Habitat For Humanity Affordable Housing Team

ABK Company
Engineering Capstone Students
2112 S Huffer Ln
Flagstaff, AZ 86011

December 12th, 2018

Dr. Stephen Mead
Project Client
Habitat for Humanity

Dear Dr. Mead,

The following document contains information regarding the team's understanding of the assigned capstone project, the scope of the project, and cost of engineering services. Please look through the content within the document and provide the team with any feedback. This includes inaccuracies or new information the team may not have previously known. We look forward to working with you, as well as any comments or suggestions you may have for this project.

Thank you and have a wonderful day.

Best regards,

Abdulrahim Abdullah, Mobarak Alsulaiman, David Borja, Michael Bulriss, and Anna Kurn

Habitat for Humanity Tiny Homes Affordable Housing Site Design Proposal for Flagstaff Unified School District in Flagstaff, Arizona

ABK

ABK Company

Abdulrahim Abdullah

Mobarak Alsulaiman

David Borja

Michael Bulriss

Anna Kurn

Proposal Draft 5: Final Proposal

Revised: December 11th , 2018

Table of Contents

Table of Tables

Table of Figures

List of Abbreviations

ADA: Americans with Disabilities Act

ADEQ: Arizona Department of Environmental Quality.

COF: City of Flagstaff

FUSD: Flagstaff Unified School District

NAU: Northern Arizona University

1.0 Project Understanding

1.1 Project Purpose

Habitat for Humanity is entering a joint venture project with Flagstaff Unified School District (FUSD) to provide solutions for affordable housing options in Flagstaff. The proposal provides housing options that allow Flagstaff Unified School District and the Flagstaff community to retain teachers by reducing the cost of living. The project is to provide a preliminary site plan, including: grading and drainage plan, road/parking design, storm water management design, site utility infrastructure, and preliminary cost estimate. The site design will include sewer, water, electricity for utilities and housing, and fire systems. The project must comply with COF (City of Flagstaff) codes and ADA standards. The preliminary site plan provided at the end of this phase will incorporate value engineering options and integrate thoughtful design to aid in affordable efforts of this development.

1.2 Project Background

The project site location is property owned by FUSD near the School District Offices and Sinagua Middle School in Flagstaff, Arizona. Figure 1 provides further location information. The site is currently a wooded, undeveloped area.

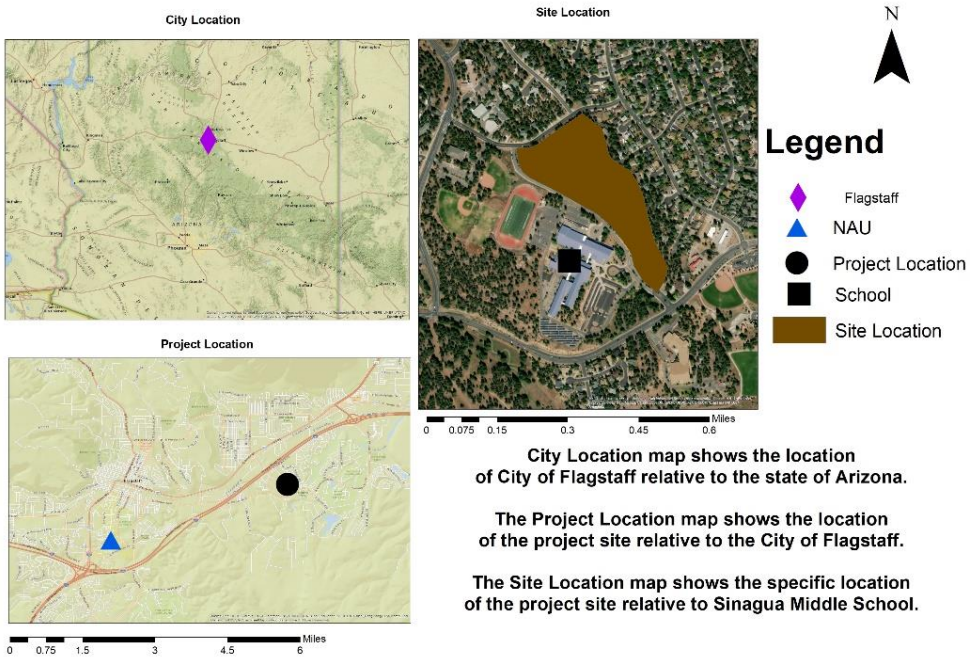

Figure 1: Project Location for Affordable Housing Project in Flagstaff, AZ

1.3 Technical Considerations

Technical considerations relating to the project include: use of existing data for development of a topographic map, utility infrastructure, grading and drainage design, road and parking design, curb and gutter design, stormwater management, and an overall cost estimate. Descriptions of each technical aspect are provided in the following subsections.

1.3.1 Existing Topography

Topographic layout including elevations, contours, and natural and manmade characteristics will be developed by use of existing COF data. Contours will be provided in 1-2 foot intervals per City of Flagstaff requirements. The site survey will follow City of Flagstaff Code Title 13 [1]. Computer drafting software will be used to provide contour data from the site.

1.3.2 Utility Layout and Coordination

Utilities included in this project are the design of water and sewer systems. The connection points for electricity, gas, and communication will be provided. Existing utility infrastructure needs to be identified using Blue Stake to determine connection point locations. Connections will be permanent. All utilities will follow City of Flagstaff Municipal Code [3].

1.3.3 Grading and Drainage Design

Flagstaff, Arizona requires a drainage plan to reroute water from snow and rainfall once coming in contact with the property. The project team will need to design and slope the area in a way that complies with City of Flagstaff codes while guiding runoff into storm water systems. City of Flagstaff code requires that all storm water be retained on site [2]. The grading design will need to minimize the need for cut and fill to minimize construction cost impacts [2].

1.3.4 Road and Parking Design

The tiny home community will require accommodations for the people and vehicles utilizing the 45 unit community. Roads for entry into the premises and parking lots for tenants their vehicles are essential to the design of the site. The parking will be designed as a communal lot to save space within the development. COF code section 13-10-001-0001 will be used for alignment, elevation, and curvature requirements. [2]. A preliminary road and parking design plan will be provided in consideration with these items.

1.3.5 Curb and Gutter Design

Designing curbs and gutters are an efficient way of collecting and guiding runoff into storm water systems. The combination of both curb and gutter can reduce the amount of water seeping into the pavement. The curbs and gutters will be designed in conjunction with road, parking, and sidewalks to ensure access routes are still available during storm events [2].

1.3.6 Storm Water Management

Flagstaff requires site design to route and drain storm water to handle heavy rainfall events. Management practices for storm water must reduce the risk of flooding and unwanted objects from entering the system. Retention ponds, seeding, sedimentation controls, vegetation, and SWPPP will be used to prevent erosion on the site. Storm water management need to follow City of Flagstaff Municipal Code [2].

1.3.7 Preliminary Cost Estimate

The cost estimate summarizes the price of equipment, materials, labor, and other resources involved with the project. The cost estimate will provide projected cost of construction and will serve as a feasibility analysis for the client and stakeholders. Adjustments regarding scope of project can be made as necessary to potential purchases to decrease the overall cost of the project.

1.4 Potential Challenges

Site conditions, such as land restrictions, weather, topography, and trees present themselves as challenges. The goal is to fit 45 tiny homes within a reserved area with an unclarified amount of acreage. The site design must compliment contour lines to avoid excessive amount of cut and fills which would raise the cost of the project. City of Flagstaff code 10-30.20.040 'Affordable Housing Incentives' states that although affordable housing developments may have reduced resources protection standards, a certain percentage of trees must be preserved in the area [3]. The percentage of trees preserved depends on the category the development is deemed to be.

The design must also comply with City of Flagstaff codes and American Disability Act (ADA) standards. This could prove challenging because the parking lot will be communal so the project will require ADA compliant parking as well as a graded path to reach the ADA compliant housing [4]. Potential issues include residents who have guests who are handicapped needing to access non-ADA compliant housing. The team will need to decide whether to make the entire community ADA compliant or only a select few houses in the community. The topography of the site area will influence sidewalks, ramps, and parking lots to ensure each meet standards. Slopes of the land must be considered throughout the design process.

1.5 Stakeholders

Flagstaff Unified School District, Habitat for Humanity, City of Flagstaff community and potentially the NAU Board members are the main stakeholders for this project. The FUSD is working with Habitat for Humanity to develop this affordable housing project for educators and will provide the land. The project economically impacts the COF and its community because educators will reside in the new homes and provide quality education services to Flagstaff

schools. NAU has an interest in the project and the final report will potentially be presented to the board members of the university.

2.0 Scope of Services

2.1 Task 1: Preliminary Site Visit and Assessment

A preliminary site visit was done in the company of the client and TA to conduct a preliminary site assessment. Information gathered from this site assessment will be incorporated into the plans produced for this project. The boundaries of the project were identified by the client. Also, the transformer boxes were identified by the client. Utility pipelines will need to be connected to the identified transformers. The results of visual soil assessment show that the site contain mostly rocky material. The grade and elevation change across the site area was noted and will be discussed in more detail in the grading and drainage section. It will also be shown in the final grading and drainage plan that will be produced in this project. Civil 3D will be used for this task. Preexisting onsite utilities will be identified using Bluestake and incorporated into the grading and drainage plans. The connection points to the road which are the entrance and exit of the project location were determined during the site visit by the client. The team will use engineering judgment to decide the best way to connect the entrance and exit of the project site. The road will be produced using Civil 3D and incorporated into the road and parking plans. The design will follow City of Flagstaff code 13-03-003-0003 [1].

2.2 Task 2: Grading and Drainage Design

2.2.1 Site Map

A site map that incorporates the topographic feature and contour lines will be used to determine the amount of cut and fill will be developed. The site map will be acquired from existing topography through the City of Flagstaff database.

2.2.2 Existing Hydrology

Existing hydrology will be analyzed by assessing the topography of the project site and researching similar sites. Hydrology studies completed in the area will be used to determine peak flow values and existing drainage routes will be used to aid in the grading and drainage plan.

2.2.3 Existing Hydraulics

Existing hydraulics will be analyzed by investigating the current mitigation techniques for the site and identifying any existing infrastructure for hydraulics using BlueStake.

2.2.4 Hydrology Design

Hydrology design will need to incorporate the new topography of the area and additional infrastructure to be added. Software will be utilized to model the hydrology of the new site design. Drainage plans and a Stormwater Pollution Prevention Plan will be developed based on the hydraulics and hydrology analysis. A justification will be provided for the use of surface and

or underground detention. Drainage plan will follow City of Flagstaff Stormwater Management Design Manual [5].

2.2.5 Hydraulics Design

Hydraulics design will include the proposed site storm water and sewer systems. Modeling software will be utilized to ensure the designed conveyance system can handle the necessary capacity. The size of the pipes will follow the standards and specifications of the City of Flagstaff Municipal Code [2].

2.3 Task 3: Roads, Curb, and Gutter Design

2.3.1 Current Conditions and Access Identification

Current roads surrounding the site will be located to find possible intersection points between the new and existing roads using the information from the site visit and google earth. Slopes of the site will also be identified using the data from the field survey. Data on the number of trees will be found using the ratio from the tree survey.

2.3.2 Roads and Parking Design

New road and parking lot alignments will be designed using the data from the field survey and accessibility of existing roads. Centerlines, offsets, curvatures, and elevations for a new road and parking lots will be designed in AutoCAD using the surveying data. New interchanges with the existing roads also will be designed in AutoCAD as well.

2.3.3 Curb and Gutter Layout

New curb and gutter and sidewalk alignments will be designed using the data from the field survey and the new road design. Offsets, curvatures, and elevations for new curb and gutter will be designed in AutoCAD. New curb and gutter design will correlate with the new road design. The full design will be done using AutoCAD.

2.4 Task 4: Utility Coordination and Layout

2.4.1 Utility Layout

All utility pipelines and adjustments will be identified and shown within the location plan. Utility connections will be permanent per City of Flagstaff codes. Connections will be provided from the electrical supply to the tiny homes but no design will be done. The gas supply was located on the Sinagua Middle School property during the site visit and connections will be provided to the community but not incorporated into the design.

2.4.2 Water

All existing water pipelines will be identified using BlueStake. Existing water main access point on Sparrow Avenue. Both existing water pipelines and access point will be shown in the site plan. Water mains will be connected between the tiny homes and the access point identified. All water pipelines will follow City of Flagstaff Municipal Code guidelines and standards in addition to Arizona Department of Environmental Quality (ADEQ) [2]. Civil 3D will be used to design the water pipeline connections.

2.4.3 Sewer

All existing sewer pipelines will be identified using BlueStake. Existing sewer main access point location need to be identified during the site survey. Both the existing sewer pipelines and the sewer access point will be shown in the site plan. Needed additions and connections will be made to connect the tiny homes into the access point identified. Spiration from the water pipelines will be taken into consideration when designing the connections [2]. Civil 3D will be used to design the sewer pipeline connections.

2.5 Task 5: Plan Sets

2.5.1 Cover Sheet

The cover includes an overview of the project location with regard to Flagstaff, AZ, in addition to contact information of the client, engineers, utility companies, and other contributors where applicable.

2.5.2 Notes and Details

The notes and details sheet lists all applicable standards and codes the contractor will follow, in addition to details of designs used in the project referenced in the plan set.

2.5.3 Existing Site Plan

The existing site plan will display surveying topographic curves, control points, and infrastructure currently at the site.

2.5.4 Grading and Drainage Plans

The grading and drainage sheets will highlight the proposed tiny home community and parking lot with all necessary plans/profiles, contours, and details of stormwater infrastructure.

2.5.5 Road Curb and Gutter Plan

The road, curb, and gutter plan sheet will illustrate the location of proposed roads, curbs, and gutters at the project site.

2.5.6 SWPPP

A Stormwater Pollution Prevention Plan (SWPPP) will detail how the contractors can lower the effects on the stormwater system from pollution caused by construction. This sheet will also list Safety/Risk factors that show potential hazardous areas.

2.6 Task 6: Preliminary Cost Estimate

A detail sheet containing costs for construction and labor will be provided. Value engineering will be incorporated to the design to provide a preliminary and feasible cost analysis for construction of the site design. Total cost estimate will be provided to the client.

2.7 Task 7: Deliverables

2.7.1 30% Design Report

A 30% Design Report will be provided for progress update to the client and grading instructor so that minor corrections to the design may be incorporated. The 30% report should include the completion of the cover sheet of the plan set and preliminary designs.

2.7.2 60% Design Report

A 60% Design Report will be provided for progress update to the client and grading instructor so that minor corrections to the design may be incorporated. Design requirements and applicable standards will be incorporated in this design stage.

2.7.3 90% Design Report

A 90% Design Report will be provided for progress update to the client and grading instructor so that minor corrections to the design may be incorporated. At this point, the design is mostly complete. Corrections will be made to ensure accuracy and complete final design.

2.7.4 Final Report

The final design report will be presented to the client to provide a basis of construction cost for implementation. A final presentation to the stakeholders will provide an opportunity to present design and answer additional questions.

2.7.5 Final Website

A final website will be provided as a deliverable for the client to have access to all completed documents and plan sets. The link will be provided to the client upon completion of the project.

2.8 Task 8: Project Coordination

2.8.1 Meetings

Meetings are conducted on a regular basis with the technical advisor (Stephen Irwin), grading instructor (Dr. Dianne McDonnell), client (Dr. Steve Mead), and the capstone team. Meetings are to occur with each advisor at least four times per semester but are scheduled more frequently as needed. All meeting minutes are clearly recorded and are assembled in a meeting memo binder for reference.

2.8.2 Schedule Management

The schedule is reviewed for upcoming deliverables and tasks on a weekly basis. Considerations for drafting durations and review time will be incorporated into the schedule to ensure an accurate timeline is provided. The schedule is shown as a Gantt Chart with major tasks outlined as the critical path.

2.8.3 Resource Management

Resources for this project must be used efficiently to ensure success. Equipment for surveying will be borrowed from Northern Arizona University and appropriate procedures will be followed for scheduling and check out. Computer drafting will be completed on school computers and availability of necessary software must be confirmed. A budget for completion of the project will be developed and reviewed weekly to ensure the time allotted on a task is properly executed.

2.8.4 Project Tracking

Project tracking aids in planning and assigning tasks for completion with adequate time to complete them. This is an ongoing task as part of schedule management and project coordination. As such, project tracking is an item of review at client and grading instructor meetings.

2.9 Task 9: Project Limitations

2.9.1 Limitations

This project is limited by the abilities of the student capstone team, the time constraints of the project, and the budget supplied by the client. Components that would typically be required for a project of this scope are excluded below due to these constraints.

2.9.2 Challenges

Challenges as identified in Section 1.4 will be addressed by using resources and management skills effectively. Schedules will be adjusted to prepare for winter conditions.

Challenges of technical ability for this project will be mitigated by using our technical advisor, client, and research abilities to develop solutions within our scope of work. Exclusions are provided to minimize the amount of challenges due to limiting factors of the project and technical ability.

2.9.3 Exclusions

Exclusions are described below are based on time limitations and recommendations from the technical advisor and client.

- In the geotechnical aspect of the project, there will not be any type of soil testing. A preliminary soils investigation to identify the soil material of the project site will be conducted but a geotechnical analysis is excluded.
- Because of the large scale of the project site and the time limitation, there will not be a full site trees survey. An estimation will be determined using a map overlay method or by surveying a small area then using a ratio to estimate the total trees.
- No survey data will be taken by the team. Existing data from COF will be used for this project
- Traffic Analysis impact will be excluded. Per the client, the focus is on the cost analysis and to disregard any impact analysis.
- Environmental Impact Analysis will be excluded due to the focus on the cost analysis aspect of the project and the time limitation the team will face.
- Structural engineering and retaining wall design will be excluded due to time limitation and overall focus of the project.
- Utilities design will only include the water and sewer systems but not the electrical and gas

3.0 Schedule

The project schedule was created based on the project scope. The schedule includes all major tasks, subtasks, and deliverables discussed in the project scope. The project has a duration of 74 days starting on January 14th and ending on May 6th. The Grading and Drainage design will be the first task after the preliminary site visit, it will begin January 21st and it will last for 52 days until its completion on April 2nd. Road, Curb, and Gutter design will begin on January 23rd and last 50 days until April 2nd. The utility coordination and layout will last for 10 days and begin on April 3rd and end on April 16th. The main project deliverable will be the construction plan sets that will be developed throughout the entire duration of the project as tasks are completed. The plan sets will take 75 days and be completed by May 7th.

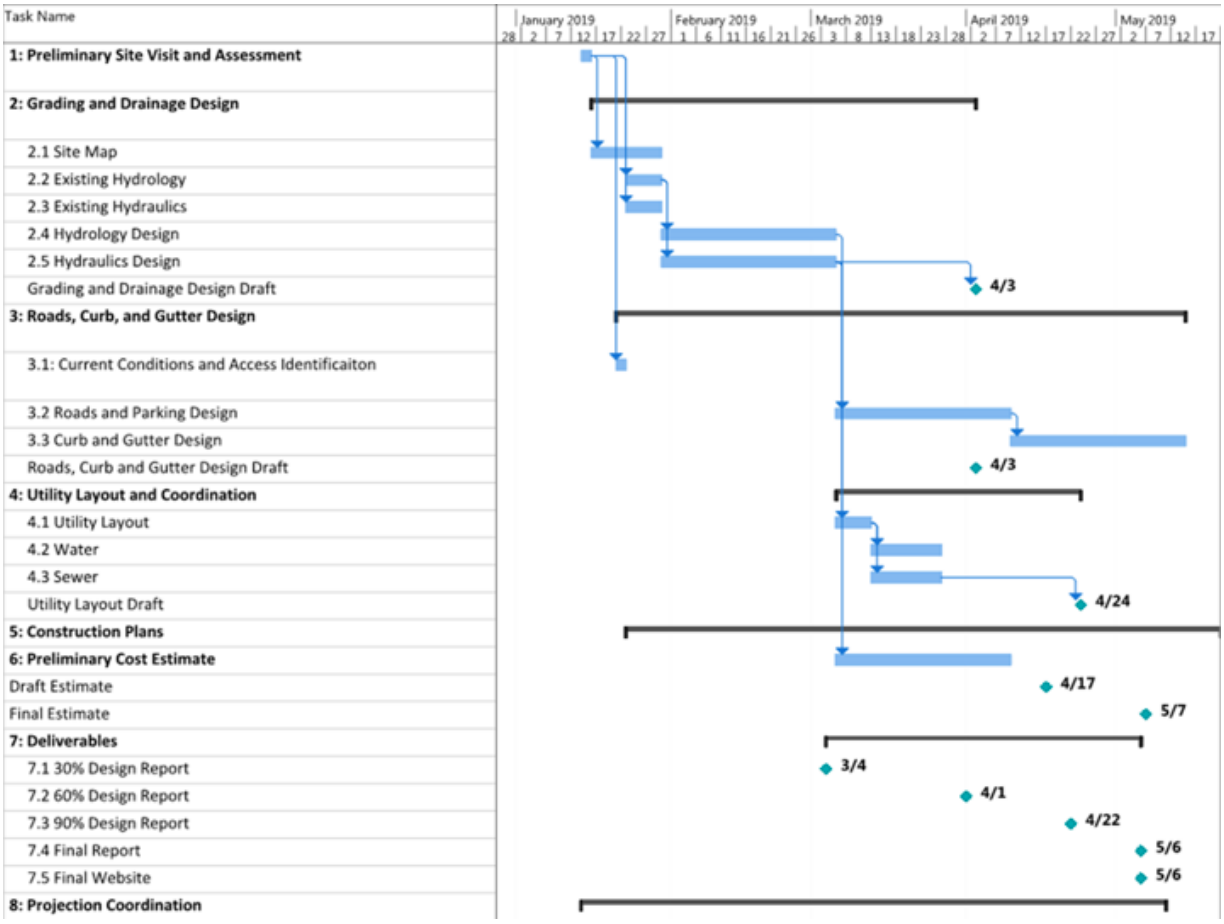

Figure 2: Gantt Chart Schedule

3.1 Critical Path

The critical path is the sequence of tasks in the schedule that must be tracked to successfully complete the project on time. The critical path is outlined in red on Figure 3. The numbers in blue are the earliest start time, and the numbers in purple are the latest finish time. The tasks with no float days are highlighted in yellow. The path in red must be followed to successfully complete the project on time.

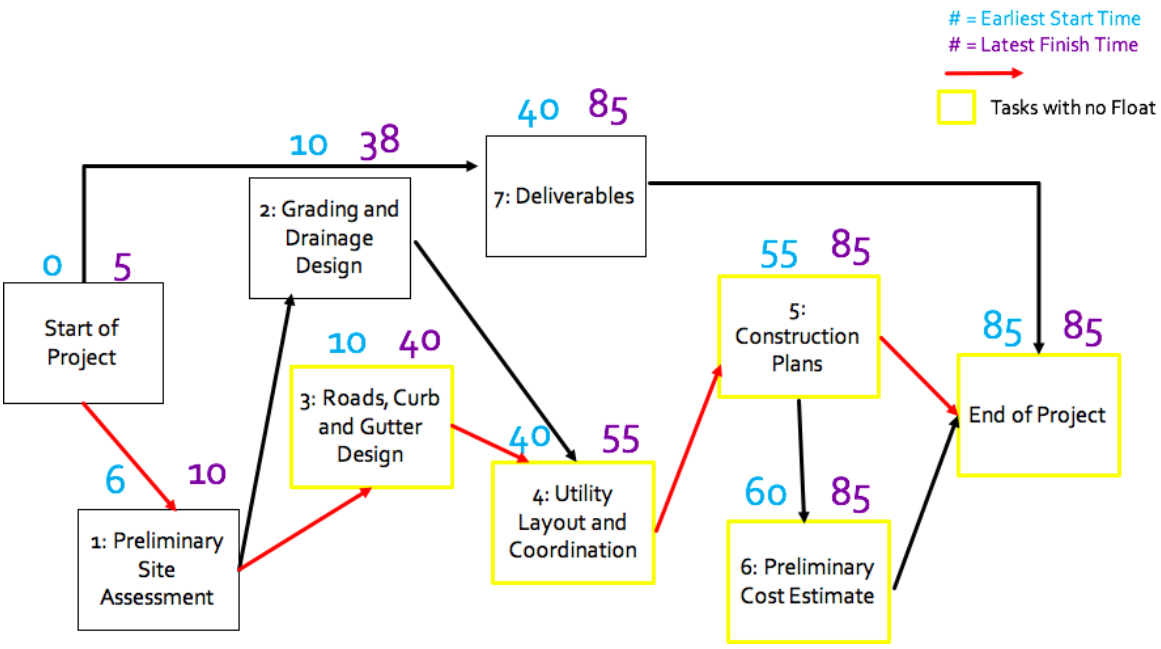

Figure 3: Critical Path of Project

4.0 Staffing Plan and Cost of Engineering Services

Four team members have been assigned for the competition of this project. Their titles and qualifications are listed as follows:

- Senior Engineer *(referred as SENG)*: Holds a Professional engineering license and is heavily involved in coordination and review of the project. The senior engineer provides input of the design of the project and is responsible for review and acceptance of the final construction plans. The SENG is responsible for attending meeting with the client and managing the budget and resources.
- Engineer *(referred as ENG)*: The engineer holds a Professional engineering license and is responsible for the development of the construction plans. They aid the EIT and Intern in the development of grading and drainage plans and road design and are responsible for review of the final design.
- Engineer in Training *(referred as EIT):* Has completed an engineering program and is working towards completion of a professional engineering license. The EIT is responsible for development of the designs for roads, cut and fill, and utilities, with the oversight for the Engineer and Senior Engineer.
- Intern *(referred as INT):* the intern is a part-time student that is fully committed to this project when in the office. They assist in the development of the grading and drainage plans, as well as the roads, curb, and gutter design, with EIT as a direct resource.

A summary table with each member's allocated hours to each task is provided in Table 1 below.

Table 1: Working Hours of each Team Member by Task

Task	SENG Hours	ENG Hours	EIT Hours	INT Hours
1.0 Preliminary Site Visit and Assessment		8	4	4
2.0 Grading and Drainage Design	20	60	55	55
3.0 Roads, Curb and Gutter Design	16	60	55	55
4.0 Utility Layout and Coordination	8	40	40	10
5.0 Construction Plans	40	80	60	60
6.0 Cost Analysis	16	10		
7.0 Deliverables	35	10		
8.0 Project Coordination	80			
Subtotal	215	268	214	184
Total (hours)	881			

The cost of engineering services was determined by billing rates of each team member and is inclusive of all necessary measures to complete the outlined tasks. The billing rates were determined as provided in Table 2 below. No subcontractors will be used for completion of this project and have been excluded from this proposal. Reimbursable expenses for meetings have been provided as a line item in the cost estimate. Table 3 below provides the complete cost of engineering services for this project.

Table 2: Cost of Engineering Services

Personnel	Classification	Hours[1]	Rate, $/hr	Cost
	SENG	215	150	$32,250
	ENG	268	91	$24,388
	EIT	214	65	$13,910
	INT	184	23	$4,232
TOTAL				$74,780

[1] Number of hours/day × number of days, for each classification

5.0 References

[1] City of Flagstaff, "Title 13 Engineer Design Standards and Specifications for New Infrastructure," 24 October 2018. [Online]. Available: https://www.codepublishing.com/AZ/Flagstaff/.

[2] City of Flagstaff, "Flagstaff Municipal Code," 24 October 2018. [Online]. Available: https://www.codepublishing.com/AZ/Flagstaff/.

[3] City of Flagstaff, "Title 10: Flagstaff Zoning Code," 24 October 2018. [Online]. Available: https://www.codepublishing.com/AZ/Flagstaff/.

[4] Department of Justice, 15 September 2010. [Online]. Available: https://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm.

[5] City of Flagstaff, "City of Flagstaff Stormwater Management Design Manual," March 2009. [Online]. Available: https://www.flagstaff.az.gov/DocumentCenter/View/58133/SWMgmtDesignManual-3-09?bidId=.