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Project Understanding for San Simon Basin Dam Evaluation

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Table of Contents

List of Tables
N/A

List of Figures

Abbreviations

- ANSI - American National Standards Institute
- ANS - American Nuclear Society
- DBA - Dam Breach Analysis
- HEC-RAS - Hydrologic Engineering Center's River Analysis System
- ISC - Industrial Source Complex Model
- BLM - Bureau of Land Management
- GIS - Geographic Information System

1.1 Project Purpose

The San Simon Basin in southeast Arizona near the city of Safford is requesting a dam-breach evaluation for a failure analysis. In this project, the main challenges include economic evaluation, community flood safety impact, and a dam system breach failure evaluation. The team will need to consider the main function of the original dam structures, the water flow rates of the basin, and the downstream affected municipalities. If the dam fails, the reduced functionality of the system will negatively affect the local communities including ecology, the safety of biologic organisms, the property of residents, and the impact on local agricultural cultivation.

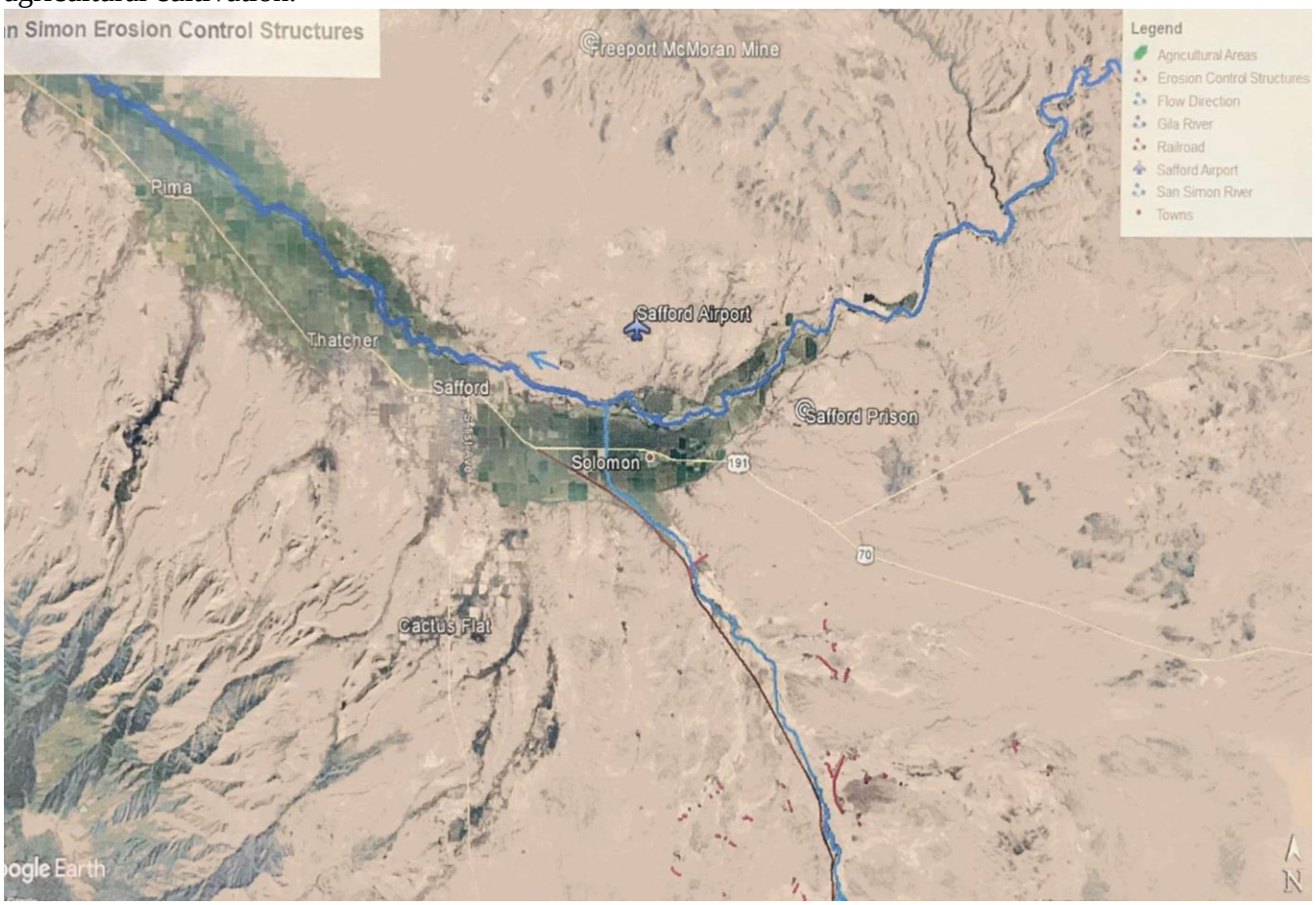

Figure 1: San Simon Erosion Control Structures[1]

1.2 Project Background:

1.2.1 Description of Technical Aspects:

The San Simon Basin dam system is currently categorized as low-hazard dam system. A low-hazard dam is a system that does not cause casualties, serious economic losses, and major environmental impact to the surrounding area. The decision to remove a dam is complex, requiring owners and regulators to weigh a dam's current value in accomplishing its original purpose. The design purpose includes flood control, agriculture, recreation, and power generation. Other passive benefits include the dam's ongoing effects on public safety, water quality, fish, and cultural values[2].

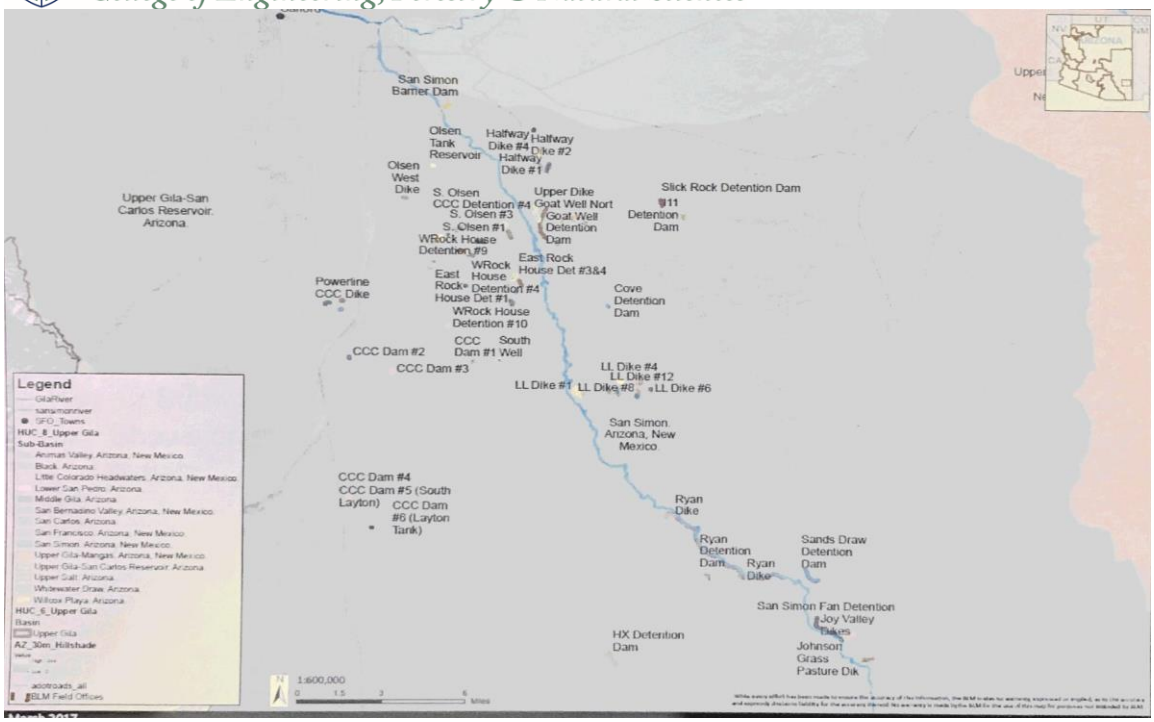

Figure 2: Structure Locations [3]

1.2.2 Civil and Environmental Technical Aspects:

a. Hydrological Observations:

The dams have changed the river hydrological function by raising the water level and slowing down the flow. Loss of the dams directly affects the runoff regulation, land-use changes, and the hydrologic models corresponding to the rivers. This could result in a downstream water flow increase by changing the seasonal hydrologic data and allowing for more sources of water input. Destruction of the dam systems will also eliminate the detaining function of the system, resulting in faster velocities, more dramatic flow regime fluctuations and more destructive supercritical flows.

b. Pollution Evaluation:

If the dam is removed, air pollution may be created by the demolition process. The main pollutant is dust during the dam removal process which can cause respiratory problems in humans. Prior to applying a correction to existing emissions inventories, additional field studies are required. In view of the good agreement between the ISC and data collected in the desert, daytime conditions but the poor agreement between the ISC and measurements under stable conditions with large roughness heights, some selected field studies that span a range of land cover and atmospheric stabilities are recommended[4].

c. Ecological Investigation:

Dam removal can affect the river's ecosystem and biodiversity in both the short-term and long-term. The main short-term effect is increased erosion of surrounding channels due to supercritical flow regimes running through the dirt lined channels. This will change the immediate habitat for the organisms of the ecosystem. The long-term removal of the dams may increase the populations and diversity of aquatic

insects, fish and other organisms. Perennial wetlands around the detention basins may be lost, but new wetlands and waterfront ecosystems are likely to develop along the river banks.

1.2.3 Humanity Impact Assessment:

Based on the team meeting with BLM, the dams are considered a low-hazard system. This means that failure is unlikely to result in loss of life and result in minor increases to existing flood levels at roads and buildings [5]. However, this assessment was performed before Stafford became a population center. This presents a risk for human life around the wash basin area, so community outreach is necessary. A site visit is necessary so that the impacts to the surrounding environment and populations can properly be determined.

1.2.4 Dam Breach Analysis:

A Dam Breach Analysis or DBA is used to assess the consequences of a dam failure. It can be used to evaluate the the areas that will be flooded and determine the height of the flooding for an expected storm event. Evaluated events are for both storm based failures, as well as "sunny day failures" which assume the dam failed on an average flow [6]. Using software such as HEC-GeoRAS, HEC-RAS, and ArcGIS, the DBA can be completed [7]. In order to effectively perform the analysis the elevation and volume of the current reservoir as well as the Manning's coefficient of the flow must be determined. Generally, a 50-year storm or a perceivable max precipitation is used to evaluate the breach[6]. Using these softwares it is effective to perform event based analysis. This analysis will result in maximum water surface elevation, channel velocity, and a floodplain inundation map[8].

1.3 Technical Considerations:

In this project, we need to apply to environmental assessment, GIS, and GPS. We need to measure the water flow of the river, the reservoir capacity, and the downstream ecological environment analysis.

1.3.1 GIS Map:

The latest topographic map of the whole area is the most important reference for evaluation and a GIS map can be used for this reference. GIS can be used to determine the spatial analysis of geographic dimensions, geographic length, area, and volumes of structures and land needed in the analysis portion of the lab.

1.3.2 Hydraulic Engineering:

It is necessary to measure channel slope, channel material, channel shape, and involved hydraulic structures. The team needs to measure the dam's detention capacity and use it to determine potential flood related damages. Only using the GIS map and the hydraulic engineering knowledge can simulate and evaluate the water flow result after removing the dam system.

1.3.3 Ecological Environment:

Ecology involves the study of biological interactions, other organisms, and their non-biological components. Demolition of the dam may overwhelm the original animal habitat resulting species extinction [9]. The overload of undetained water may cause an increase in water pollution due to increased sediment pickup as the water flows down the now open channels.

1.4 Potential Challenges:

If the design basin is to take a failure approach, there are three issues to be particularly concerned about the study and research. First, would be extended operations of the current dam structures which could lead into geologic problems. Second, it is necessary to consider the ecological environment that has been established around the reservoir which will change due to the removal of the basin. It is necessary to establish a new balance in a fairly long period of time, thus the impact on the ecological environment surrounding the channel and the impact of the upstream and downstream socio-economic development of the basin. The construction of detention dams is for the benefit of slowing down storm flows and abandoning the structures can leave it unsafe. Loss of proper function of the system could also result in the system slowly pollution the surrounding area due to negligence. In the following list, a risk analysis of dam removal will be provided. (Note: the report only provides analysis of the content, does not provide a solution)

1.4.1 Geological Disasters:

Earthquakes may be caused by changes in the river and dam systems (Refer to the ANSI standard N170-1976, replaced by the ANSI / ANS 2.8, "Determining the basis of the design of the power reactor site flood", July 28, 1992)[10]. After the dam is removed, floods in the flood season may affect the downstream towns, such as Safford, endangering the safety of the residents. After the decline of water level in the detention area, the original detention area was submerged. A large amount of land released, the formation of large tracts of desolate wetlands, if not treated and used, will produce landslides, debris flow and other natural disasters.

1.4.2 Ecological Environment Impact:

Dam removal will change the upstream and downstream aquatic ecosystems. This effect varies with time and space. After the demolition of the dam, the water environment will face the dynamic state of the reservoir from the static state of the reservoir to the river, which is opposite to the static water state of the river when the river water environment is changed from the dynamic state of the river to the dam. "Reverse ecological environment". The reverse ecological environment problems faced by the project will bring great influence to the ecological environment of the reservoir area and downstream. Dam removal will damage the just-formed reservoir ecological environment balance, a variety of fish habits will be broken, facing the problem of adapting to the new environment. The treatment of sediment deposition in the reservoir area and the series of ecological and environmental problems caused by the sediment discharge to the downstream flora and fauna and the production and life; the effect of dam removal on the

ecological environment near the dam site and how to restore the construction problem[11].

1.4.3 Pollution:

The main causes of water pollution in the reservoir area are as follows: pollution of the construction itself; flooding of various pollution sources; water heterogeneous layer effect; changes in hydrogeological conditions and human factors. During the construction period, a large amount of engineering and living waste is generated, resulting in an increase in the degree of pollution of the river water body in the demolition project. Even after the completion of the project within a few years after the rain will still wash the scene of a large number of pollutants into the river body. After the demolition of the reservoir will cause the lower reaches of the groundwater level, pressure, temperature changes. The dissolved power of the groundwater eruption will increase, the number of subsurface increases, especially in the rainy season. Will increase the suspended solids and dissolved solids in the water. In addition, the analysis needs to take into account the bulk of the dam after the demolition of a large number of dam material and the disposal of harmful substances[11].

1.5 Stakeholders

The stakeholders involved in the San Simon Basin dam breach analysis are the Bureau of Land Management, the local town community, Northern Arizona University, and the student engineers involved in the project. The local community involves the flood basin affected farmers, the residents of Safford, Arizona, and the motorists of the local highways and roadways. Northern Arizona University is helping to fund this project for the student engineers involved, so liability to complete the project as the Bureau of Land Management's request will affect both Northern Arizona University and the student engineers involved.

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