THIS IS A TEMPLATE SCOPE

Title (name of the project)

Scope of Work

Your names

(Graphic)

Date

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Introduction

About a paragraph. In the introduction, you want to give a brief explanation of why this project is requested and what the deliverables will provide. For example, if you are being asked to conduct an energy audit for a school, you should talk about why this is being requested (sustainability, costs, limited world energy supply, school wants to set an example by doing … etc. Then what will the deliverable be and how will it be used. Don't worry about being redundant – you will certainly repeat this many times.

Project Description

About ½ a page. An overview of what will be done (who, what, when, where, why) … For example who will the team be, who (the client) will you work with, what data/information will be collected, when and where will this information be gathered, and finally what will this information and data analysis provide.

Background

About 1-2 pages. Give some technical background on the measurements, analysis techniques, expected use of these data. In other words, what is this all about. Use sub-headings, diagrams … etc.

Methods

About 2-3 pages. This is the meat of your scope. EXACTLY what will you do. Break things down into easily understood tasks. Designate the tasks with titles (perhaps even sub-titles) and numbers. The same task designations will be placed in the Deliverables and Schedule sections. You are describing to the client what they will be paying for. They should pay very close attention to this. They want to make sure you know what they want and that their money will be well spent.

Deliverables

About ½ page. This is another critical portion of your scope and the client will be paying very close attention to what you are promising to deliver. Be sure to clearly describe the use of the deliverable.

Schedule

This is a graphical display of tasks and times you will be working on the tasks. Multiple tasks can be done during the same time period. For example, if you continually draft parts of your final product (a report, design …) that will actually begin very early. Be sure to identify target dates and to use the same task designation as listed in the Methods section.

An example MQP schedule is below:

Activity	Week							
	1/8/11	1/15/11	1/22/11	1/29/11	2/5/11	2/12/11	2/19/11	2/26/11
Project Start Logistics								
Move Into Kentucky Housing								
Go Through Orientation								
Visit Dam #8								
Make observations with help of Stantec as to major changes from known conditions								
Research Appropriate Design Considerations/Criteria								
Stantec Publications								
Stantec Staff Interviews								
Contact Vendors								
Online Sources								
Design Foundation Based on Considerations								
Perform Calculations (approx. flow rate, pore pressure)								
Use CAD to draft schematics as needed								
Create Deliverables								
Draft/Expand Background								
Draft Report Methodology and Conclusions								
Draft Poster								
Submit Final Report								
Give Presentations								
Give Presentation								

Budget

How much is all of this going to cost? For each task you can identify staff members (Project Manager, Chief Engineer, Engineer, CAD personnel … etc). Each type of employee would have a different rate and each would spend a different amount of time per task. This is how you would develop your budget. For student projects, we typically do not concern ourselves with the budget, as the amount of time needed to produce a budget is very high.

References

List sources of information. It could include books, journals, people you talked to, web sites … etc. There are various formats you could use. The most important part of a reference section is that the reader would be able to access those references – in other words, you provide sufficient information.

Two example scope documents follow:

Renovation of Kentucky Lock and Dam #8

MQP Proposal

Michael Kendall
Karyn Sutter

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Introduction

A replacement for the Kentucky River Dam No. 8 is in the final stages of design. Although the main dam construction method has been determined, several design decisions still remain. One of the most critical is how to improve the foundation. Because of karstic geology in the region, a significant amount of seepage occurs through the foundation of the current Dam No. 8 in areas where significant voids or solution features are encountered. This has resulted in a loss of drinking water for the nearby community including the city of Nicholasville. The karstic geology also raises concerns regarding the Bearing capacity of the foundation. An evaluation of different dam improvements that would address these concerns is needed.

Project Description

Our Master Qualifying Project will involve recommending foundation improvements as part of the renovation of Kentucky River Dam No. 8. The specific methods we will consider are grouting, positive cut-off walls, aprons and combinations of the three. The evaluation criteria for each method will depend on such considerations as: cost, risk, environmental impact and effectiveness.

After studying the extent of the karstic features present at the renovation site using a recently performed geotechnical evaluation and applying the previously mentioned criteria, we will develop a report outlining a proposed design. In considering approaches, we will also estimate the cost of materials and labor necessary to perform the work. It should be noted that future dam replacements along the Kentucky River will likely need similar foundation improvements to those which are required at KY River Dam No. 8. Therefore, our

recommendation will be of value to Stantec and the Kentucky River Authority, not only by addressing the problems at the lock and dam No. 8 site, but also by serving as a guide in designing the improvements to those future projects.

Background

Positive Cut-Off Wall

A common technique used to decrease soil permeability and control seepage is the cut-off wall. A cut-off wall is a broad term for any underground vertical structure that serves as a barrier. Several different variations of cut-off walls have been designed and constructed. Types of structures include sheet pile (steel, wooden), concrete and soil-bentonite. (*Bruce*, R*essi di Cervia*, & *Amos-Venti*, 2006). While typical concrete cut-off walls involve placing concrete within an excavated trench, variations exist such as secant pile walls and diaphragm walls.

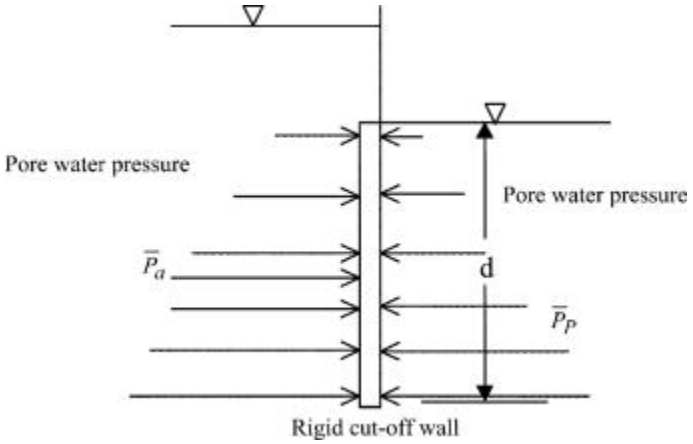

Figure 1: Free body diagram of sheet pile cutoff wall;
(Singh, Mishra, Samadhiya, & Ojha, 2006)

Cut-off walls are constructed in foundations of nearly every composition. In general, the type of wall chosen greatly depends on the ground composition of the site in question. When the ground consists of rock, a concrete structure must be used. It also depends on the remediation goal. If the wall must withstand a pore water pressure difference (such as in the case of Kentucky River Dam No. 8 and in the diagram above) it is referred to as a positive cut-off. These walls consist of concrete or thick steel pile construction.

One of the largest examples of cut-off walls in which the ground conditions were similar to those at Kentucky River Dam No. 8 was included as part of the Wolf Creek remediation project. The ground conditions at this site were similar in that they featured dam fill over karstic limestone. The walls were constructed of concrete and consisted of

24inch diameter piles joined by precast panels. The project featured two walls, one approximately 270,000 sq. ft. in area and the other approximately 261,000 sq. ft. The structure was imbedded into bedrock at an average depth of 280 ft (*Bruce*, et al., 2006).

Grouting

Grouting is a general term for the process of filling gaps and crevices in the subsurface with a low strength cementous material. There are several different types of grouting techniques including but not limited to grout curtains, grout caps, grout galleries, and blanket grouting (Weaver & Bruce, 2007). Grout curtains are used to control seepage by injecting grout into areas of the ground with high permeability. This method only reduces permeability and cannot be precisely controlled. Blanket grouting is similar however it is typically applied to the shallow area directly under the dam. In addition to reducing the permeability, the blanket increases the bearing capacity of the ground underneath. Each of these techniques can utilize a variety of grouting materials with either high or low mobility. High mobility grout mixes (HMG) are useful in situations where voids are small and difficult to access (Warner, 2004). Low mobility grout mixes (LMG) are preferred for larger openings and to ensure that only the intended area is grouted.

Combinations

In many if not most cases grouting and a cut-off wall are used in dam construction. However, the particular technique, type and dimensions of each method used vary from project to project and are unique to each site.

Methods

The following tasks will be completed throughout the 8 weeks to complete the project.

Task 1. Evaluate and Analyze the Existing Dam Conditions

To evaluate the existing site conditions we will go over the November 15th 2011 geotechnical evaluation, hold interviews with Stantec staff, as well as visit the dam itself. The main goal of the visit(s) will be to familiarize ourselves with the layout of the dam and surrounding geography and compare observations taken during the geotechnical evaluation with up-to-date observations (to the extent necessary or possible).

Task 2. Research Evaluation Criteria/Considerations

There are four criteria/considerations that will be researched in order to decide on what foundation improvement techniques are best suited for the site. These include effectiveness, cost, environmental impacts and risks. Each of these evaluation criteria will be applied to the different foundation improvement techniques.

a. Effectiveness
    i. Will the methods, reduce the seepage occurring through the foundation to acceptable permabilities?
b. Cost
    i. What will the anticipated labor and supply costs be?
    ii. What are the estimated maintenance costs?
    iii. Will the capital costs exceed the budget allocated by the Kentucky River Authority?
c. Environmental Impacts
    i. Based on existing conditions, how will each improvement method affect the surrounding area?
    ii. What permits would be applicable?
d. Risks
    i. What happens if we miss a seepage point?

In order to determine answers to these research questions we will hold interviews with Stantec Staff, analyze reports of previous dam renovations conducted in the area/areas with similar characteristics, use textbooks such as Geotechnical Engineering by Donald P. Coduto, and follow design guides. In the case of costs, it may be necessary to contact vendors/firms if information from other projects is not available or sufficient.

Task 3. Create report or table summarizing criteria research

Advantages and disadvantages for each improvement technique will be compiled as applied to rock foundations.

Task 4. Select and recommend a foundation improvement program at the site.

A brief discussion will be provided as to why this approach is best suited for this site based on the evaluation of the alternative.

Task 5. Outline proposed foundation improvement design alternatives

Create schematic outlining an appropriate design(s) by combining the results of the criteria study with design calculations and recommendations. Applicable calculations and guidelines will likely be found as print materials at Stantec, textbooks, or online materials such as those supplied by the Army Corp of Engineers. This final component of the MQP will complete the requirements of a capstone design.

Schedule

Activity	Week							
	1/8/11	1/15/11	1/22/11	1/29/11	2/5/11	2/12/11	2/19/11	2/26/11
Project Start Logistics								
Move Into Kentucky Housing								
Go Through Orientation								
Visit Dam #8								
Make observations with help of Stantec as to major changes from known conditions								
Research Appropriate Design Considerations/Criteria								
Stantec Publications								
Stantec Staff Interviews								
Contact Vendors								
Online Sources								
Design Foundation Based on Considerations								
Perform Calculations (approx. flow rate, pore pressure)								
Use CAD to draft schematics as needed								
Create Deliverables								
Draft/Expand Background								
Draft Report Methodology and Conclusions								
Draft Poster								
Submit Final Report								
Give Presentations								
Give Presentation								

Legend	
	Category
	Task

Deliverables

The final deliverables of this project will include a report on general evaluation criteria for dam foundation improvements as well as a schematic design for improving the foundation of Kentucky Dam #8. The design will likely include schematics specifying the layout of the proposed design. The evaluation will look into areas that include effectiveness, cost, environmental impacts and risks. The capstone design component of the project, which is the final design for the foundation improvements we recommend, will be presented in a report that will be submitted to both Stantec and WPI.

Appendix A: Capstone Design Statement

The Accreditation Board for Engineering and Technology (ABET) requires that all accredited engineering programs include a capstone design experience. This requirement is met at WPI through the Major Qualifying Project (MQP). The American Society of Civil Engineers (ASCE) specifies that this capstone experience must include the following considerations: economic; environmental; sustainability; manufacturability; ethical; health and safety; social; and political. This MQP will meet the ABET and ASCE requirements by going through a "design process" where several of the above factors will be used to evaluate the best alternative. More specifically, they will be the criteria that determine the optimal level of improvement to address the water seepage issues at Kentucky Dam No. 8. Using models developed by Stantec Consulting Services Inc., applicable calculations and historical reports outlining current improvement techniques, we will estimate the anticipated effectiveness of certain designs. We will then evaluate the alternatives in terms of financial costs, environmental impact, and constructability. This will most likely be an iterative process resulting in the optimal design to be recommended by Stantec Inc. to the Kentucky River Authority.

Appendix B: Tasks by Week

Week 1:

- Get acclimated
- Begin to evaluate existing dam conditions
    - Geotechnical Evaluation (recommendations, significant findings)
    - Discussions with Stantec staff
- Meet with Stantec advisors
- Contact WPI advisors on weekly basis updating on progress

Week 2:

- Continue evaluating existing dam conditions
- Continue research from B term
    - Evaluation Criteria
    - Solution methods
    - Structural/Hydrology Equations
- Visit Dam #8
    - Become familiar with layout and how it relates to schematics/pictures
- Begin writing up background to be used in final report
- Meet with Stantec advisors

Week 3:

- Finish compiling existing dam conditions
- Continue Researching
- Finish writing up background
- Meet with Stantec advisors

Week 4:

- Finish major researching tasks
- Begin outlining specifications of proposed designs based on evaluation criteria
    - May include computer drafting
- Begin writing up methodology for final report
- Meet with advisors

Week 5:

- Research as needed
- Continue outlining design specifications(s) based on evaluation criteria
- Begin drafting final report including writing up deliverables
- Meet with advisors

Week 6:

- Continue work on design
- Continue working on final report
- Meet with Advisors

Week 7:

- Finish design
- Finish final report and send to advisors for review
- Draft poster
- Work on presentation

Week 8:

- Present Project to Sponsors
- Submit MQP

Appendix C: Bibliography

Bruce, D. D. A., R*essi di Cervia, D. A.*, & *Amos-Venti, D. J.* (2006). *Seepage Remediation By Positive Cut-Off Walls: A Compendium And Analysis Of North American Case Histories*: Canadian Dam Association, Edmonton, AB (Canada).

Commission, F. E. R. (2005). Engineering Guidelines for the Evaluation of Hydropower Projects

Nemati, K. M. (2007). Temporary Structures. University Of Washington

Singh, A. K., Mishra, G. C., Samadhiya, N. K., & Ojha, C. S. P. (2006). *Design of a Rigid Cutoff Wall*. Journal of Infrastructure Systems.

Stantec. (2011). *Geotechnical Study and Existing Conditions; Kentucky River Lockand Dam No. 8*.

Warner, J. (2004). *Practical handbook of grouting soil, rock, and structures*. Hoboken, N.J.: John Wiley & Sons,.

Weaver, K., & Bruce, D. (2007). *Dam foundation grouting*. ASCE Press.

WORCESTER POLYTECHNIC INSTITUTE

Evaluating Ground Stabilization Methods for a Coal Combustion Landfill

Scope of Work

Victoria Howland and Scott Turgeon

12/20/2011

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Description

Byproducts of coal combustion plants can cause water and soil contamination if not disposed of properly in a landfill. Given an earthquake, the landfill would be subject to various modes of failure, releasing byproducts into the surrounding environment. This project will assess ground improvement techniques to be used at an existing landfill containing coal combustion byproducts. The project team will identify applicable stabilization methods and perform a multi-criteria decision analysis to pinpoint which ground stabilization technique is most suitable. For the analysis, the practices considered will include deep soil mixing, stone columns, slurry trenching, and jet grouting. Once the evaluation is completed, the team will then create a preliminary design for the most suitable ground stabilization technique identified, for a generic coal combustion landfill.

The final deliverables for this project will include a multi-criteria decision analysis for Stantec, a final presentation to conclude all findings for Stantec, a capstone design that applies the best stabilization method as determined by the decision analysis, a poster summarizing methodology and conclusions, and a Major Qualifying Project (MQP) report to submit to the Worcester Polytechnic Institute (WPI) advisors.

Background

This section is going to briefly discuss research conducted to develop the scope of work. The topics included in research include ground stabilization techniques and description of the multi-criteria decision analysis.

Ground Stabilization Methods

Ground Stabilization is necessary at a Coal Combustion Residue landfill because the failure of the landfill effect the local environment. Seismic activity causes liquefaction which causes lack of shear strength within the subsurface materials. The objective of this project is to improve the stability of the landfill. This will be done by looking into four stabilization methods.

Deep Soil Mixing

The goal of deep soil mixing is to create a uniform soil that has lower compressibility and permeability while simultaneously improving its strength (Coduto, 1999). The intended outcome is to improve the current soil at the construction site so that it will have the ability to resist seismic movement. This method has been used to retrofit existing sites to improve the seismic stability at the location. Different types of deep soil mixing have been developed to correspond to alternative types of soil conditions.

Jet Grouting

This method is designed to inject a grout into the soil to fill the voids between the soil particles. Grout is made up of water, sand, and cement and is injected into the ground in a liquid state. Once the grout enters the ground, it hardens to form a solid mass (Coduto, 1999). This method is valuable because it removes the voids between the soil particles and reduces the amount of water that can enter these pores, stopping potential liquefaction while compacting the surrounding soil. This method could also be used to solidify the ash that is contained in the landfill.

Stone Columns

Stone columns are a series of columns along a slope that are filled and compacted with gravel, which are designed to allow drainage while reinforcing the current soils. The columns are constructed by creating a hole and filling it with stone gravel, which is then compacted using vibration (Raj, 1999). The horizontal shear strength of the stone columns have been previously tested and can withstand forces generated during a seismic event.

Slurry Trenching

The slurry trench method consists of inserting retaining walls into the ground surrounding the landfill. The walls are cast in place onsite by filling a trench with bentonite slurry. The trench is later filled with concrete and can often have steel reinforcements. This method can be beneficial because it contains the groundwater within the landfill. These walls can be up to four feet wide and cover a depth of up to 100 feet (Nemati, 2007).

Multi-Criteria Decision Analysis

A multi-criteria decision analysis is a method of making a decision based on different criteria which have weighted values, designed to ease the decision-making process. The goal of this analysis is to determine which ground stabilization method would be the best choice to implement in a given coal combustion byproduct landfill. Potential criteria for this analysis will include costs, benefits, soil conditions, feasibility, hazards, and modes of failures. The final decision matrix can be used on future projects to expedite the process of choosing a ground stabilization method (Department for Communities and Local Government, 2009).

Methods

The scope of this project is to develop a decision analysis for selected ground stabilization techniques in a coal combustion landfill. The ground stabilization methods that will be evaluated include deep soil mixing, jet grouting, stone columns, and slurry trenching. Each method will be evaluated to understand the criteria in which it would be most successful for implementing the technique.

Methodology

The goal of this project is to provide Stantec with feasible methods of stabilizing the ground in and surrounding an existing coal combustion landfill. A decision matrix will be provided to Stantec for future applications, as well as a preliminary design of the best ground stabilization method identified through the multi-criteria decision analysis. To complete these goals, the following steps will be taken.

Task 1. **Background research:** Conduct background research needed to complete the multi-criteria decision analysis.

a. Topics of research include deep soil mixing, jet grouting, stone columns, and slurry trenching. The University of Kentucky Library will be of use for research conducted through textbooks, online journals, and online subscriptions. The WPI Library can also be connected to from Kentucky for access to online databases or journal subscriptions. Stantec may also provide a series of valuable

resources including professional subscriptions, books, and professionals in the field. They will also have knowledge of other professionals in the area, such as contractors, suppliers, or retail professionals that could answer more specific questions about installation and construction.

b. Another area of research will be information about existing CCB landfills under consideration for implementation of ground stabilization techniques. To obtain this information, the project team will peruse previous applicable Stantec projects, prior project proposals, identify geographic conditions of the area, and contact outside sources that either operate or are directly involved with coal combustion landfills.

Task 2. **Analyze Research:** Analyze ground stabilization methods using further detailed research. Use previously conducted research to begin assessing the ground stabilization methods identified, and identify resources that could provide further detailed research.

Task 3. **Multi-Criteria Decision Analysis criteria:** Develop criteria for multi-criteria decision analysis using significant attributes that are cultivated through research. The criteria will be determined through research of the ground stabilization techniques and professionals in the field such as contractors, suppliers, or retail specialists. Criteria may include installation and maintenance costs, soil conditions, modes of failure, hazards, benefits, and feasibility of installation.

Task 4. **Weighting system:** Develop weighting system for the multi-criteria decision analysis using specific attributes determined through research on each of the ground stabilization techniques. All needed conditions to assign numerical values to the associated criteria will be considered, based on importance to Stantec which will be determined through Stantec correspondence.

Task 5. **Conduct Multi-Criteria Decision Analysis:** A ground stabilization technique matrix will be developed that utilizes the weighting system established in the prior step. As the decision matrix is developed, all the benefits and disadvantages of each stabilization method in terms of each decision criteria will be compared, and all findings will be assessed to identify a viable stabilization technique.

Task 6. **Landfill Design:** Designing the generic landfill will result from a culmination of the previous steps. As background research is conducted, variables of coal combustion landfills will be identified, providing a better understanding of how certain factors effect coal combustion landfill success. Since the ground stabilization techniques will theoretically be implemented into an existing landfill, the project team will be determining a viable existing landfill to implement the ground stabilization techniques into. Existing coal combustion landfills will be identified that are exhibits of success in order to delve into the variables and conditions of its performance. A few key elements in generating a successful landfill may include size, topography, climate, and soil conditions.

Task 7. **Capstone Design:** The last step in the methodology is generating the capstone design, through implementing the best ground stabilization technique, as identified by the multi-criteria decision analysis, into the generic existing landfill. As the ground stabilization technique is implemented into the landfill, the design criteria for this method will be discussed, including the benefits and weaknesses of the method in terms of the preliminary design.

Deliverables

The final deliverables for this project will include a Multi-Criteria Decision Analysis for Stantec, a formal presentation to conclude all findings for Stantec, and a capstone design that utilizes the best stabilization method as determined by the decision analysis.

The decision analysis will assess the cost, economic variables, feasibility to implement/use, and the hazards associated with using the design. Identifying the design criteria for best success will assist the Stantec Engineers in the future to recognize which stabilization technique would be most suitable under certain specifications, if need be.

A formal presentation to conclude all findings will be prepared for the Stantec engineers and any other interested parties. The presentation will focus on the design criteria for each ground stabilization technique and how each method can be implemented in a coal combustion byproduct landfill.

A capstone design that utilizes the best stabilization method will be incorporated into the project. The decision analysis will identify which method is best for the given design criteria and then the capstone design will demonstrate the implementation of the best method.

A Major Qualifying Project (MQP) report that incorporates all background, methodology, and conclusions of the capstone design will be submitted to WPI. It will provide a thorough review of how the capstone design was produced.

Appendix A- Capstone Design Statement

According to the Accreditation Board of Engineering and Technology (ABET), all undergraduate engineering students are required to complete a capstone design that incorporates the technical, non-technical, and problem solving aspects of their course studies. The capstone design of this team will consist of creating and analyzing a multi-criteria decision evaluation to determine the best ground stabilization method for a coal combustion residue landfill. The best methods will then be implemented into a generic existing design landfill. Six constraints will be analyzed in accordance with the ABET General Criterion for capstone design; they are listed below.

Constructability

The best ground stabilization method will be designed into the generic landfill. The method to be used is determined by the multi-criteria decision analysis, which makes a decision based on the attributes of the landfill. This method of making a decision can be reused on other projects to determine the most beneficial stabilization method to construct.

Economic

The construction and implementation of the best ground stabilization method will have economic costs to the contractor, or any other sponsoring agency. The costs of the ground stabilization methods will be analyzed in the multi-criteria decision analysis in order to produce the best results using the lowest cost. There would also be economic impacts, such as water and soil contamination or safety concerns from the heavy metals that are released, to the surrounding area if the landfill were to fail.

Environmental

This project will have an environmental impact because the failure of the landfill would affect the environment. Coal ash contains heavy metals and other compounds that are toxic to human and wildlife populations. The implementation of new ground stabilization methods will reduce the risk of an environmental catastrophe occurring due to the failure of the landfill.

Ethical

Ethics play a role in all design and construction applications. The ethical decisions involved in this project consist will be reflected in the weighting system for the multi-criteria decision analysis. Specific weights will be given to specific criteria and a balance between cost and degree of ground

stabilization will be determined. If the balance sways more towards lower cost thus creating a lower degree of stabilization, then the ethics of that decision could come into question because there is a high risk of landfill failure.

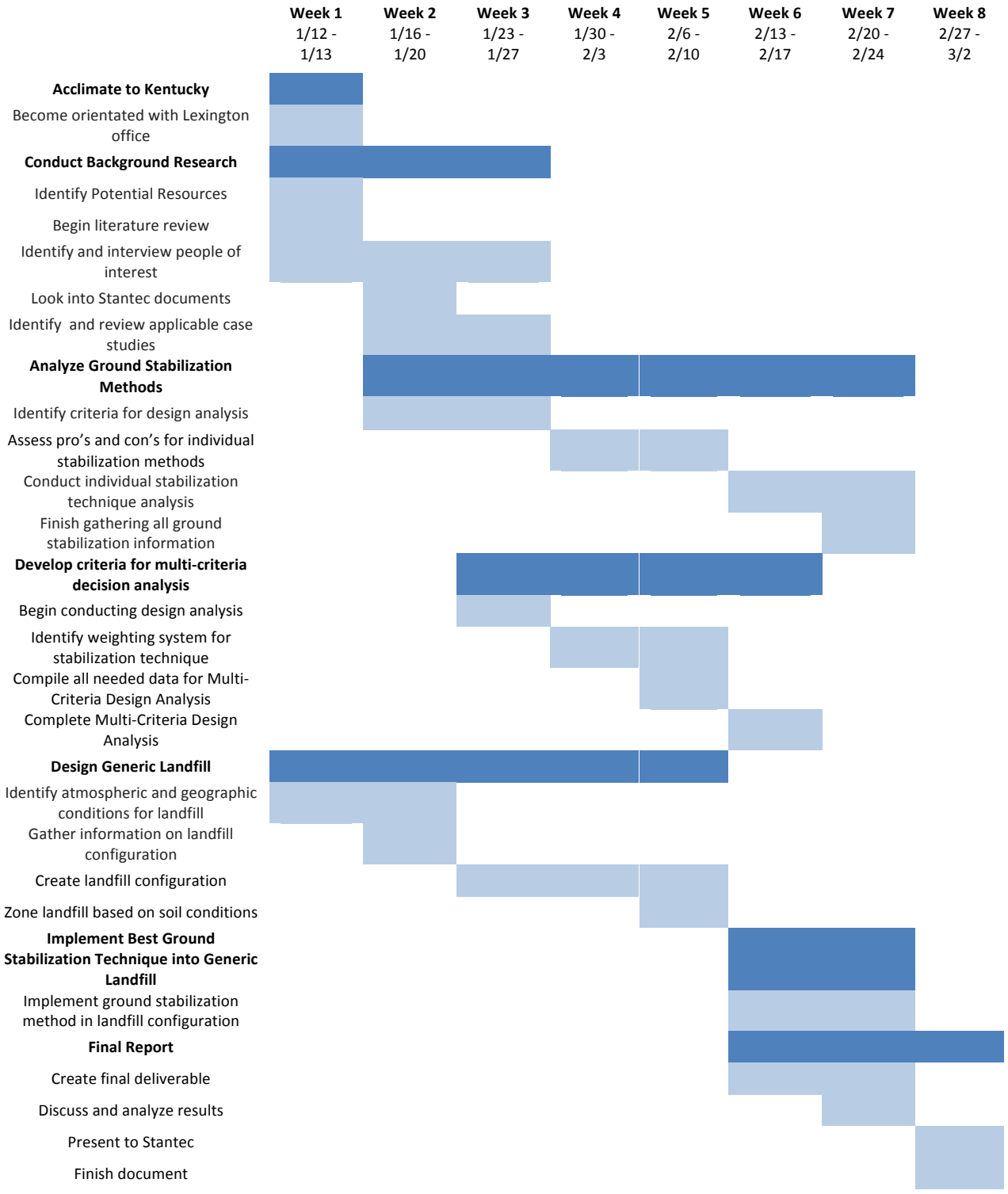
Health and Safety

Public health and safety is impacted by this project because the coal byproducts can cause an environmental issue. If the landfill were to fail because of poor ground stabilization then the coal combustion residue would be released into the environment. If this were to happen then the local groundwater supply, as well as the surrounding public, would be affected.

Sustainability

Sustainability takes into account social, environmental, and economic aspects of a design. The planning and implementation of new ground stabilization methods will encompass all three of these aspects, in terms of implementation, short term affects, and long term affects. The multi-criteria decision analysis will look at the sustainability of the proposed stabilization methods.

Appendix B- Preliminary Schedule



Complete any unfinished tasks

Appendix C- Tasks

Week 1

- Main Objective
  - Familiarize ourselves with Stantec office and resources
- Tasks
  - Identify potential resources
  - Begin literature review and background research
  - Identify people of interest
  - Become orientated with Lexington office
  - Begin identifying atmospheric and geographic conditions for landfill

Week 2

- Main Objective
  - Utilize potential resources
- Tasks
  - Gather information on landfill configuration
  - Continue background research
  - Look into Stantec documents
  - Set up interviews with people of interest
  - Identify applicable case studies
  - Complete all atmospheric and geographic design conditions
  - Identify criteria for preliminary design analysis

Week 3

- Main Objective
  - Complete all major background research
- Tasks
  - Begin landfill configuration

- Discuss pro's and con's for stabilization methods
- Interview people of interest
- Review applicable case studies
- Begin conducting preliminary design analysis
- Finish background research

Week 4

- Main Objective
  - Interpret data for conducting Multi-Criteria Design Analysis
- Tasks
  - Continue landfill configuration
  - Identify weighting system for stabilization technique
  - Assess pro's and con's for individual stabilization methods

Week 5

- Main Objective
  - Begin conduction Multi-Criteria Design Analysis
- Tasks
  - Complete landfill configuration
  - Solidify weighting system for stabilization technique
  - Zone landfill based on soil conditions
  - Continue individual stabilization technique analysis
  - Compile all needed data for Multi-Criteria Design Analysis

Week 6

- Main Objectives
  - Identify ground stabilization method using Multi-Criteria Design Analysis
- Tasks
  - Finish individual stabilization technique analysis
  - Compute Multi-Criteria Design Analysis

- Begin implementing ground stabilization method in landfill configuration
- Begin creating final deliverables

Week 7

- Main Objective
  - Design ground stabilization method into landfill
- Tasks
  - Continue final deliverables
  - Discuss and analyze results
  - Compile all final data needed for ground stabilization method design
  - Complete ground stabilization method into landfill

Week 8

- Main Objective
  - Complete final deliverables
- Tasks
  - Present results to Stantec
  - Complete final document
  - Wrap-up any unfinished tasks

Bibliography

American Coal Foundation "FAQs About Coal." Teachcoal.org. American Coal Foundation, 2010. Web. 09 Nov. 2011. <http://www.teachcoal.org/aboutcoal/articles/faqs.html>.

Coduto, Donald P. Geotechnical Engineering: Principles and Practices. Upper Saddle River, NJ: Prentice Hall, 1999. Print.

Department for Communities and Local Government. "Multi-Criteria Analysis: a Manual." Crown, Jan. 2009. Web. 6 Dec. 2011. <http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf>.

EPA_1. "Boiler Slag." *EPA.gov*. Environmental Protection Agency, 26 July 2011. Web. 14 Nov. 2011. <http://www.epa.gov/wastes/conserve/rrr/imr/ccps/boilslag.htm>.

EPA_2. "Bottom Ash." *EPA.gov*. Environmental Protection Agency, 26 July 2011. Web. 14 Nov. 2011. <http://www.epa.gov/wastes/conserve/rrr/imr/ccps/bottomash.htm>.

EPA_3. "Flue Gas Desulfurization Material." *EPA.gov*. Environmental Protection Agency, 26 July 2011. Web. 14 Nov. 2011. <http://www.epa.gov/wastes/conserve/rrr/imr/ccps/fgd.htm>.

EPA_4. "Fly Ash." *EPA.gov*. Environmental Protection Agency, 26 July 2011. Web. 14 Nov. 2011. <http://www.epa.gov/wastes/conserve/rrr/imr/ccps/flyash.htm>.

Nemati, Kamran M. *Temporary Structures: Slurry Trench/Diaphragm Walls*. Tech. University of Washington, 2007. <http://courses.washington.edu/cm420/Lesson6.pdf>.

Raj, Purushothama. *Ground Improvement Techniques*. 1999. Print.

Tomeczek, Jerzy. *Coal Combustion*. Malabar, FL: Krieger Pub., 1994. Print.