plan (WP). This addendum will present the proposed number of locations and types of samples for Phase II. The Data Evaluation Summary Report of Phase I will be turned in after the field work and the data validation.

ZINC SITE MAPPING

My involvement in this project was in the Project Planning and Support task. For this task, the contractor must provide enough information about the site to the EPA client. Proper presentation regarding planning and support to the client is critical for the job approval and execution. Traditionally, 2D maps and satellite images were used for presentation purposes to EPA. Nowadays, 3D graphics are highly advanced and it is possible to offer a 3D map that can be animated as well. Different effects can be used, such as flying over the site to add perspective to the presentation.

For this project, ArcGIS 10 was used for mapping the wells on the site. The ArcGIS files have already been created for positioning the monitoring wells and some of the contour lines of the site. For this task, it is intended to add shapefiles for (1) transportation such as roads and railroads, (2) former buildings foundations, (3) water bodies, (4) vegetation, and (5) surrounding industrial and residential buildings.

ArcGIS

ArcGIS from Esri is a powerful tool for mapping and geospatially analyzing maps. Therefore, GIS certified experts are important staff in companies like Sullivan. ArcGIS provides the ability to geolocate monitoring wells and also uses available online geodatabases with maps and satellite imagery. Besides being able to complete 2D maps, ArcGIS also provides versatility for creating 3D maps. Another great feature is the capability of importing 3D objects from CAD programs such as AutoCAD, SolidWorks, and 3Dsketch.

Therefore, for the Zinc Site, contour lines were downloaded from online geodatabases. Also, the shapefiles were added to the 2D maps and then 3D objects were used for certain symbols such as residences, trees, industrial structures, water tanks, etc. A satellite image was downloaded using Bing Maps (Figure 2). This map will allow us to georeference the monitoring wells and the structures that can be found at the site.

Figure 2. Satellite view courtesy of Bings Maps of the Zinc Site.

3D marker symbols were added for positioning the former building foundations, the monitoring wells, the railroad, the road, the furnace, the water tank, and the vegetation (Figure 3).

Figure 3. Added 3 D symbols to the Zinc Site.

In order to get a better picture of the site, several photos taken by field staff were carefully reviewed. It was determined to use medium-sized trees and phragmites to represent the surrounding vegetation.

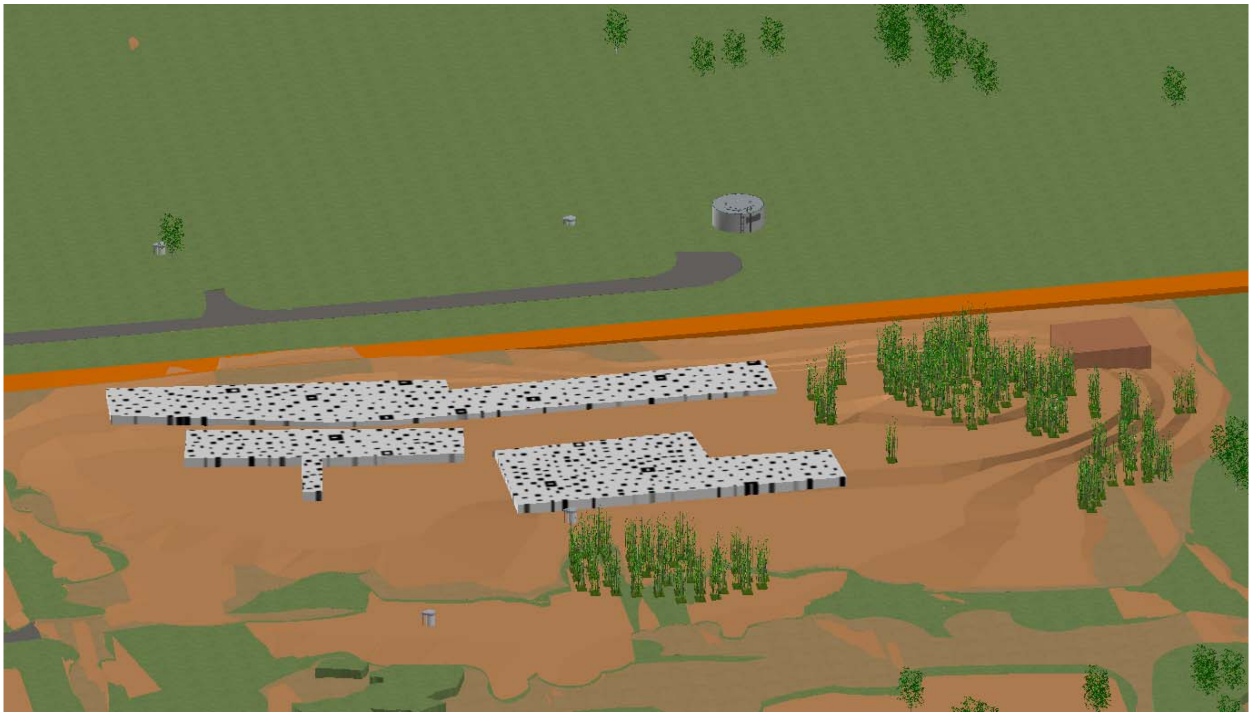

Figure 4. 3D representation of the Zinc Site.

The 2D map was exported to ArcScene from ArcMap. The fileshapes created in ArcMap include the position of every object besides added features such as color and textures. In Figure 4, the former building foundations, the furnace, the water tank and the vegetation on the site can be observed. The monitoring wells are represented as well.

However, this task still needs to be refined due to the lack of better computational resources regarding the rendering of the images. Running with a faster computer will result in better 3D maps and available effects.

CONCLUSIONS

This summer internship has provided different skills for me to develop. First, I learned about the different steps and organization needed for working for a federal client such as EPA under CERCLA. I was involved in the 3D representation of maps for the site. These tasks required me to learn ArcGIS extensions, ArcMap and ArcScene. Also, I was involved in field work for other projects where security signs were posted and photo logging was performed. Another task I performed was quality control of the data before the submittal of final reports. Overall, I learned about many management issues related to private contractors such as allocating resources for performing a job and community meetings for explaining the technologies used.

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