NORTHERN ARIZONA UNIVERSITY

College of Forestry, Engineering, and Natural Sciences

FINAL PROPOSAL

476 CAPSTONE PROJECT:
RYAN'S TRAIL ROAD REDESIGN IN COCONINO COUNTY, FLAGSTAFF, ARIZONA

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1.0 Project Understanding

1.1 Project Purpose

The residents of Lockett Ranches have requested improvements for an existing private road. The Ryan's Trail Capstone team will be evaluating potential design options. The clients would like to enhance many elements of the road including: the ease of snow removal, the suitability for all vehicle types, the durability for regular use, insurance of proper drainage, and the cost effectiveness of road maintenance. The team will be expected to recommend designs that best satisfy all the said requests within the means of the clients. These designs will be dependent upon the team's thorough analysis both in the field and in the office. A renovation may include a change of material and a change in the road structure.

1.2 Project Background

1.2.1 Location

Located in a residential development, Ryan's Trail is a quarter-mile long, 12-foot-wide private road (Figure 1). It is located west of N. Wildcat trail and is east of Hattie Greene Road northeast of Flagstaff, in Coconino County (Figures 2&3).

Figure 1: Ryan's Trail Photo by: McKenzie Moten [1]

Figure 2: Flagstaff, AZ Site Map [2]

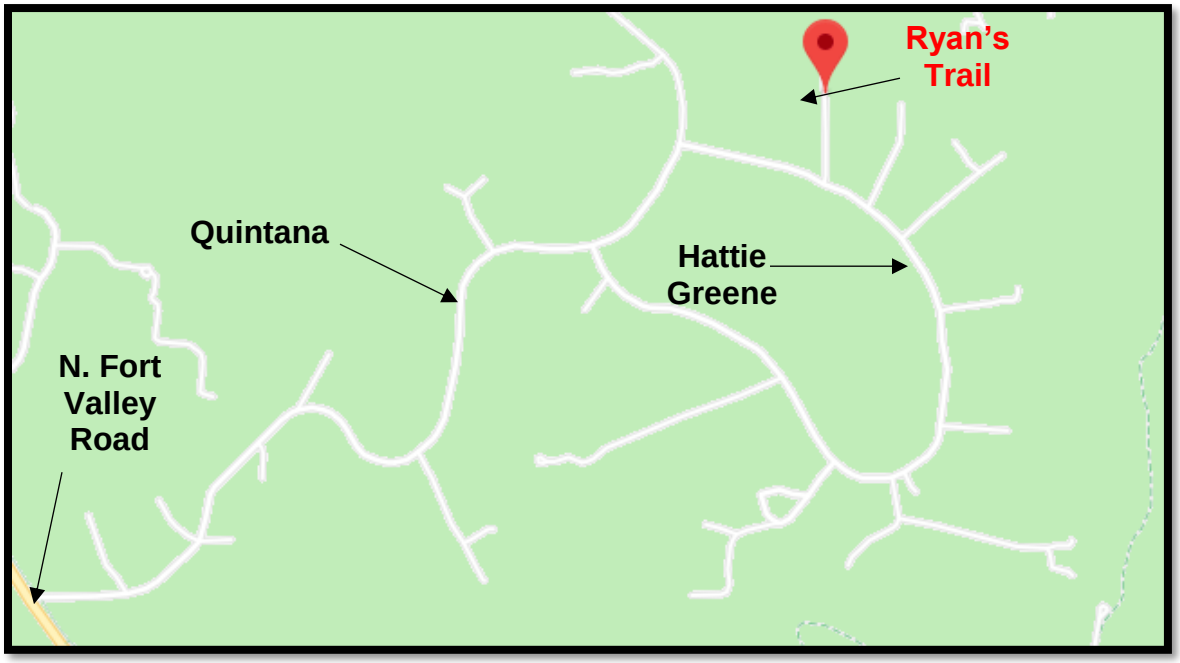

Figure 3: Ryan's Trail, Coconino County, AZ Site Map [2]

1.2.2 Existing Soil Conditions

The team will perform an analysis using "GIS" (Geographic Information Systems) to determine the specific soil classification of Ryan's Trail next semester. The current road is composed of crushed cinders.

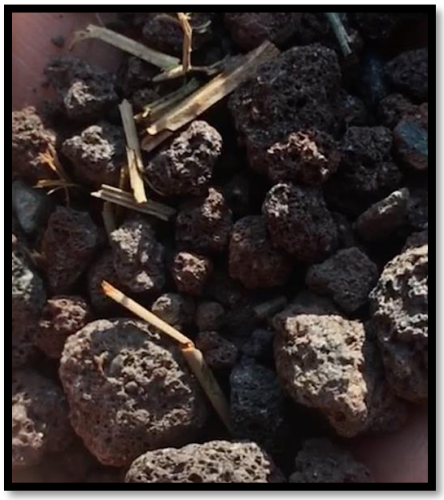

Figure 4: Current Soil Conditions of Ryan's Trail, Photo by: McKenzie Moten [1]

1.2.3 Climate Conditions

Research was conducted about the existing climate conditions of Flagstaff in preparation for next semester, as it will be one of our design constraints. The road could potentially melt or have a high brittleness due to the high and low environmental temperatures native to Flagstaff. The significant precipitation (including snow) can cause erosion which may result in the cracking of the road and other safety concerns. Flagstaff is located at a high altitude and contains forest and desert climates. The average temperature in Flagstaff is -0.5° Celsius or 31.2° Fahrenheit. Annually, the lowest temperature on average is -8° Celsius during winter and the highest is 30° Celsius during the summer. The average precipitation in Flagstaff, AZ can be seen in Figure 6.

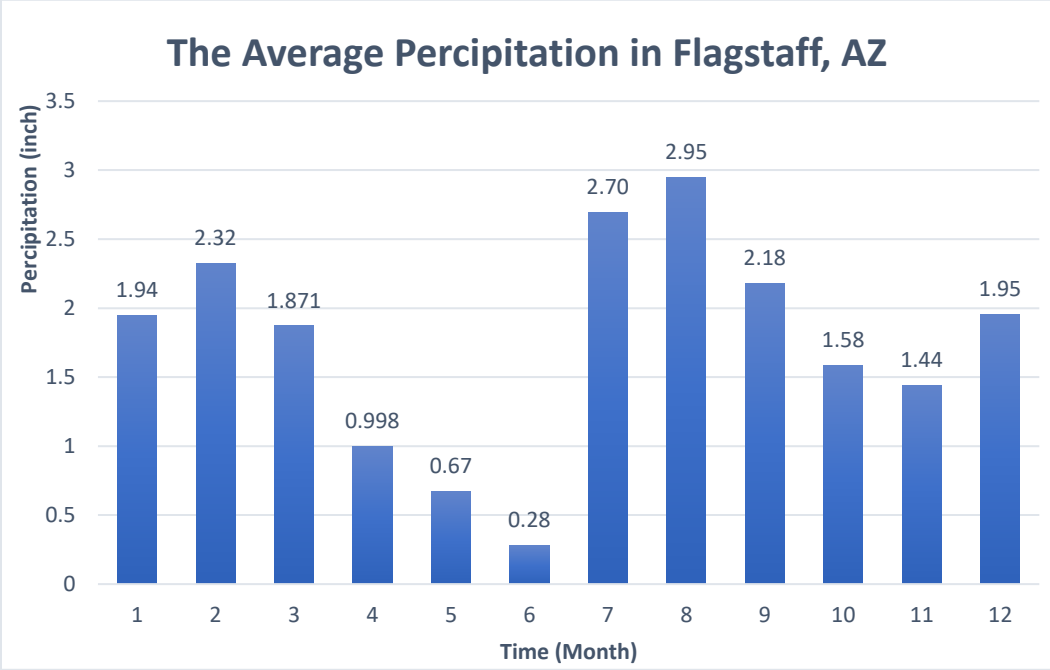

Figure 5: The Average Annual Rainfall [3]

1.2.4 Codes

From background research conducted previously, the following codes will be used as references and guides for the Ryan's Trail improvement [6]. Chapter 4 of the Coconino County Engineering and Construction Criteria Manual illustrates design criteria and chapter 6, which discusses grading and excavation. The government of Arizona revised the codes above to regulate the construction in Arizona.

1.2.5 Existing Utilities

The existing utilities such as the current well system (Figure 6) that are located under Ryan's Trail needed to be identified to prevent damage during the road redesign. Blue Stake was contracted to help prevent incidents such as gas leaks or the leakage of electricity. The Blue Stake information will be available on "Arizona 811" or one can call 811 to request more details.

Figure 6: Existing Conditions- Well System, Photo taken by: McKenzie Moten [1]

1.3 Technical Considerations

1.3.1 Site Investigation

The site investigation will include blue stake and surveying. The points gathered by the Nikon Total Station will be analyzed in AutoCAD and ArcGIS to properly design for snow removal, drainage, and everyday residential use.

Figure 7: Field Surveying [4]

1.3.2 Hydraulic Analysis

A hydrology study will assist in determining the size of the storm water infrastructure. The existing drainage is through culverts (Figure 7) HEC-HMS and the USGS watershed information will be used to define and run a model of the watershed of N. Ryan's Trail. This model will allow the team to understand the amount of drainage and flow involved in the location and ensure that the design will meet minimum requirements. The storm duration requirements for this site will be a 100-year storm, as will a 5-year storm, for better accuracy and range of data as requested by the client.

Figure 8: Existing Culvert, Photo by: McKenzie Moten [1]

1.3.3 Life Cycle Cost Analysis

The life cycle cost analysis is going to compare the installation and maintenance costs of all alternative designs. This will allow the client to choose which design that they find more suitable for their financial and living circumstances. The life cycle cost analysis will include a feasibility report.

1.3.4 Design

After the clients have made their selection about which proposed preliminary design they would like to pursue, the team will create a final design. This will include all finite details about the road including financial aspects and subcontractors.

1.4 Potential Challenges

Overview: The potential challenges to overcome include: the county code limitations, climate concerns, financial constraints, materials, time constraint, and satisfying the different preferences and existing driveway designs of the residents.

1.4.1 County Codes

The team will follow County guidelines. To satisfy all of their requirements the regulations provided by Coconino County, the above specifications will be followed precisely.

1.4.2 Financial Restrictions

The budget has not been set by the clients to date, but there is a financial limit and the team is required to find a high-quality solution that is still affordable. The road's maintenance is to be included as well. To ensure the most inexpensive option is chosen, a life cycle cost and feasibility analysis will be done as mentioned above.

1.4.3 Weather Conditions

The weather cannot be controlled, however, to compensate for its unpredictability, the team will include additional time into the schedule and use materials that are suitable for the potential weather conditions. The team will also survey in the fall semester instead of the anticipated spring.

1.4.4 Resources

The team will mitigate this challenge by having the clients choose their design with a sufficient amount of time for construction and by locating material suppliers in advance.

1.4.5 Time Restriction

The result of a time restriction is the students will be required to develop a design process that can be completed within the given two semesters and be prepared for construction by mid- May.

1.4.6 Client Preference and Budget

There are many individuals that will dictate the final design for the road improvement. All the individuals will have a different preference for the budget and have a different type of driveway that will join the renovated road. The team will keep everyone well informed via a personalized website, emails, and meetings with the Homeowner's Association (HOA). The individuals will have an opportunity to reach out to the team with any questions or concerns throughout the process as well.

1.5 Stakeholders

Dr. Dianne McDonnell serves as the main point of contact for the community. The drainage of the road and construction will affect residents and those adjacent to Ryan's Trail who don't use the road. The HOA is responsible for creating the rules and standards of the community and applying the monthly collected fees to the development to keep it to those standards. Coconino County is responsible for all infrastructure and roads built within the limits.

2.0 Scope of Services

2.1 Site Investigation

2.1.1 Blue Stake

There are a number of existing utilities along Ryan's Trail. These lines have existing boxes and hand holes that will require adjusting to grade if the road elevation is changed. The boxes that need to be adjusted will be called out on the plan set by "Blue Stake" mentioned above.

2.2.2 Equipment

Site investigation includes:

- Total Station
- Data Collector
- Prism Rod
- Tape Measure
- Hammer
- Spikes

2.2.3 Field Surveying

A field survey will be performed using the equipment, outlined in the previous section, to collect the data necessary to create a scaled map of the existing topography. The survey will be limited to the existing roadway of Ryan's Trail. This includes the cross section of the road, utilities within the roadway, and trees that may fall within the bounds of the proposed road.

2.2 Site Map

A topographic map will be created using the data collected from the field survey. This map will be drafted using AutoCAD and Civil3D.

2.3 Conceptual Design

The final road design will be based upon the client's preference in material. The team will recommend alternatives to the client, which will be based upon cost of material, function, maintenance costs, and aesthetic appearance. The existing road alignment will remain unchanged. However, the existing road profile may change based upon chosen material and existing drainage.

2.3.1 Existing Design

The existing design will be analyzed to determine the existing costs of maintenance, function, and appearance.

2.3.2 Road Improvement Alternatives

The team will provide alternative solutions to the existing road. This includes construction cost, time, and subcontracting companies to complete the project.

2.4 Hydrology

Our design will promote proper drainage function by removing potential basins and allowing the water to flow towards drainage structures. If the existing grade does not provide proper drainage function, action will be taken to ensure it will. This includes the potential addition of storm drain infrastructure.

2.4.1 Watershed Analysis

This will be done using a model program that will be determined after the topographic development shows the elevation changes (most likely HEC-HMS). The modeling information will then show where diversions need to be inserted and taken out during construction and where the team can expect the most watershed and drainage.

2.4.2 Culvert Design

There are several existing culverts along Ryan's Trail. They have been placed appropriately for the current road design. However, with improvement/redesign they may need to be relocated or removed. Proposed structures will be called out on the plans.

2.5 Life Cycle Cost Analysis

As seen in the "Technical Considerations," the life cycle cost analysis is a component that is included in the team's scope. This shows the life cycle of the different materials in their entirety for the client to compare.

2.5.1 Feasibility Report

The feasibility report, provided by the team, will include the proposed alternative with detailed information concerning the opportunities that

both options will have. This will contain the cost of maintaining the existing road.

2.5.2 50% Report

The 50% Report will include the complete analysis of the two material options and will be presented with a foundation to elaborate on once a solution is selected. After this report, the significant details provided to the client in the feasibility report should remain the same.

2.6 Final Design

2.6.1 Final Report

The final report will state the selected design and what will be completed.

2.6.2 Presentation

The presentation will summarize the report and allow the stakeholders to ask questions.

2.7 Project Management

2.7.1 Meetings and Consultations

The students are responsible for hosting meetings with the technical advisor, the clients, and their grading instructors. They will also host meetings with the original and potential contractors.

2.7.2 Website

The students will create a website to document their progress and allow communication.

2.7.3 Deliverables

The formal deliverables required of the team are:

- Feasibility Study
- 50% Report
- Final Report
- Final Presentation
- Website

2.8 Project Limitations

2.8.1 Project Challenges

The potential challenges to overcome, as stated in section 1.4, are the county code limitations, climate concerns, financial constraints, materials, time constraint, and satisfying the different preferences of budgets and existing driveway designs of the residents.

2.8.2 Project Exclusions

There are no project exclusions.

3.0 Schedule

3.1 Duration

The project is split into five different phases and will last about four months. We will begin the project in January and end with the final design in May.

3.2 Major Tasks

The major tasks include a site investigation, conceptual designs, hydrology, life cycle cost analysis, and a final design. The site investigation and hydrology analysis will take 75 days. After the topographic map is complete, conceptual designs will be prepared after an additional 75 days. With the conceptual designs complete, a life cycle cost analysis will be performed and will take 12 days. This will lead us to our final design that will take 25 days to complete.

3.3 Deliverables

The deliverables for this project include a topographic survey, three conceptual designs, a watershed analysis, a feasibility report, a 50% submittal, a final design, and final report.

3.4 Critical path

The critical path begins with the site visit and then to the proposed designs and hydrology. From there, it moves to the life cycle cost analysis, and finally, the complete design. This path will potentially take the most time to complete. Attached is a Gantt Chart with the critical path identified.

4.0 Project Staffing

4.1 Staff

- Project Manager (PM)
- Design Engineer (DE)
- Drafter (CAD)
- Two-Man Survey Crew (SC)
- Tech (T)

4.2 Qualifications

The following list is the qualifications of our design team:

Hydraulic Engineering
Hydrology
Traffic Analysis
Engineering Economics
Surveying
Our team has attained competence in the above areas through the Northern Arizona University Engineering program.

4.3 Budget

A table of the staffing hours and their corresponding pay can be found in the Appendices (Table 1)

4.4 Justification

The Project Manager is in charge of each aspect of the project, including meetings and correspondence with the client and stakeholders. It is the job of the Project Manager to keep everyone on task and on schedule. The Project Manager will also review all deliverables for completeness and correctness.

The Design Engineer is responsible for most of the design work. They Design will perform the brunt of the calculations and analysis. It is the job of the Design Engineer to work with the Drafter to prepare plan sets.

The Drafter will prepare all plan sets created by the Design Engineer. They will also prepare the topographic map from the provided Survey Crew.

The Survey Crew will perform a topographic survey of site.
The Tech is responsible for preparing the website for the project.

5.0 Cost of Engineering Services

A table of the cost of Engineering Services can be found in the Appendices (Table 2). The total cost for the project is projected to be around $55,000.00. The cost may be higher than what the project will cost, in efforts to prevent going over budget.

6.0 References

[1] M. Moten, Artist, *Ryan's Trail.* [Art]. 2017.

[2] Google LLC, "Google Maps," Google LLC, 2017. [Online]. Available: https://www.google.com/maps. [Accessed November 2017].

[3]2017. [Online]. Available: https://www.harvestingrainwater.com/wp-content/uploads/2009/10/One-Page-Place-Assessment-Flagstaff-AZ.pdf. [Accessed: 14- Sep- 2017].

[4] G. Aleck, "Land Surveying Business for Sale / Surveyor - Indiana", *Calder Capital, LLC*, 2017. [Online]. Available: https://www.caldergr.com/land-surveying-business-for-sale/. [Accessed: 01- Dec- 2017].

7.0 Appendices

Table 1: Staffing

	Staffing (hours)					
	Project Manager (60%)	Design Engineer (55%)	Drafter (40%)	Survey Crew (60%)	Tech (50%)	Total for Services
Rates (per hour)	$ 55.00	$ 45.00	$ 35.00	$ 60.00	$ 20.00	215
Task						
Site Investigation	24	15	8	25	0	**72**
Site Map	0	0	10	10	0	**20**
Conceptual Design	30	60	30	0	0	**120**
Hydrology	18	25	5	0	20	**68**
Life Cycle Cost Analysis	45	50	0	0	0	**95**
Final Design	20	40	10	0	10	**80**
Project Management	35	20	0	0	45	**100**

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Table 2: Cost of Engineering Services

	Cost of Engineering Services					
	Project Manager (60%)	Design Engineer (55%)	Drafter (40%)	Survey Crew (60%)	Tech (50%)	Total for Services
Rates (per hour)	$ 55.00	$ 45.00	$ 35.00	$ 60.00	$ 20.00	215
Task						
Site Investigation	24	15	8	25	0	**72**
Site Map	0	0	10	10	0	**20**
Conceptual Design	30	60	30	0	0	**120**
Hydrology	18	25	5	0	20	**68**
Life Cycle Cost Analysis	45	50	0	0	0	**95**
Final Design	20	40	10	0	10	**80**
Project Management	35	20	0	0	45	**100**
Subtotal (hours)	172	210	63	35	75	**555**
Subtotal Pay ($$)	$9460.00	$9450.00	$2205.00	$2100.00	$ 1500.00	**$24715.00**
Benefits (% Compensation)	$5676.00	$5197.50	$882.00	$1260.00	$750.00	**$13765.50**
Profit Margin ($$)	$1395.35	$1104.65	$1543.50	$1470.00	$581.40	**$6094.9**
Overhead ($$)	2790	2209	3086	2940	1163	**$12,188**

Total	**19322**	**17962**	**7717**	**7770**	**3994**	**56,765**

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Proposal Grading Rubric:

Item	**Below Average** **Pts < 75**	**Average** **Pts = 75-89**	**Above Average** **Pts = 90-100**
Appearance, grammar, technical writing style (10%)	Required sections missing; Poor formatting or appearance; Hard to follow, wordy, obvious multiple authors; Grammatical errors;	All required elements present but some errors in: • appearance • organization • readability • grammar errors	All required elements present; High quality appearance; Organized, easy read; Few or no grammatical errors
Technical Content – understanding (30%)	Any 1 of: • Continued misunderstanding of project; • obvious disconnect with client; • no maps; • lack of incorporation of previous comments	Sufficiently indicates good communication with client and understanding of project; sufficient maps; most comments incorporated.	Clear understanding and communication w/ client; Excellent graphics/maps; Well defined exclusions; All comments incorporated in revision.
Technical Content – scope (30%)	Tasks disorganized or missing; insufficient technical understanding; minor or missing discussion of direct impacts of project	Comprehensive but could be better organized; demonstrates general knowledge of technical work needed; some indication of direct impacts of project	Comprehensive; Logical organization of tasks; Demonstrates knowledge of technical work needed; Demonstrated full understanding of direct impacts of project
Technical Content – schedule (15%)	Any 1 of: Schedule overly simplified, hard to follow, not explained well; lack of critical path	Sufficient but could be better detailed; overly simplified critical path	Easy to follow chart with clear explanatory narrative; clear critical path
Technical Content – cost proposal (15%)	Any 1 of: Table hard to follow, details missing, insufficient explanation, obvious errors	Sufficient but could be better detailed	Easy to follow table; complete breakdown on large numbers; clear explanatory narrative