Arkansas River Corridor Projects Control Scheme Considerations

TO: Tulsa County

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FROM: CH2M HILL

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Introduction

Tulsa County, as part of the Arkansas River Corridor Master Plan (Carter & Burgess, 2004; C. H. Guernsey and Company, 2005), is undertaking an improvement project on the Arkansas River. The primary goals of the overall project are to improve least tern habitat, improve fish habitat and fish passage, improve the function of the river system itself, enhance economic development, increase recreational opportunities, and increase connectivity between the river and surrounding communities. The conceptual project components are described in detail in the Technical Memorandum (TM) entitled Baseline Project Summary for the Arkansas River Corridor Project (CH2M HILL, 2009). Key components include:

- Design of habitat improvements along the corridor
- Design of bank stabilization in select areas
- Design of a new Sand Springs low-head dam, pedestrian bridge, and amenities
- Design of modifications to Zink Dam and lake with whitewater features
- Design of a new South Tulsa/Jenks low-head dam, pedestrian bridge, and amenities

To meet the goals and objectives identified in the Vision Plan created for the Arkansas River Corridor Projects and to provide a safe recreational experience for the public, the dam and river system must be monitored and controlled in a manner that links each of the dams, provides key information to the system operators, and provides this information in a timely manner, such that an appropriate response, if needed, can be executed.

The purpose of this TM is to present a recommended framework for controlling flow between the series of dams, as well as controlling flow through individual dams and the associated appurtenances.

Background

According to the River Parks Authority (RPA) website, the RPA is a public trust created in 1974 to develop and maintain public park areas along the Arkansas River in Tulsa County. The RPA's mission is "to maintain, preserve and develop the Arkansas River and/or land areas adjacent to the river within Tulsa County for the economic and cultural benefit of the community and to promote public use of all park lands and facilities under the Authority's jurisdiction" (RPA, 2009). In view of this mission and the RPA's record of success over the decades, the RPA is the logical choice to operate the proposed dam system.

Currently, there are two operational dams in the vicinity: Keystone Dam and Zink Dam. Keystone Dam is owned and operated by the U.S. Army Corps of Engineers (USACE) and is located approximately 13 miles upstream of Sand Springs (USACE, 2009). Keystone Dam has 12 gates and, when completely open with a full pool, can pass 960,000 cubic feet per second (cfs), although 305,000 cfs is the highest ever recorded at the dam. This high flow was recorded during the flood of October 1986. The reservoir created by the dam spans 26,000 acres and is intended for flood control purposes. The U.S. Geological Survey (USGS), in collaboration with the City of Tulsa and the USACE, records daily discharge and temperature at the Arkansas River 11th Street Bridge in Tulsa.

Zink Dam is located at approximately East 30th Street South on the Arkansas River. The dam, completed in 1982, is owned and operated by the RPA. The dam provides a lake of high aesthetic quality with a pool that extends approximately 2 miles to the north. The dam has two sets of bascule gates, each of which is approximately 100 feet in length.

Proposed Control Components

Dam operations associated with the proposed low-head dams will greatly depend on upstream flow, as well as current or future weather conditions. Additionally, the operators will need video monitoring capabilities to monitor potential acts of vandalism or breaches in security or public safety. The following sections describe the proposed method for operating the dam system by gathering all necessary data in a central location and defining numerical or visual triggers for response.

Overall Control Scheme

Each dam would have a Dam Control Center where flow and video data are collected and recorded. These data would then feed an Operations Control Center, where operators would monitor the data and modify dam operations accordingly and/or alert the necessary responsible parties of an impending emergency. For both geographic location and available resources, it is anticipated that the RPA or the Tulsa Emergency Operations Center would house the staff and equipment required to operate the dam system.

Because of the small distance between the Dam Control Centers (on the order of 5 river miles) and the lack of tall buildings or trees between them, CH2M HILL believes radio frequency (RF) would be a viable, relatively low-cost method for communication among the Dam Control Centers and Operations Control Center. Should the path between dams become obstructed, cellular is an option as well. However, in the project team's experience, while cellular is more expensive than RF, it is not as reliable as RF and greatly depends on the service provider. The most reliable (but most expensive) option would be a lease line telephone. The project team concluded that the reliability gained with a lease line telephone would be negligible and would not justify the additional cost.

For video monitoring, an Ethernet network over RF would be the most economical option as well. However, this feed would not be full streaming; a full streaming video would require a fiber optic network, which is a relatively large expense that is not anticipated to be cost-effective.

The proposed Dam Control Centers at the Sand Springs and South Tulsa/Jenks dams would feed data over RF to the Dam Control Center at Zink Dam, and the Zink Dam Control Center would then transmit data from each Dam Control Center to the Operations Control Center. This is illustrated in the Control Plan Schematic provided in Figure 1. Further linkages could convey the USACE and/or USGS gauge data in the form of transmissions from Keystone Dam Bridge via RF to the most upstream of the proposed dams, Sand Springs, and the 11th Street Bridge gauge to Zink Dam, and these data would also be transmitted to the Operations Control Center.

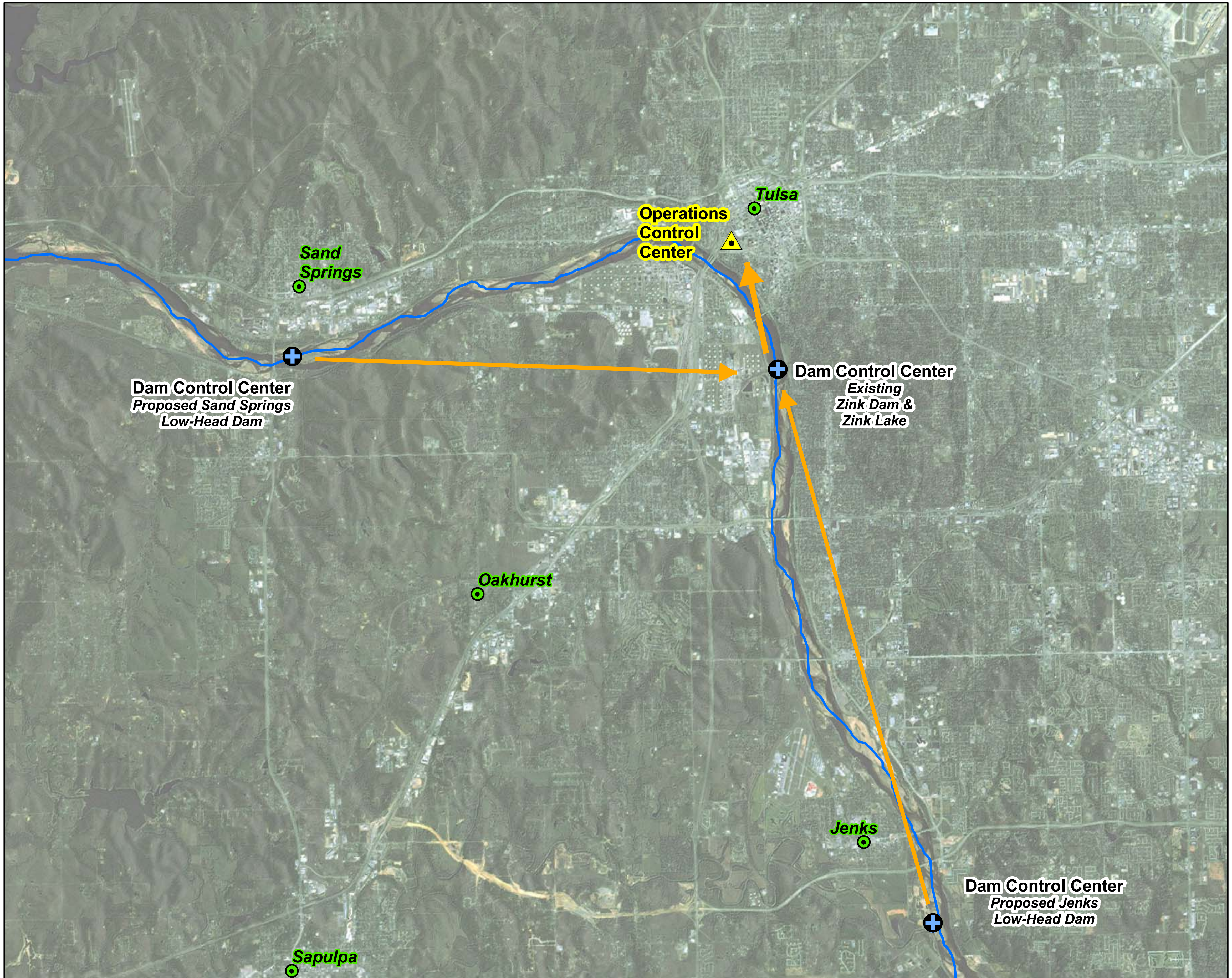
Dam Control Centers

Each proposed dam would support a pre-engineered building that would house a Dam Control Center. While a simple control panel is an option, a relatively inexpensive building would be more protective of the monitoring equipment, would provide air conditioning so the system components would not overheat, and would provide a workspace that would simplify maintenance compared to a control panel. This building would also house a motor control center for electrical needs (e.g., a 480-volt switch gear).

At the Zink Dam location, the existing control building can be considered for rehabilitation and installation of the Dam Control Center.

For flow monitoring purposes, each dam must be equipped with flow measuring devices that provide real-time data to the Operations Control Center. Several methods of flow monitoring are available commercially and the one selected for each of the dams must be as accurate as possible and easily integrated into the data transmission system. All of these data, including data from Keystone Dam, would be fed to the Operations Control Center. Additionally, weather information would be collected. A rainfall-radar system is an option, and this would provide a ground-truthed radar system to generate information regarding weather conditions, such as approaching heavy rain that could exacerbate already high river stages and cause flooding. This system would include rain gauges and stream gauges.

With the flow and weather data collected, a previously developed model would then be used to provide recommended modifications to dam operation and/or warning alerts related to potential increased water volumes that would affect recreation and/or nearby residents. Specific triggers for modifying dam operation will be defined in a future phase of this project and would take into account concerns in the areas of aquatic habitat, recreation, infrastructure design capacity, and public safety. Should a response beyond modifying dam operation be necessary, emergencies would typically be divided into three or four categories, each with associated triggers and responses. This is discussed in more detail in the Public Safety TM.



LEGEND

- Proposed Dam Improvements
- Cities
- Arkansas River
- Data Communication

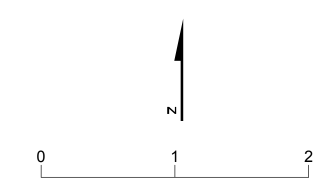


Figure 1
Control Plan Schematic
Project Location
Tulsa, Oklahoma

For alerts, autodialers are an option; however, these devices simply send an alarm at a pre-defined trigger and do not convey the reason for the alarm. The proposed Supervisory Control and Data Acquisition (SCADA) system, discussed in more detail in the next section, would serve the same purpose in addition to its other functions. For example, the SCADA system could be used to send an email or text message at a specified trigger to a pre-selected phone number and/or email address.

A programmable logic controller (PLC) at each Dam Control Center is anticipated to provide sufficient control of dam operations. Specifically, it would operate the actuator that would be controlling the dam gates and collect all of the data being monitored, such as flow, weather, and intrusion alarms. One large actuator or two smaller units with a 480-volt power rating would allow operators to remotely monitor the position of the gates and change the position should that be desired. The Dam Control Center system would also include local hand switches at each gate that would allow manual control of the dam at the Dam Control Center itself, rather than having to rely on remote control from the Operations Control Center.

For video monitoring, motion detection security cameras are recommended; cameras should be placed in a configuration that limits public access as much as possible. Motion detection lighting near the dam itself is also a good option, as it tends to serve as a deterrent to unauthorized activities. The parks would be lighted in a manner that accommodates park visitors without creating a nuisance at nearby residences. For safety purposes, a flow trigger can be defined that would initiate a siren and/or lighted beacon. In addition, safety call boxes would be added throughout each of the parks created as a result of this project. The project team recommends a fence (at least 8 feet high) around the dam itself and associated buildings and equipment. The public would be able to access the area via the pedestrian bridge.

It is anticipated that power would be provided from the local electric utility. Backup generators are an option for potential power outages. The dam control system design team would need to define how much backup power would be required—that is, how long would operators need to continue collecting data should a power outage occur and how long would they need to continue remotely operating the gates. An uninterruptible power supply (UPS) system would provide sufficient power for approximately 2 hours. If the operators need to retain the ability to open and close the dam gates, this would require an onsite or portable generator.

Operations Control Center

At the Operations Control Center, the SCADA system would include a Human/Machine Interface (HMI), which would be necessary to monitor and control dam operations and would require computers dedicated to this purpose. It is anticipated that these computers would be Dell or Hewlett-Packard based. The interface for those computers would also likely be manufacturer-provided software. All three of the most common PLC manufacturers (Allen-Bradley, GE, and Modicon) provide a software package with their equipment. This software tends to be relatively easy to configure, learn, and maintain and is also much less expensive than obtaining a stand-alone software package. However, the manufacturer-supplied software would be sufficient only if it is addressing the dam operations described in this TM. Should other functions be required of the software, the stand-alone types may be more appropriate (e.g., Wonderware).

The video monitoring equipment would require a personal computer separate from the SCADA system. This would include one monitor for each dam surveillance system and/or one monitor with each camera's display on a split screen configuration. This would also be associated with a large hard drive or other means of mass data storage, the actual size depending on the amount of backup video desired.

Ethernet access would be provided at the Operations Control Center to enable the operators to monitor weather and/or other pertinent news. A separate personal computer would be dedicated for this purpose so that SCADA system cyber-security measures would not be compromised.

References

Carter & Burgess. 2004. *Final Arkansas River Corridor Master Plan, Phase I Vision Plan.* Prepared for Indian Nations Council of Governments (INCOG).

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