CENE476

JOHN WESLEY POWELL BLVD EXTENSION – EAST

Final Proposal

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List of Abbreviations

CAD – Computer-Aided Design

CCDDM – Coconino County Drainage Design Manual

COF – City of Flagstaff

COFSMDM – City of Flagstaff Stormwater Management Design Manual

EIT – Engineer in Training

GIS – Geographic Information System

HCM – Highway Capacity Manual

JWP – John Wesley Powell

MUTCD – Manual on Uniform Traffic Control Devices

TIA – Traffic Impact Analysis

1.0 Project Understanding

This section outlines the purpose, background, technical considerations, potential challenges, and stakeholders of this project.

1.1 Project Purpose

The purpose of this project is to design an approximately 2.5-mile roadway extension to the existing John Wesley Powell (JWP) Boulevard in Flagstaff, Arizona [1]. This extension will be from the current east terminus of JWP Blvd, continuing east to intersect with the existing Fourth Street on the east side of town, adding another east/west arterial roadway to the area road network. The addition of this arterial to the network will aim to reduce the amount of traffic using the existing east/west arterials and open the opportunity for future land development. The project area includes parcels owned by Northern Arizona University, the City of Flagstaff and Pine Canyon [2]. The project area contains multiple parcels categorized by the City of Flagstaff (COF) as new growth for future urban/suburban development. Many of these parcels have utility access or close access to utilities, making them attractive candidates for development [3].

This new roadway extension will conform to City of Flagstaff and Coconino County requirements and standards to convey traffic safely and efficiently along its alignment, including considerations for pedestrians, cyclists, and public transit.

1.2 Project Background

The current alignment of JWP Blvd runs northeast from Lake Mary Rd to the northeast corner of the Pine Canyon neighborhood in Flagstaff, where it terminates at a dead end. The existing road is one lane in each direction. Figure 1-1 below indicates the location of the project within the City of Flagstaff, with call outs for the current terminuses of the project. Figures 1-2 and 1-3 offer more detailed views of the eastern and western terminuses, respectively.

FIGURE 1-1, PROJECT LOCATION WITHIN FLAGSTAFF [4]

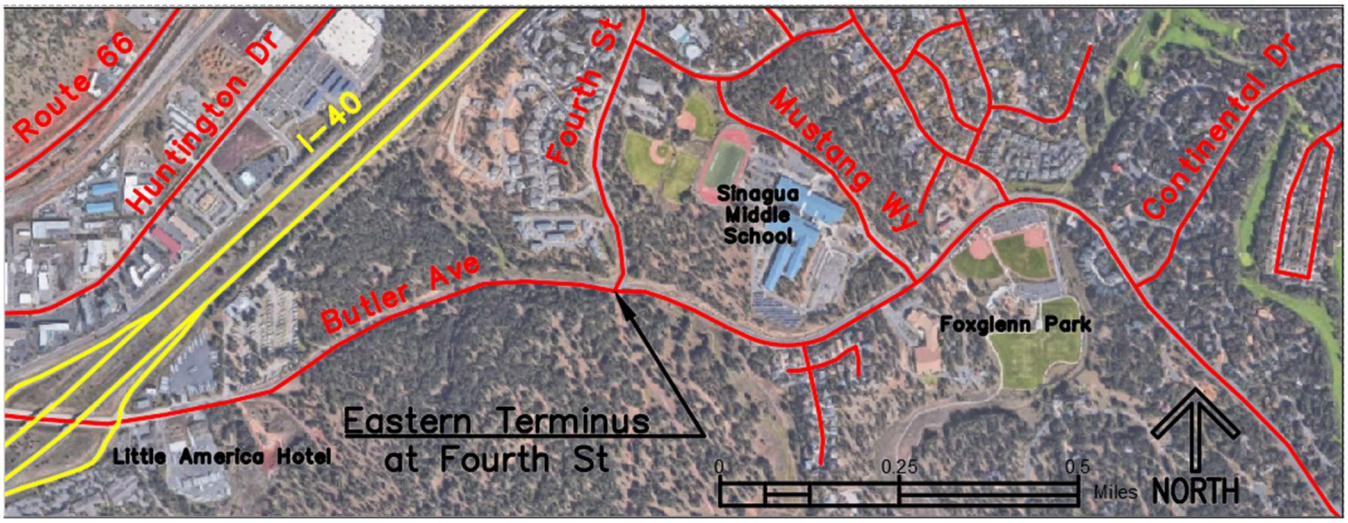

FIGURE 1-2, EASTERN TERMINUS OF PROJECT [5]

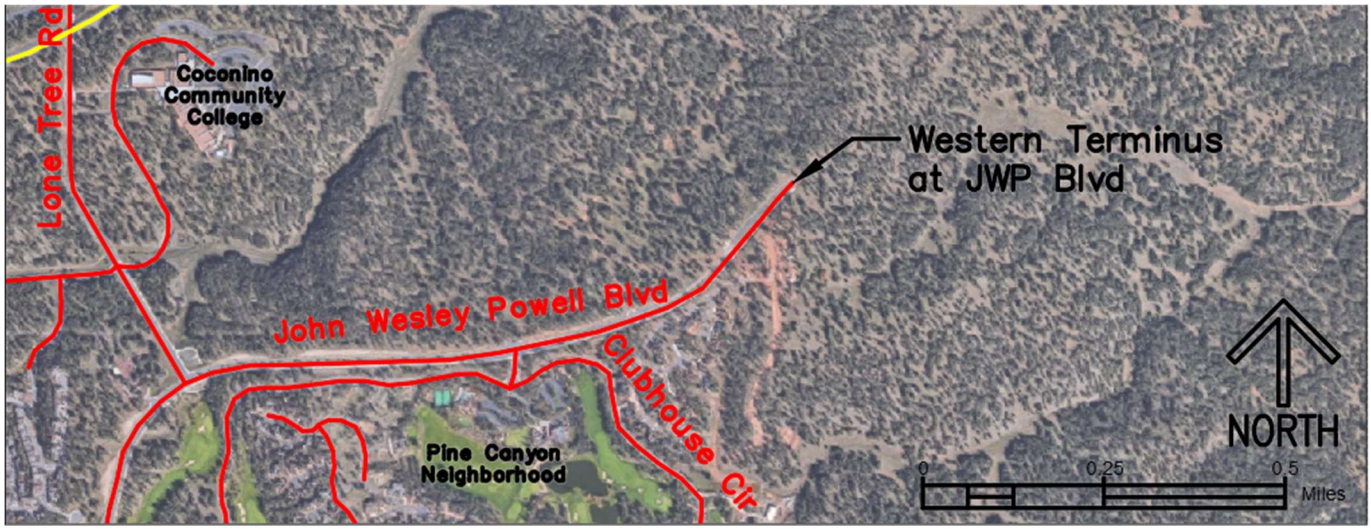

FIGURE 1-3, WESTERN TERMINUS OF PROJECT [5]

The current project area is covered in forested rural land, with minimal development between the termination of JWP Blvd and the Fourth Street intersection. Major land parcel owners in the project area include Juniper Point, Symmetry Companies, Arizona Board of Regents for Northern Arizona University, Little America Hotels & Resorts, and multiple individual owners [6]. The Arizona Trail, a popular recreation trail, crosses the project area. The Rio de Flag also flows through the project area. Harold Ranch Road currently exists as an unpaved road to access homes in the project area. These existing features will all need to be accommodated for in the project design. Figure 1-4 below shows the project area, with major roadways and landmarks shown including the Arizona Trail and Rio de Flag.

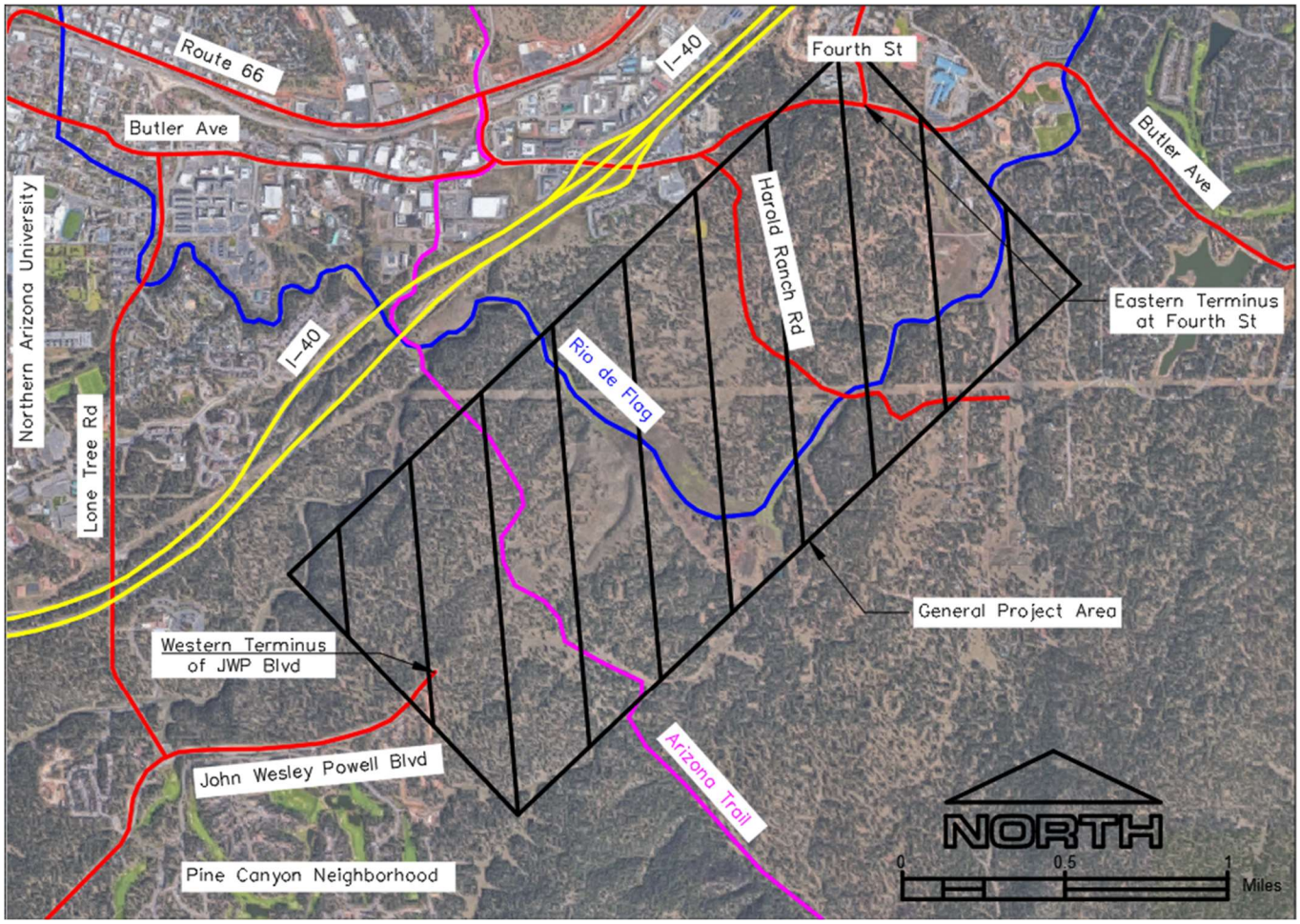

FIGURE 1-4, PROJECT AREA [5]

1.3 Technical Considerations

Some technical considerations for this project will include a site visit along with topographic surveying of the project area. Likewise, GIS mapping and CAD work will be required for utility information and design. Hydrological and hydraulic analyses of the area will be required for pre- and post-drainage design as well as the river crossing design. A detailed traffic analysis will also be required for determining volumes that will affect design. Finally, the project will require following all applicable standards and regulations. These standards include the following.

- City of Flagstaff City Code, Title 13 Engineering Design Standards and Specifications for New Infrastructure [7]
- AASHTO, A Policy on Geometric Design of Highways and Streets (Green Book) [8]
- Manual on Uniform Traffic Control Devices (MUTCD) [9]
- Highway Capacity Manual (HCM) [10]
- Coconino County Drainage Design Manual (CCDDM) [11]

1.4 Potential Challenges

One potential challenge is obtaining sufficient right-of-way for the roadway, bike lane, sidewalks, intersection area, and turn lanes, as well as sufficient area for any future expansion the roadway may need. This challenge is due to the multiple property owners in the area who desire road access to their property, as well as those who may not. The roadway alignment will need to factor in these desires while still efficiently and safely traversing the area. Collecting complete data regarding the landownership in the project area will be an important future consideration for the project.

Another potential challenge is that the construction of a new roadway can interrupt wildlife movement in the project area, which creates dangerous situations for both wildlife and roadway users. This project will consult with the Arizona Game and Fish Department to create a wildlife corridor to allow safe animals movement through the project area. This will need to be done while protecting the safety of both wildlife and roadway users.

1.5 Stakeholders

The City of Flagstaff and Metroplan Flagstaff, the clients for this project, are the primary stakeholders. City of Flagstaff tax revenue will be the main source of project funding. Other stakeholders include the multiple property owners in the project area who will be affected by the future proposed alignment, as well as being involved in future right-of-way considerations. These include Northern Arizona University and Little America Hotels & Resorts, as well as private individuals. Flagstaff residents and visitors are also considered stakeholders and will benefit from and utilize this project for improved travel within and through the city.

2.0 Scope of Services

This section details the major tasks and associated sub-tasks that need to be performed for this project to be completed.

2.1 Task 1.0: Obtain Existing Data

Existing data will be obtained before any assessment or analysis to better understand the existing conditions and to obtain a good understanding of the project from a data perspective.

2.1.1 Task 1.1: Topo/GIS Data

Topographic data for the site will be obtained through City of Flagstaff (COF) and the open GIS data portal [12]. This data will be used to create the base map that will be used to show existing conditions and be the basis for project design.

2.1.2 Task 1.2: Land Ownership Data

Current ownership of land within the project area will be obtained from the Coconino County Parcel Viewer [12] to address right-of-way issues.

2.1.3 Task 1.3: Geotechnical Data

Geotechnical data will be obtained from the USDA Soil Survey website [13] and existing data provided by COF [12]. This data will be used to determine the structural strength of the roadbed soils and to identify required subbase materials.

2.1.4 Task 1.4: Traffic Projections Data

Future traffic projections will be obtained from MetroplanFlagstaff [14] and will be used in the traffic assessment and considered in design. Data will include traffic volumes and vehicle type.

2.2 Task 2.0: Site Visit

A site visit will be conducted. Photos will be taken of important site conditions such as terrain features, steep slopes, eroded areas, signs of wildlife usage, fences, and widths of the Rio de Flag creek bed to better understand the existing conditions. Site details, including any measurements taken, will be documented in a project log book.

2.3 Task 3.0: Preliminary Traffic Assessment

Using data obtained from Task 1.4, a traffic assessment will be conducted to determine future anticipated traffic volumes, peak hour directional trips, and turning volumes to determine required number of lanes and intersections. Traffic simulations will be run using Vissim or Synchro software to determine this data while maintaining an acceptable level of service. A Traffic Impact Analysis (TIA) will be conducted according to the COF and the TIA manual to assess the conditions of the proposed roadway and identify preliminary traffic problems.

2.4 Task 4.0: Hydrologic Analysis

This task consists of the details necessary to perform a hydrologic analysis. A hydrological analysis is necessary to assure that the new roadway is unaffected during extreme precipitation events, and to clearly identify where water crossings must be considered.

2.4.1 Task 4.1: Identification of Watersheds and Determination of Peak Flows

In this subtask, necessary steps will be taken to identify the appropriate watershed(s) and determine peak flows based on the 50-year and 100-year storm events [11] [15].

2.4.1.1 Task 4.1.1: Delineate Watersheds

Watersheds will be delineated using existing topography. Multiple watersheds may be identified for this project.

4.4.1.2 Task 4.1.2: Determine Time of Concentration

The time of concentration will be calculated using methods described in Chapter 3 of the City of Flagstaff Stormwater Management Design Manual (COFSMDM). The time of concentration is the time necessary for runoff to travel from the most hydraulically remote part of the watershed to the point of interest. This will be determined by using equations for sheet flow, shallow concentrated flow, and open channel flow as they apply.

4.4.1.3 Task 4.1.3: Determine Peak Flows

Peak flows will be determined using the Rational Method as described in Chapter 3 of the COFSMDM. The Rational Method can be used if the drainages are discerned to be less than 20 acres. If the identified watershed(s) exceed 20 acres, HEC-HMS will instead be used to determine the peak flows.

2.4.2 Task 4.2: Modeling

Hydrologic modeling will be performed to ensure accuracy of peak flow calculations from Task 4.1. This will likely include HEC-HMS modeling.

2.5 Task 5.0: Roadway Design

This task consists of the details of the roadway design.

2.5.1 Task 5.1: Base Map Development

A base map will be developed using Civil 3D from topographic and GIS data gathered in Task 1.1. This map will show existing conditions and be used as the basis for design.

2.5.2 Task 5.2: Roadway Design

The roadway will be designed using data from Tasks 1.1, 1.2, 1.3, 1.4 and COF standards. Each stage of the design will include the development of plan sets.

2.5.2.1 Task 5.2.1: Determine Alignment

Multiple alignment options will be identified. Civil3D will be used to create preliminary alignments, vertical and horizontal curves, and corridors for each alternative. Preliminary horizontal and vertical curves for each alignment will be designed and analyzed. Bike lane considerations will be included in the design of the roadway cross-section. A decision matrix will be used to select the final road alignment. Once selected, any remaining design elements for the road will be completed.

2.5.2.2 Task 5.2.2: Intersection Design

Two intersections are expected for the project, located at Harold Ranch Road, and Fourth Street/Butler Avenue. The AZ Trail crossing will be considered and designed in this sub-task. Like Task 5.2.1, multiple alternatives for each intersection will be developed and analyzed, using decision matrices for final selection.

2.5.2.3 Task 5.2.3: Sidewalk Design

Pedestrian accessibility will be designed to address COF preferences. Sidewalk and road crossings will be designed with compliance of COF and ADA requirements.

2.5.2.4 Task 5.2.4: Signing and Striping Plan

Signing and striping plans will be produced for the proposed roadway and will address all necessary markings and signs required by the COF.

2.5.2.5 Task 5.2.5: Lighting Plan

A lighting plan will be produced and will address COF requirements.

2.5.3 Task 5.3: Wildlife Mitigation Considerations

Data gathered in previous tasks will be analyzed to determine appropriate solutions for wildlife mitigation techniques to be incorporated in the roadway design.

2.6 Task 6.0: Final Hydrologic and Hydraulic Analyses

This task considers design of required hydraulic structures for the roadway.

2.6.1 Task 6.1: Selection of Hydraulic Structures for Water Crossings

For each structure needed, alternatives will be developed and preliminarily designed. A decision matrix will be used to select the best alternative for each location needed.

2.6.2 Task 6.2: Design of Hydraulic Structures for Water Crossings

Design of the selected hydraulic structures will be completed with COF requirements outlined in the COFSMDM being met for each structure.

2.6.3 Task 6.3: Final Hydrologic and Hydraulic Analyses

Hydrologic models will be adjusted to account for post-design conditions and will be re-run to ensure compliance with COF requirements. Hydraulic models will be developed to check that all design solutions meet COF requirements.

2.7 Task 7.0: Plan Set Development and Cost Estimate

In this task, a plan set will be developed, and a construction cost estimate will be made.

2.7.1 Task 7.1: Plan Set

Using Civil3D, a plan set will be developed showing all aspects of design, including cover sheets, general notes, improvements plans, and typical details.

2.7.2 Task 7.2: Construction Cost Estimate

An Engineer's Opinion of Probable Cost will be provided.

2.8 Task 8.0: Impacts of Project

Social, environmental, and economic impacts will be evaluated and discussed.

2.9 Task 9.0: Deliverables

The deliverables for this project include all necessary documents given to all parties concerned.

2.9.1 Task 9.1: 30% Submittal

The 30% submittal will include Tasks 1-3 and will consist of 30% drawings, a presentation, and a 30% report on February 16, 2024.

2.9.2 Task 9.2: 60% Submittal

The 60% submittal will include Tasks 4-5.1 and will consist of 60% drawings, a presentation, and a 60% report on March 22, 2024.

2.9.3 Task 9.3: 90% Submittal

The 90% submittal will include all technical tasks (Tasks 5.2-6) and will consist of 90% drawings and a 90% report and website on April 19, 2024.

2.9.4 Task 9.4: Final Submittal

The final submittal will consist of the final plan set, a presentation, a website, and a final report. The presentation will be on April 26, 2024 and the final report, plan set, and website will be due on May 7, 2024.

2.10 Task 10.0: Project Management

The project will be managed through the following subtasks.

2.10.1 Task 10.1: Meetings

Meetings will be conducted regularly with the GI, TA's, clients, and the team. Meeting agendas will be provided 24 hours prior to each meeting and meeting minutes will be sent to all attendees within 24 hours after the meeting.

2.10.2 Task 10.2: Schedule Management

The project schedule (Gantt Chart) will be reviewed throughout the project to ensure tasks are completed on time. Submittals will be completed with an internal deadline for the group the Sunday prior to the due date to ensure sufficient time for review.

2.10.3 Task 10.3: Resource Management

The team will track staff time and other expenditures throughout the project to ensure that engineering cost estimates are met or reduced.

2.11: Exclusions

This project will exclude a full geotechnical analysis report and instead use existing geotechnical data and online databases. Natural gas, electric, telecommunications, and fiber line placement designations will be excluded because these lines are typically designed by the utility companies. The design of city water and sewer lines will also not be performed due to time constraints.

3.0 Schedule

The project duration is planned for 77 working days, from January 15, 2024, to May 7, 2024. The entire project schedule in Gantt chart form can be found in Appendix A. The project is expected to happen during the Monday through Friday work week, with no work scheduled for the week of March 11th to account for spring break.

The first major tasks to be completed are Task 1.0 Obtain Existing Data and Task 2.0 Site Visit. Task 1.0 is scheduled to begin on the first day of the project, January 15, 2024. Both tasks will happen simultaneously with Task 1.0 taking 7 days to complete and Task 2.0 taking 3 days, beginning 4 days after the start of Task 1.0. Both tasks will be completed 7 days into the project.

Task 3.0 Preliminary Traffic Assessment, Task 4.0 Hydrological Analysis, and Task 5.0 Roadway design will be started simultaneously on January 24, 2024. Task 3.0 is scheduled to be completed in 10 days, Task 4.0 is scheduled to be completed in 20 days, and Task 5.0 is scheduled to be completed in 40 days. Task 3.0 must be completed before Task 5.2 Roadway Design can be started.

Task 6.0 Post Design Hydrological and Hydraulic Analysis is scheduled for 25 days, starting on February 21, 2024. This task will begin at the same time as Task 5.2.3 Signal/Intersection Design. Once both Tasks

5.0 and 6.0 are completed, Task 7.0 Plan Set Development and Cost Estimate can be started. Task 7.0 is scheduled to be completed in 13 days and will begin on April 3, 2024. This task will be the final design-related task for this project.

Task 8.0 Impacts of Project will begin once Task 2.0 Site Visit is complete. This task will be considered throughout the rest of the project design.

The milestones for this project include the 30% submittal on February 16, 2024, the 60% submittal on March 15, 2024, the 90% submittal on April 19, 2024, the final presentation on April 26, 2024, and the final submittal on May 7, 2024. These milestones will serve as concrete dates for the project status to be evaluated and are crucial to the success of the project.

The critical path is identified by the red tasks on the Gantt chart. The critical path displays the tasks which must be completed on time to keep the entire project on schedule. All the subtasks for Tasks 1.0, 2.0, 3.0, 4.0, and 6.0 are part of the critical path. Tasks 5.0 and 7.0 is not entirely on the critical path because subtasks 5.1 Base Map Development, 5.2 Roadway Design, and 7.2 Construction Cost Estimate will be started and completed within other tasks or are not required to be finished for other later tasks to begin.

4.0 Staffing Plan

This section outlines the required positions, billing rates, and the staffing matrix required for completion of this project.

4.1: Personnel

The project requires the following staff positions: Senior Engineer (SENG), Engineer (ENG) and Engineer-In-Training (EIT). The qualifications required for each position are identified below.

Qualifications for the Senior Engineer are a master's degree in engineering, a Professional Engineer's (PE) license and fifteen (15) years of experience. The Senior Engineer has experience in leadership (leading projects and entire teams), in solving complex engineering problems, mentoring junior engineers, and in project management.

Qualifications for the Engineer are a bachelor's degree in engineering, a PE or EIT license, and three (3) years of experience. The Engineer has experience in problem-solving, innovative thinking, thoroughness with the design, testing, and implementation of solutions, project management principles, communication with client or the public, and technical writing.

Qualifications for the Engineer-in-Training (EIT) are a bachelor's degree in engineering and a solid understanding of foundational knowledge in engineering principles and relevant technologies, and the basic ability to analyze and solve engineering problems.

4.2: Staffing Matrix

Table 4-1 summarizes the total number of personnel hours for each position by task. In total, this project is estimated to take 646 personnel hours to complete.

TABLE 4-1, STAFFING MATRIX

Task	SENG Hours	ENG Hours	EIT Hours
1.0 Obtain Existing Data			
1.1 Topo/GIS Data		5	5
1.2 Land Ownership Data		5	5
1.3 Geotechnical Data		5	5
1.4 Traffic Projections Data		5	5
2.0 Site Visit			20
3.0 Preliminary Traffic Assessment	2	8	25
4.0 Hydrologic Analysis			
4.1 Identification of Watersheds and Determination of Peak Flows			
4.1.1 Delineate Watersheds		5	15
4.1.2 Determine Time of Concentration		5	5
4.1.3 Determine Peak Flows		5	10
4.2 Modeling	2	10	30
5.0 Roadway Design			
5.1 Base Map Development		5	15
5.2 Roadway Design			
5.2.1 Determine Alignment	2	30	40
5.2.2 Intersection Design	2	30	30
5.2.3 Sidewalk Design		10	5
5.2.4 Signing and Striping Plan		10	5
5.2.5 Lighting Plan		10	5
5.3 Wildlife Mitigation Considerations	5	10	10
6.0 Final Hydrologic and Hydraulic Analyses			
6.1 Selection of Hydraulic Structures for Water Crossings		30	5
6.2 Design of Hydraulic Structures for Water Crossings		20	20
6.3 Final Design Hydrologic and Hydraulic Analyses	5	30	15
7.0 Plan Set Development and Cost Estimate			
7.1 Plan Set	10	40	60
7.2 Construction Cost Estimate	5	10	
8.0 Impacts of Project	5	10	5
10.0 Project Management	20	10	5
Subtotal	58	308	345
Total (person-hours)	711		

5.0 Cost of Engineering Services

Table 5-1 below presents the cost of engineering services for the John Wesley Powell Blvd east extension. These items are separated into three categories: personnel, supplies, and subcontracting.

TABLE 5-1, ENGINEERING COST OF SERVICES

Categories	Classification	Hours	Rate, $/hr	Cost, $
1.0 Personnel	SENG	58	228	13,224
	ENG	308	143	44,044
	EIT	345	76	26,220
Total Personnel				83,488
2.0 Supplies	Computer Lab Rental	76 days	$100/day	7,600
3.0 Total				**91,088**

The total project cost is $91,088. Computer lab rental includes the CENE Traffic Lab and the NAU CEIAS Computer Labs that provide software needed for the project (Civil 3D, HEC-HMS, VISSIM/Synchro). During the three-day window given for Task 2.0 Site Visit, only one day will be used to investigate the site and no lab work will be done. This means that the computer lab rental will be 76 days.

6.0 References

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[13] USDA, "Web Soil Survey," USDA, 7 January 2019. [Online]. Available: https://websoilsurvey.nrcs.usda.gov/app/.

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[15] City of Flagstaff Engineering Division Stormwater Management Section, CITY OF FLAGSTAFF STORMWATER MANAGEMENT DESIGN MANUAL, Flagstaff, 2009.

Appendix A: Project Gantt Chart

ID	Task Name
1	**1.0 Obtain Existing Data**
2	1.1 Topo/GIS Data
3	1.2 Land Ownership Data
4	1.3 Geotechnical Data
5	1.4 Traffic Projection Data
6	2.0 Site Visit
7	3.0 Preliminary Traffic Assessment
8	**4.0 Hydrological Analysis**
9	**4.1 Identification of Watersheds and Determination of Peak Flows**
10	4.1.1 Delineate Watersheds
11	4.1.2 Determine Time of Concentration
12	4.1.3 Determine Peak Flows
13	4.2 Modeling
14	**5.0 Roadway Design**
15	5.1 Base Map Development
16	**5.2 Roadway Design**
17	5.2.1 Determine Alignment
18	5.2.2 Intersection Design
19	5.2.3 Sidewalk Design
20	5.2.4 Signing and Striping Plan
21	5.2.5 Lighting Plan
22	5.3 Wildlife Mitigation Considerations
23	**6.0 Final Design Hydrological and Hydraulic Analysis**
24	6.1 Selection of Hydraulic Structures for Water Crossings
25	6.2 Design of Hydraulic Structures for Water Crossings
26	6.3 Final Hydrologic and Hydraulic Analyses
27	**7.0 Plan Set Development and Cost Estimate**
28	7.1 Plan Set
29	7.2 Construction Cost Estimate
30	8.0 Impacts of Project
31	**9.0 Deliverables**
32	9.1 30% Submittal
33	30% Submittal
34	9.2 60% Submittal
35	60% Submittal
36	9.3 90% Submittal
37	90% Submittal
38	9.4 Final Submittal
39	Final Submittal
40	10.0 Project Management