Runoff Engineering, Inc.

Proposal: Flagstaff Family Food Bank Flood Remediation Project

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1 PROJECT OVERVIEW

The purpose of this project is to remediate potential flooding issues at the Family Food Bank storage site. Flooding issues are occurring due to storm water runoff events which may have an occurrence of every year for the past five years.

The site can be located in Flagstaff, AZ at 3805 E Huntington Dr. next to Interstate 40.

Figure 1-Location of Flagstaff Food Bank (Google Maps, 2015)

The current condition of the site is that it lies at the bottom of an incline of the area, resulting in water accumulation in and around the site. Figure 2 shows the site location in relation to E. Huntington Dr.

Figure 2-Location of Food Bank next to Huntington Dr.

From Figure 2, the incline of the parking lot in front of the Food Bank can be seen as a problematic area for the accumulation of surface runoff. The curb on E. Huntington Dr. guides the water runoff, but as a result of the location of the parking lot in front of the site, the curb is non-existent, resulting as the runoff exiting the roadway and onto the site. From Figure 3, barricades can be seen as a form of temporary solution to the flooding at the site.

Figure 3-Barricades on Site (From Right of Building)

From Figure 3, the use of barricades and sand bags are meant to divert water away from the front parking lot and toward the east side of the site. Figure 4 indicates the left side of the building where water has been diverted. This also indicates the low incline for the water to run off the site.

Figure 4-East Side of Food Bank Building

There have been many forms of diverting water away from the site as well as protecting the building itself from ponding. The use of sand bags were also used along the north side of the building to stop the water from flooding the inside. Regardless of all the many forms of diverting water away from the site, water still accumulates to a high degree around the building and on-site.

Figure 5-Clogged Storm Drains Surrounding Site

Additionally, clogged storm drains on the road near the site are hindering some of the surface runoff from being diverted appropriately. From Figure 5 it can be seen that frequently clogged drains are apparent.

2 TECHNICAL CONSIDERATIONS

For the Family Food Bank flood control and remediation project, there are several technical considerations that will provide an efficient, cost effective, and safe solution. The team's main focus will consist of; surveying and mapping, plan development, hydrologic and hydraulic modeling, and geotechnical analysis. All of these technical aspects will be necessary and shall be performed over the course of the project. This section of the proposal will briefly describe the technical aspects required of an engineering firm to address a flood remediation project.

2.1 Overview

When dealing with flood control and remediation, there are several technical aspects engineering firms must understand in order to create an efficient, cost effective, and safe solution. The surveying and mapping of the project's site is one of the first steps in accomplishing these goals. The data plots created by surveying not only lays out property lines, but also enables engineers to understand how the topographic features of the site will affect runoff of water and its natural paths. Another important technical aspect of a

project is the plan development. With a proper plan, engineering firms are able to create efficient schedules and generate economic proposals in order to show the client that their bid is the most cost-effective and efficient. Furthermore, a proper plan development includes the utilization of the engineering design process to generate the best solution for the client. A more detailed technical aspect of flood control and remediation is the use of hydraulic and hydrologic models. These models will show engineers the characteristics, such as runoff rates, a project site will exhibit using event hydraulic modeling. A common software used for this is HEC-HMS. While a properly configured hydrologic model will account for most of these characteristics, geotechnical analysis must also be performed. This will help engineers understand how the soil will behave on the site. Further discussion on these aspects will be addressed below.

2.1.1 Surveying/Mapping

In order to organize as well as communicate aspects of a project's site to all members of the project, surveying of the property will be the first task. This will map out the client's property to establish the property lines and boundaries. It is important to establish these boundaries so that all members of the project are aware of where the property begins and ends as to avoid confusion. Not only can mistakes involving encroachments and easements slow down a project's completion time and cause legal issues, they can also cost thousands in additional construction requirements [1]. Once the surveying is completed, the data will be used for many different technical design aspects of the project, aspects discussed further within this document.

When a project's focus is to remediate flooding, it is important to develop elevation data, data that will be obtained while surveying the site. Elevation data can be important in understanding how and why flooding is occurring at a specific area of a site. Furthermore, topographic maps developed from surveying the site will be used as a communication tool between client and project members.

2.2 Project Management

Any engineering company providing services must devise a plan. This plan is a strategy which outlines due dates for deliverables, estimations for costs for the project, as well as developing the framework for the design process. An outcome of developing a plan would lead to better organization and the ability to function more efficiently for the duration of the design process.

2.2.1 Schedule

A schedule will be made in order to ensure that deliverables are submitted on time. This is important so that the company remains on track and that there is minimum turnaround time. An existence of a schedule is so that the company and client have an understanding of when things will be done. "An important tool to use for planning is the Gantt chart, as it is most commonly used for tracking project schedules" [What, 2015]. This tool is also important because the schedule depends on the client's needs and must be open to change. Therefore, the schedule will be firm yet flexible enough in case the client wants to make changes or if problems arise during the project. An example may include installing a culvert that may need to be done by a certain time, such as before the rainy season.

2.3 Economics

Before making a proposal to a client for flood remediation services, a company must estimate the costs that will accumulate throughout the project. An economic analysis will be conducted which will help decide the outcome of the proposal. The company hopes to provide its engineering services to the client at a price that will satisfy both the client and the company. "These budgets consist of all field related expenses, administrative and overhead costs, logistics, equipment rentals, service contractors and material expenses" [EPCM, 2015]. Costs for engineering services may include services such as hydrologic and hydraulic analysis, surveying, environmental impacts, and geotechnical engineering.

2.4 Design Process

As part of plan development, the engineering design process is key in developing solutions for the client's flooding issues. Through the engineering design process, steps will be taken to identify the problem, gather data by way of surveying, geotechnical and hydrological analysis as well as hydraulic analysis and analyze the quality of those solutions in order to conceive a desirable outcome for the client. One of the beneficial aspects of this process is that it can be repeated multiple times until a desirable outcome is achieved.

2.5 Hydraulic and Hydrologic Analysis

Any industry that deals with flood remediation relies heavily on hydraulic and hydrologic analysis and modeling. Companies are able to address why flooding occurs and the effects a solution may have further down the watershed by utilizing hydraulic and hydrologic models for estimating runoff quantities, impacts on flood basins, and hydraulic forces that impact drainage systems.

2.6 Event Hydrologic Modeling

Most flooding issues coincide with certain rainfall events. "Event hydrologic modeling reveals how a basin responds to an individual rainfall event" [Chu, 2015] which would include the quantity of surface runoff, the event's peak runoff, and the time of the peak. Thus, "fine-scale event hydrologic modeling is particularly useful for understanding detailed hydrologic processes" [Chu, 2015] and how those processes can be dealt with in order to fix a flooding issue.

2.7 HEC-HMS

One hydrologic modeling software available to engineering firms is the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS). This system uses a lumped hydrological modeling calibration. These types of models use historical data, such as gauge data, from watersheds in order to characterize the watershed and expected flows. While some projects are small in scale compared to their relative watershed areas, knowing the expected runoff rates in the area based on long-term historical data can give engineers a better understanding of how rainfall events will affect the site.

2.8 Geotechnical Analysis

Geotechnical analysis must be performed when construction is a potential solution to an engineering problem. Geotechnical analysis of a project's site provides useful information regarding soil types, bearing capacities and strengths, infiltration rates, and effective pressures that may change or influence designs. Furthermore, geotechnical analysis and studies "analyze groundwater depth, optimum depth of building foundations, and the stratification of land, which provides engineering designs the resistance necessary to properly size" [Hontus, 2015] any infrastructure that goes on, or under, the ground surface. In order to build culverts or channels, a common solution to flooding, such geotechnical analysis will provide engineers with appropriate data for design criteria.

3 STAKEHOLDERS

The potential stakeholders for this project are the Food Bank, the population of Flagstaff, and Flagstaff city engineers. The Food Bank is currently the property owners and any damages or losses accrued on the site would directly affect them. If the food stored at the storage unit is damage or found to be spoiled, the population of Flagstaff that uses the Food Bank for meals will also be affected. Furthermore, if the cause of the problem stems from poor design of runoff mitigation, then the city engineers responsible for said designs will also have some liability and might have to help pay for any alterations needed.

4 SCOPE OF SERVICES

The following list comprises of a scope of services that Runoff Engineering, Inc. will provide to its client.

- **Task 1.0 Site Evaluation**
  - Task 1.1 Neighborhood Survey – Flood Evaluation
    - ➢ Task: Interview neighboring companies within the area to determine if flooding is localized. Interviewing neighboring companies on past and present flooding issues within the area will pinpoint the flooding problem.
    - ➢ Deliverable: *Neighborhood Evaluation Report*
  - Task 1.2 Current Drainage Evaluation (Hydrology/Hydraulics)
    - ➢ Task: Obtain data from city engineers and/or current city rainfall data to be used for the hydraulic analysis calculations.
    - ➢ Deliverable: *Rainfall Data*
- **Task 2.0 Surveying**
  - Task 2.1 Topographic Maps (Property & Road)
    - ➢ Task: Survey the road as well as the Food Bank Property to collect Point Plots. Develop a topographic map based on survey data pertaining to Huntington Road, Flagstaff Food bank property, and include collected past survey data from the city. Establishing topographic maps based on the road and property will aid in the communication process between the engineers, clients and stakeholders.
    - ➢ Deliverable: *Topographic Map*
- **Task 3.0 Permitting/Standards/Codes**
  - Task 3.1 City Drainage Codes
    - ➢ Task: Obtain city drainage codes from city of Flagstaff, specifically from the City Engineer and the Engineering Specialist. Using the drainage codes will aid in investigating different design alternatives for drainage, due to the fact ADOT does not have jurisdiction on the road in front of the food bank.
    - ➢ Deliverable: *Drainage Code Report*
    - ➢ Exclusion: Only applicable drainage report will be reported on.
  - Task 3.2 ADOT Drainage Codes (Highway)
    - ➢ Task: Obtain drainage codes from ADOT for Interstate 40 located behind the food bank property. Drainage codes will be important for establishing the proper route for water drainage from the

property. It may be against regulation or code to transfer stormwater runoff from the property to the highway.
    - ➢ Deliverable: *Applicable ADOT Drainage Codes Report*
    - ➢ Exclusion: Only applicable drainage report will be reported.
  - Task 3.3 Property Rights
    - ➢ Task: Determine property ownership for surrounding areas. Property rights will be important in determining design alternatives in order to avoid a possible conflict of diverting water onto neighboring property.
    - ➢ Deliverable: *Property Rights Report*
    - ➢ Exclusion: Only applicable drainage report will be reported.
- **Task 4.0 Design Alternatives**
  - Task 4.1 Hydrologic and Hydraulic Modeling
    - ➢ Task: Assemble plot points from the survey to model the hydrologic conditions of the site. Analyze current hydrologic conditions, such as: infiltration and runoff rates due to high risk storm events, which will be accomplished by utilizing hydrologic and hydraulic modeling software (IE: HEC-RAS). Determine current water routes and where the flooding occurs based off of these models. Analyze the current physical layout of the property to aid in determining a proper resolution.
    - ➢ Deliverable: *Hydrologic and Hydraulic Model*
  - Task 4.2 Stormwater Runoff Evaluation
    - ➢ Task: Procure different stormwater runoff designs from the City of Flagstaff. The stormwater runoff designs will be used to determine feasibility and economics of design alternatives which will focus on flows due to high risk storm events.
    - ➢ Deliverable: *Final Design*
  - Task 4.3 Geotechnical Constraints (feasibility)
    - ➢ Task: Perform a geotechnical survey of the site. This may include on-site visual inspections, sand cone tests, or bore hole samples. Determine any constraints due to soil conditions, such as infiltration rates, on or surrounding the site, for design alternatives.
    - ➢ Deliverable: *Final Evaluation of Soil for Design*
  - Task 4.4 Economic Analysis
    - ➢ Task: Evaluate costs for the design phase, construction phase, life cycle costs, and a present day worth analysis of design alternatives. This analysis will aid in assessing which design alternative is most cost effective.
    - ➢ Deliverable: *Economic Analysis*
  - Task 4.4 Environmental Impacts

- ➢ Task: Develop a runoff mitigation system to control pollutant discharges due to urban runoff. These techniques can focus on both water quantity control and enhancing water quality. Prevent pollution through low influence development and green infrastructure techniques like the installation of green roofs as well as enhanced chemical handling. Runoff mitigation systems can involve infiltration basins, constructed wetlands as well as retention basins.
- ➢ Deliverable: *Environmental Impact Report*

- **Task 5.0 Project Management**
  - Task 5.1 Project Schedule
    - ➢ Task: Utilize scheduling software, Gantt charts, to determine critical paths, float areas for the project. Design a schedule to achieve the client's objectives and to produce a high quality project on-time and within budget.
    - ➢ Deliverable: *Project Schedule*
  - Task 5.2 50% Design Report
    - ➢ Task: Produce a 50% design report to show the client the progression of the project. To vet out any discrepancies or errors that may hinder the project and to keep the client informed on progress.
    - ➢ Deliverable: *Design Report*
  - Task 5.3 Final Design Report
    - ➢ Task: Consolidate all findings, analyses, results, and design alternatives in a coherent and concise manner. Determine whether deliverables have been met and if the client's expectations have been met.
    - ➢ Deliverable: *Final Design Report*
  - Task 5.4 Final Presentation
    - ➢ Task: Develop a clear and concise presentation assessing that the project and design alternatives are feasible. To infer deliverables have been met and that the client's expectations have been met.
    - ➢ Deliverable: *Final Presentation*
  - Task 5.5 Website
    - ➢ Task: Develop a functional website that includes information necessary for website visitors interested in the Food Bank Flooding project stages and Deliverable. A website that serves as a gateway to all the information available on the project. Development of a website can impart to a broad range of engineers a viable solution to a similar flooding problem.
    - ➢ Deliverable: *Website*

5 SCHEDULE

The following chart shows the proposed schedule Runoff Engineering, Inc. would follow in order to complete the project in a cost effective and efficient manner.

Name	Duration	Start	Finish
Project Schedule	143 days	Wed 10/28/15	Fri 5/13/16
Neibhorhood Survey (Interviews)	15 days	Mon 11/2/15	Fri 11/20/15
Surveying	25 days	Thu 3/10/16	Wed 4/13/16
Researching Permitting/Standards/Codes	33 days	Mon 1/25/16	Wed 3/9/16
Design Alternatives	22 days	Thu 4/14/16	Fri 5/13/16
Hydrologic and hydraulic modeling	31 days	Fri 1/1/16	Fri 2/12/16
Stormwater runoff evaluation	44 days	Mon 2/15/16	Thu 4/14/16
Geotechnical Constraints	4.2 wks	Mon 2/1/16	Mon 2/29/16
Economic Analysis	2.4 wks	Fri 4/15/16	Mon 5/2/16
Environmental Impact Study	2.2 wks	Mon 4/18/16	Mon 5/2/16
Project Management	143 days	Wed 10/28/15	Fri 5/13/16

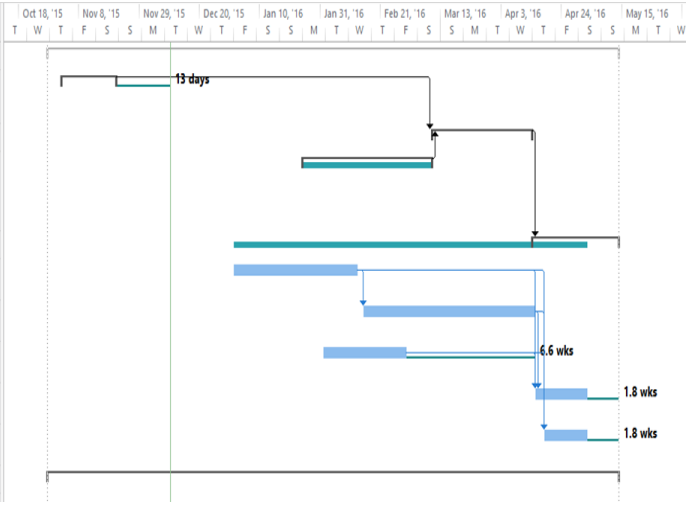

Figure 6-Schedule

The project management will occur throughout the course of the project, and Runoff Engineering Inc. anticipates that the project will take 26 weeks to complete. Runoff Engineering Inc. will use project management to organize and keep track of the completion of each task as well as maintain the project schedule as planned. Tasks pertaining to the neighborhood survey began in October and were completed this past November. Beginning next semester in February we will survey the areas of interest. Surveying plays a crucial role into the design of our project; therefore it controls the completion of the remaining tasks, specifically the design alternatives. Researching permitting/standards/codes from the city will begin in late January and extend throughout the project. This is so we remain current with the permits, standards, and codes set forth by the city, it is to be expected to take 47 days to complete. Design alternatives will be modified as we will conduct our analysis of the area, therefore it is expected to take 6.6 weeks to complete and from there we can begin the economic analysis and the environmental impact study which is expected to take 1.8 weeks to complete.

6 STAFFING AND COST

Runoff Engineering, Inc. will conduct all tasks for the Food Bank Project.

Senior Engineer (SENG) – The Senior Engineer has taken courses involving Civil as well as Environmental aspects, it is this qualification, which deams the Engineer qualified to document, survey the property, and develop the final design of the project.

Engineer (ENG) – Using problem solving techniques developed in the fields of Civil and Environmental Engineering, the Enginner will conduct research in both the project focus and site study. The Engineer will also document project material, survey the site, con duct lab analysies, and using collected data develop a final design.
Lab Technician (Hydraulic, Hydrology, and Geotechnical Engineering) (LAB) – The Lab Technician will conduct laboratory analysis within the lab and document findings for future use.
Administrative Assistant (AA) – The Administrative Assistant will document data collected by the Senior Engineer, Engineer, and Lab Technician.

The following table displays the hours to which each staff member will carry out each task.

Staffing				
Task	**SENG**	**ENG**	**LAB**	**AA**
Project Management -Meetings -Scheduling -Documentation	22	14	14	20
Research -Site evaluation -Neighborhood survey -Codes/legal standards	15	65		10
Analysis -Surveying -Geotechnical -Hydrological -Environmental		220	80	
Final Design -Final Proposals -Presentation -Website	160	40		20
Subtotal	197	339	94	50
Total (hrs)	**680**			

Figure 7-Staffing Hours

The total cost estimate for engineering services can be seen below, and has been determined to be $68,282.00.

Cost Estimate for Engineering Services				
1.0 Personnel	Classification	Hours	Rate, $/hr	Cost
	SENG	197	194	$ 38,218
	ENG	339	67	$ 22,713
	LAB	94	48	$ 4,512
	AA	50	56	$ 2,800
	Total Personnel			$ 68,243
2.0 Travel	7 meetings @ 10 mi/meeting	$0.56/mi		$ 39
3.0 Total				$ 68,282

Figure 8-Cost Estimate

7 EXCLUSIONS

Runoff Engineering, Inc. has one exclusion for the proposal, and that is to only be responsible for surveying of the client's property and 50' outside the clients parcel. Additional survey data, if required, will be attained through the city, or hirable out per the client's request.

8 REFERENCES

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