ICP-AES Analysis of Fisk and Crawford Coal Fire Plants and Ensuing Site Remediation Strategies

With the United States' transition away from a manufacturing-based economy, industrial factories are shutting down. The remnants still haunt America's cities, polluting the air, soil, and waterways with heavy metals. Thankfully on February 29th, 2012, the country's last urban coal fire power plants, the Fisk and Crawford plants on Chicago's Southwest Side, were scheduled to be decommissioned by the end of 2012 and 2014 respectively. The plants are anachronisms, built before the Clean Air Act of 1970 and escaping its management ever since. With over 100 years of airborne coal waste between the two, a number of heavy metals litter the soil in the area and are discovered at concentrations above the limit deemed safe by the Environmental Protection Agency (EPA).[1] The Pilsen and Little Village neighborhoods surrounding these former factory sites are scathed by years of polluting industry. Before pollution reducing measures, the plants contributed to over 41 deaths annually.[2] Unless a devoted remediation effort takes place, the sites will remain a blight on Pilsen and Little Village after shutdown, becoming useless brownfields. Their people will remain barred from the sites by the dangers of heavy metals in the soil. As a part of a larger project for environmental justice, I will create a plan to clean the sites of the Fisk and Crawford power plants, ridding them of contamination for future use. In a multi-stage process, I will first determine the nature of the pollution of the soil using inductively coupled plasma atomic emissions spectroscopy (ICP-AES) to chart the polluting elements and their concentrations. Then I will propose a remediation plan as well as a post-remediation use for the Fisk and Crawford sites that will best suit the surrounding communities based on interviews of leaders and case studies of similar sites.

In my current independent study with Dr. Shelby Hatch, we have been looking to correlate soil based heavy metal pollution to emissions from the Fisk and Crawford plants using elemental and isotopic ratios, revealing lead pollution in the area. After the EPA set up air monitors, airborne lead pollution levels forced them to declare Pilsen a non-attainment zone in 2008 (an area that does not meet the National Ambient Air Quality Standards).[3]After being released into the air, contaminants fall to the ground, settling in the soil. We have discovered a host of these heavy metal contaminants therein. Though the air pollution should drop off immediately after the plants are decommissioned, the contamination we have discovered in the soil is lasting. In each sample taken from the sites, we have measured at least one above-average concentration of one of the following toxic metals: Pb, As, Cd, Co, Cr, Cu, Hg, Mn, Se, Ti, and Zn. The contamination may have reached the ground water as well.

Continuing to use techniques I have learned from my research, I will determine the current chemical makeup of the soil of these sites using an ICP-AES instrument. This instrument is being used to identify the pollutants and their concentrations in the soil. The instrument works in three basic steps: atom formation, excitation, and emission. Argon gas is lit with a tesla coil inside the device to produce a plasma which is maintained by a magnetic field. After the sample has been disassociated into ions in a solution, it is introduced to the nebulizer which turns the liquid into an aerosol. This gasified sample is brought to the torch via argon gas. Atomization takes place and bonds break. Due to the high heat energy, atoms collide and gain energy, reaching an excited state. In this state, elements radiate at a characteristic wavelength. A detector picks up these wavelengths and identifies the elements involved and their concentrations.[4] This is the preferred tool for detecting traces of heavy metals in soil.

Using ICP-AES, proper soil gathering, and cleanup assessment tools, I will take five steps in my research: 1) choosing best practice for gathering soil and water samples, 2) the gathering and analysis of soil samples, 3) a literature review and remediation analysis, 4) post-remediation recommendations for site use, and 5) extraneous actions and dissemination. In 1) different soil gathering techniques will be researched. I anticipate that the EPA's two-phase soil analyses will function best though I will also take the Triad random grid sampling into consideration.[5] If I choose the former technique then I will move to 2) and gather soil samples. The two-phase sampling involves a general surface sample and historical review of the area in Phase I that would tell me which heavy metals are polluting the soil and a more specific core and groundwater sample and depth reading in Phase II that would tell me how deeply the metals infiltrate. Plot owners will be contacted in order to gain access to the sites. If denied, samples will be taken from the public area directly adjacent to the factory which should contain a similar soil makeup created by the settling of airborne particles. The soil makeup will be determined using ICP-AES. The Northwestern University History Library will be utilized to determine if there are objects like iron containment vessels buried beneath the surface. After this, the project focuses on cleanup. In 3), a plan for remediation will be constructed out of a literature review and the pollution data. I have begun this review which is listed in the appendix. In 4) recommendations will be made on how to use the site after it's remedied based on the state of the soil, the needs of the community, and analogous case studies. I am in contact with activist group leaders in the Pilsen Environmental Rights and Reform Organization (PERRO) who have stated that they will work with me. They are a voice of the community and can help determine the needs that these sites can fill. Potential sources of funding will be cited, including the plant owners who may be liable for polluting. In 5), data will be synthesized and the report disseminated in to Openlands and the National Resources Defense Council who may soon remediate a third outdated power plant.[6] A timeline for this research can be found in Figure 1.

Once dissemination is successful, the organizations tasked with cleaning the sites will be able to take my recommendations under advisement, ideally using them as a starting point. My research will act a synthesizing analysis of other case studies, rating both soil analysis and synthesizing techniques for creating cleanup plans as no literature has done before while also functioning as an analog for future efforts to clean up similarly polluted sites.

More importantly, the research will function in tandem with my current study of the Fisk and Crawford power plants in my Chemistry 399 Independent Study. I am analyzing soil samples in and around the sites in an attempt to correlate pollution in the surrounding neighborhood's soils to the pollution coming from the plants. ICP-AES is being used to determine elemental ratios. Isotopic ratios will be used as well for a more robust correlation. If pollution from the plants and in the soil have substantially similar elemental signatures, then the factories could be proved legally responsible for polluting the communities, in which case they would be found liable to fund the cleanup. With both projects completed, the people of Pilsen and Little Village would not only have a funding source for cleaning their brownfields, they would also have a plan to set this funding into action.

From this research I am familiarized with the basics of GIS mapping, one of the site analysis tools at my disposal (see Table 1). In addition, I have access to instructional literature on the ArcGIS mapping program. Another tool is a life cycle assessment (LCA) which I became familiar with during an Integrated Sustainability course I took at the Danish Institute for Study Abroad. I have experience in communications as well after working as head of communications for my professional linkage course at Northwestern. This will help me continue a dialogue with PERRO and open up new dialogues with area leaders to discuss cleanup efforts.

The citizens of Pilsen and Little Village deserve clean land after the decades of soil and lung degradation that they have endured. This project will illustrate an optimal road that the villages can take. After the research is completed, I will integrate the data into my senior research as I try to correlate the pollution of the communities to the contamination from these plants' smokestacks. I will cite both experiences as I apply for a degree in environmental law and continue seeking environmental justice. If successful, these citizens will have another option for attaining clean and functioning land.

Bibliography

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<u>Appendix</u>

Figure 1): Project Timeline

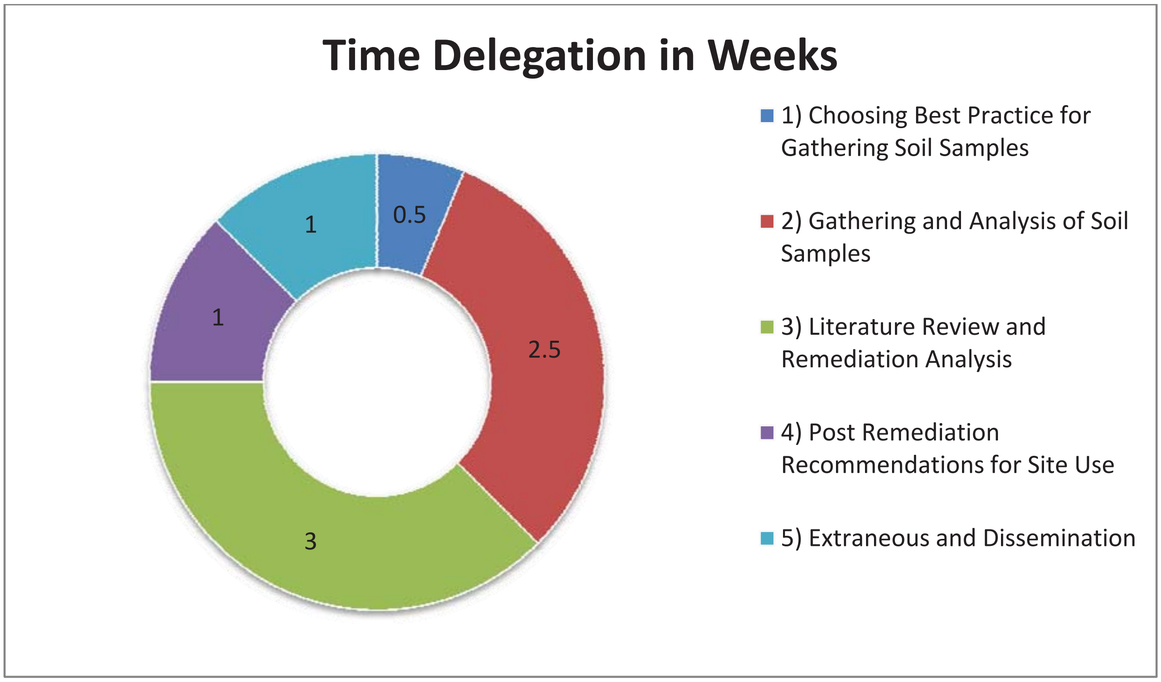

Figure 2): Mapping Heavy Metal Concentrations Across Chicago

Table 1) Remediation Literature Overview

Study	Summary
A Model for Redeveloping Complex, Highly Contaminated Sites- the Industri-Plex Site in Woburn, Massachusets	Case study that can be used as an allegory and reference for the highly contaminated Fisk and Crawford sites.
A Stakeholder's Perspective on Contaminated Land Management	Outline of existing concerns and cost that may hinder cost-effective contaminated land management.
Carcoke Company: 3 Coking Plants, 3 Regions, 3 Solutions	Case study that lists specific details about cleaning up three sites in Belgium. Details include removing the topsoil and cleaning the water.
Development and Use of Rapid Reconnaissance Soil Inventories for Reclamation of Urban Brownfields	Soil factors such as compaction are likely, difficult and expensive to modify.
Eco-Industrial Redevelopment of LA Brownfields	GIS data mapping on target areas, assessing existing industrial conditions, facilitating matching of businesses and informing policy making for future sites.
Heavy Metal Contamination in the Brownfield Soils of Cleveland	Case study explaining impacts of heavy metal polluted soil remediation inside of an urban environment, an instance similar to the situation in Pilsen and the Little Village.
Introduction to Contaminated Site Management	Lists major protection targets as human health, soil ecosystem, groundwater, and food safety. Summarizes actors involved in site management and cost benefit analysis.
Science Plus Management Equals Successful Remediation: A Case Study	Warns against premature remediation actions without conducting a thorough hydrogeologic study. Could help analyze ground water contamination.
Uncovering the Historic Environmental Hazards of Urban Brownfields	Case study that could reference important historical markers that may apply while carrying out historical research.