

Background Research for North Ryan's Trail, Flagstaff, Arizona

Yufei Cheng
McKenzie Moten
Parker Schrandt
Trevor Snipes

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Dianne McDonnell, PhD, PE, Assistant Professor
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1.0 Description of Technical Aspects

The purpose of this project is to redesign and improve the function of Ryan's Trail Road in Flagstaff, Arizona. The existing site lies on Lockett Ranches within Coconino County. The road is currently composed of cinders and is approximately 1,230 feet (ft.) long and 12 feet wide. The subjects of analysis required to design an effective and sustainable road are: surveying, watershed analysis, material sciences, existing utilities, economics, and regulations. Said technical aspects are listed below, accommodated by their descriptions.

Surveying (2.0): Surveying consists of gathering records of the existing boundaries and lot lines, performing a topographic survey, and creating a computer-drafted topographic map.

Watershed Analysis (3.0): A watershed analysis is a study of the existing watershed which helps determine drainage solutions.

Material Sciences (4.0): Material science is the study of various potential materials used for roads.

Existing Utilities (5.0): Before construction, it is important to know the existing site conditions such as the location of underground utility lines, in order to avoid conflicts.

Economics (6.0): The economics of the project are the costs of all materials and resources used. This aspect will include creating only practical and feasible designs that do not exceed the financial means of the client.

Regulations (7.0): Regulations are standards set in place by the governing body that help guide the engineer and keep projects consistent.

2.0 Surveying

2.1. Equipment

To gather accurate topographic information, the team will administer a generic topographic survey using a total station. A total station will provide existing elevations and locations of above ground utilities, which will help in designing a new roadway. To obtain the desired results, the team will use efficient and suitable procedures for university students [1].

2.2 Records

While the team will conduct surveying, it is advantageous to look at the existing boundary on the site. This reveals areas of concern and allows the team to see what has

changed. The data provided from the Coconino County Records shows various tract, parcels, and record of surveys [2]. This data gives the legal boundaries of the site and surrounding area. It will allow the team to provide the legal boundaries in our topographic map and approximate benchmark points. It will also provide existing alignments to use when developing a topographic survey.

3.0 Watershed Analysis

3.1 Drainage

The analysis of drainage is necessary because if the team does not redirect the water appropriately it can cause significant damage to the residents and local environment. The Coconino County Drainage Design Manual is what will help guide the design of the drainage infrastructure. It contains information about “Storm water management policies, recommended design procedures, and design criteria are presented herein for conducting hydrologic and hydraulic studies, design, and evaluations” [3]. Its intended use is to provide criteria for design and analysis of drainage structures in Coconino County. This applies to both public and private development.

3.2 Storm Water Pollution Prevention Plan

A storm water pollution prevention plan (SWPPP) maybe required for both the benefit of the engineer and legally by the state or county. The SWPPP is usually presented in the form of placing berms in necessary locations if called for. An analysis of the floodplain can show where these would be located. However, the team is unsure if they are submitting through the County, and will determine if a SWPPP will be used later. The Coconino County floodplain can be seen in Figure 1 below.

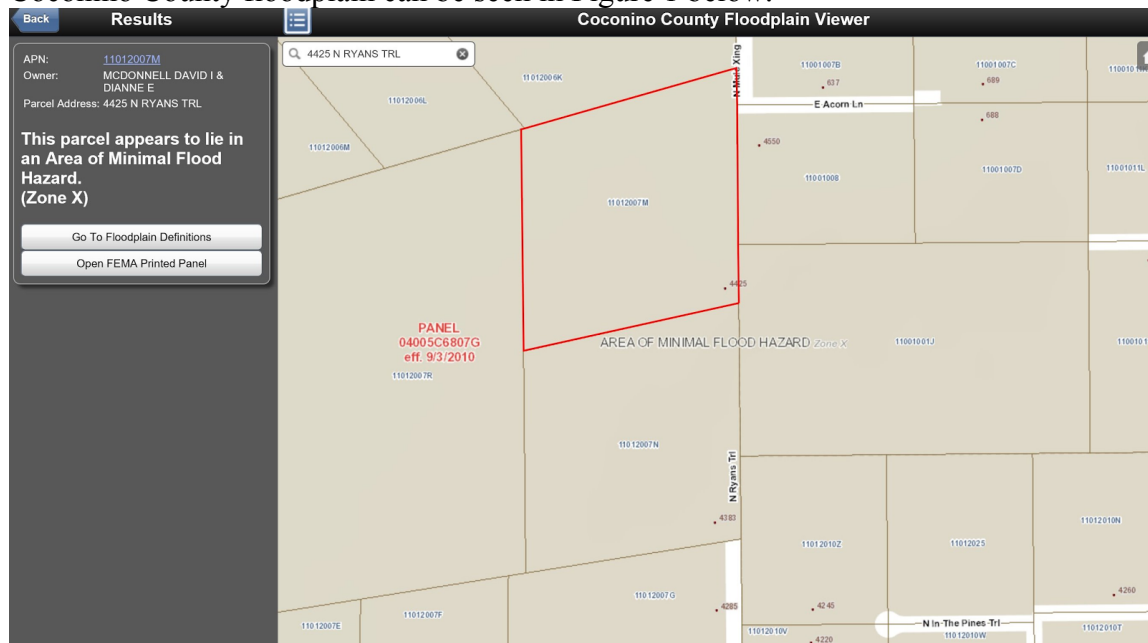


Figure 1: Flood Plane Zones in Coconino County [4]

This map illustrates that the site does not lie in a floodplain. It is in Zone X, which is an area of minimal flood hazard [4].

4.0 Material Sciences

4.1 Asphalt

Asphalt is a commonly used material for roads and there are various types. Rubberized asphalt is a road paving material that is made by mixing ground-up recycled tires, asphalt, and conventional aggregate materials [5]. This material is made in order to compensate for some of the typical disadvantages of concrete and asphalt. It is used to pave roads and replace traditional road paving materials. It has many benefits such as, low costs, a long durability, is environmentally conservative, and promotes vehicle safety.

SBS (styrene-butadiene-styrene) modified asphalt is a new material that is used to replace the traditional Asphalt in many fields. SBS modified asphalt is a modified form of asphalt to improve its quality and performances. For example, SBS can be used in heat welding when it is impractical to use hot asphalt. Also, it can be used as a cold adhesive to reduce the odor [6]. This material is easy to maintain, and it is ideal for different projects due to its self-adhesive. It works as an ideal option to extend the usage of asphalt materials.

Some of the constraints and criteria of Asphalt are that it costs less for maintenance, it has a high tolerance to cracking and rutting, it reduces noise from the road, it is safe to use, and it costs less initially [6].

4.2 Concrete

Advantages of concrete roads lay in its long durability, low equipment and fuel costs, resistance to automobile fuel spillage and extreme weather, fewer pollutants to the environment, and limited consumption of natural resources [7]. However, concrete is expensive and typically requires a strict maintenance routine. In rainy and snowy conditions, vehicles have higher risks of losing traction on concrete roads [7].

4.3 Permeable Materials

As requested by the client, permeable materials were to be researched as Flagstaff receives much rain and snow annually. The Museum of Northern Arizona has an existing permeable parking lot that the team observed. It is an expensive solution typically used for a smaller area than the given 0.23 mile road [8]. The balance of different aggregates and sealing process is extensive. The biggest advantage to this material is its ability to retain water, however, it is prone to clogs or malfunctions.

4.4 Recycled Materials

The client takes a particular interest in sustainable applications. As mentioned above in Section *4.1 Asphalt*, recycled materials are common in asphalt, but also in concrete. This can be an inexpensive option depending on the source of the recycled material. The

challenges with recycled concrete are the inability to know the specific composition of the given concrete, and the uncertainty of how the different recycled pieces will harden and compact together. Based on the provided research, if this method is used, it has been proven that a mix of fine and course recycled aggregate is the strongest solution [9].

4.5 Materials in Flagstaff Climate

The soil type and weather will have an effect on the material used. Generally, the performance of the road, the durability, the strength, and the workability of the road depend on the soil type of the current location. The best environment for the road construction is one with low chloride, low sulfate, is pH neutral and has low potential for erosion [10]. The soils in Flagstaff originate from volcanic ash with a well-drained property. The pH of the soil has a strong alkaline content, which means the road construction should neutralize the soil. The clay content is between 20 to 35 percent; sand content is between 40 to 95 percent according to the data from the USDA [11]. This means that the soil is unconsolidated, and may crack during road construction [12].

5.0 Existing Utilities

5.1 As Builts

Because the road will be built around existing homes, it is crucial that the team is aware of the surroundings. This includes both wet and dry utilities. Two days prior to surveying, Arizona's 811, formerly Blue Stake, will provide mark-out of the existing utilities [13]. This will aid the team in providing a more complete survey and will help avoid conflicts during excavation.

6.0 Economics

6.1 Construction Costs

The company that the team will be using as a source of expertise and price estimates will be EarthPro [14]. EarthPro is an excavation company that performed all of the groundwork on the client's newly built house, and therefore has pre-existing knowledge of the site. They have done ample amount of work in Flagstaff, Arizona, and can also contribute advice on the best methods for road redesign in this element.

7.0 Regulations

7.1 Codes

Ryan's Trail is located in a private residential community. The Building Permit Procedures and Minimum Plan Requirements for Residential Projects is a source, which provides the series of codes that the Coconino County must abide by for residential projects. The list of codes referenced in this source include: 2012 International Residential Code, 2012 International Building Code, 2012 International Mechanical Code, 2012 International Fuel Gas Code, 2012 International Plumbing Code, 2012 International Energy Conservation Code, 2012 International Existing Building Code and

2011 National Electrical Code (Coconino County Building Ordinance 2014-07) [15]. The information contained in these series of codes lay out the proposal instructions regarding foundation, floor plan, electrical plan, time limitations between permitting, as well as the procedures to follow to receive the proper permitting for the type of project.

When performing construction it is necessary to consider the challenges of safety. Fortunately many systems have been put into place to minimize the possibility of infrastructure failure. The team allotted the largest portion of research to regulations in efforts to prevent potential hazards to the client. The information contained in “Building and Safety in Coconino County” include the process for receiving the proper building permits [16]. The permits are varied for each type of residential, commercial or governmental project. The Building and Safety procedures allow for contractors and engineers to apply for building permits, based on their understanding and scope of their project. The importance of properly permitting a job will ensure the consistent review and inspection of the adopted codes and safety procedures. This information will be beneficial for the Ryan’s Trail Capstone Project because it is a set of guidelines and rules that we must follow to ensure public safety and proper community notices. This source will also provide us with contacts for any issues that may arise on the project site or during the designing process.

7.2 Standards

The City of Flagstaff Code, is a recently edited government document, posted on the Flagstaff Engineering Services website. The sections listed in the citation will cover the engineering design standards for construction plans, storm water management, water, sewer and other underground utilities, streets, and erosion control [17]. These standards were adopted by the city of Flagstaff for the general regulation guidelines for construction within the city. This source will act as a reference for our team to better understand the guidelines of constructing a road.

The Coconino County Engineering and Construction Criteria Manual is going serve as the main reference for the engineering standards set by Coconino County. This criteria manual presents the types of projects by the division of county, state, federal or utility company, and then goes into further detail about said project [18]. This criteria manual contains information about formatting proposals, proper and satisfactory planning and designing, surveying qualifications, time limitations, design criteria, and approval. This manual will be the team's main set of guidelines to follow with the mapping, design, and construction of the road project. The manual covers all of the steps required to properly prepare and execute an engineering construction project under the regulations of Coconino County Arizona.

Coconino County Engineering Details (2017) is a document that will act as a reference for our design team during our geotechnical and watershed analysis (section 3.0). The document consists of a series of publications of designs used for trenching and

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backfilling newly paved roads, as well as trenching and backfilling unpaved easements or streets [19]. This source provides design details, cross-sections, and notes for the Coconino County utilities, both new and existing. This document addresses different options for design and redesign of these potential issues. Using the pages listed, our team has access to design details for trenching, easements, sewers, electrical, drainage, and pavement options. [19]

The information listed here will be used to guide the design process for the improvement of N. Ryan's Trail.

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