TRUCKEE-CARSON RIVERWARE© PLANNING MODEL DESCRIPTION AND APPLICATIONS

Heather Gacek, Project Manager, Precision Water Resources Engineering, Loveland, CO, heather@precisionwre.com; Thomas Scott, Hydrologic Engineer, Bureau of Reclamation, Carson City, NV, tscott@usbr.gov; Shane Coors, Principal, Precision Water Resources Engineering, Loveland, CO shane@precisionwre.com

Abstract: The Bureau of Reclamation's (Reclamation) Lahontan Basin Area Office has developed a long-term RiverWare© model of the Truckee River Basin (Basin) including the Newlands Project area. The Truckee River basin contains seven upstream storage reservoirs, including Lake Tahoe, and terminates in the Great Basin at Pyramid Lake. The basin's seven upstream storage reservoirs are operated to meet the demands of downstream agricultural, environmental, industrial, and municipal water users along the Truckee River, as well as the agricultural demands of the Newlands Project in the Carson River Basin. Supplying the Newlands Project requires an inter-basin diversion from the Truckee River to the Carson Basin through the Truckee Canal.

The RiverWare© model, known as the Truckee-Carson Planning Model (Planning Model), was developed through a collaborative effort between several of the significant basin stakeholders, often with competing interests. Participating entities include the Bureau of Reclamation, Federal Watermaster, Truckee Meadows Water Authority, Pyramid Lake Paiute Tribe, the state of California, and the state of Nevada. The model represents the entire river system, and simulates each of the stakeholders' current operational policy. The model also allows users to adjust many operational criteria and variables to analyze proposed policy, hydrology, and water use changes for up to 100 years.

This unique collaboration has both facilitated wide acceptance of the model and driven the model development to be amenable to a wide range of applications. The model is designed to assist water managers and stakeholders in making long-term planning and management decisions. Applications include the Newlands Project Planning Study, the Truckee Basin Study, and policy revision studies.

An overview of the collaborative development process, a review of the primary model components, and a description of past, current, and proposed applications of the model will be presented.

INTRODUCTION

The Truckee River system is approximately 100 miles long, flowing from Lake Tahoe in the Sierra Nevada mountain range to Pyramid Lake in Nevada. There are seven upstream reservoirs, including Lake Tahoe, that regulate approximately 70% of the basin's water supply. The majority of the Basin water supply originates in California, while the majority of the water usage takes place along the Truckee River in Nevada.

In addition to water users along the Truckee River, water is diverted through the Truckee Canal as part of an inter-basin water transfer to supplement supply to agricultural water users in the Newlands Project within the Carson River Basin. The inter-basin diversion takes place at Derby Dam and delivers water to water users along the Truckee Canal and supplements the storage at

Lahontan Reservoir. Construction of the Truckee Canal was the first Reclamation project in 1903. A map displaying the combined Truckee and Carson River basin is shown in figure 1.

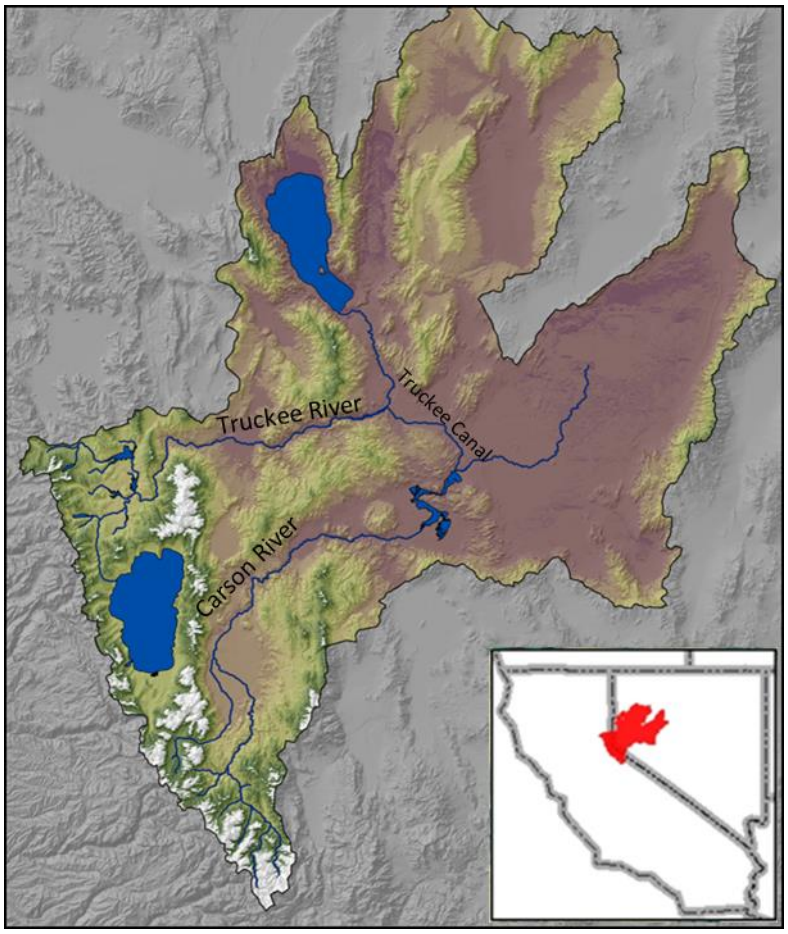

Figure 1 Map of the Truckee and Carson River Systems

A daily timestep RiverWare model has been developed by Reclamation to simulate the Truckee River System, including the Truckee Canal, for up to 100-year model runs. The Planning Model simulates the entire system's operations and performs complete daily water accounting of the water rights within the system. The model, its development process, and its uses are discussed in more detail in the following sections.

MODEL DEVELOPMENT PROCESS

The Truckee River Basin has a suite of modeling tools developed and maintained by Reclamation and the Federal Watermaster. This paper discusses the long-term Planning Model tools which were developed as part of a collaborative effort by many of the key basin stakeholders and government agencies.

Model Development Team: The Planning model was developed by a collaborative effort among many of the significant basin stakeholders, often with competing interests. Participating entities include the Bureau of Reclamation, Federal Watermaster, Truckee Meadows Water Authority, Pyramid Lake Paiute Tribe, the state of California, and the state of Nevada. In late 2009, the

formation of the Planning Model development group and the start of the development of the Planning Model began. Participating parties have met every 6 to 10 weeks in-person and/or video conference meetings to discuss development of the model and review the progress.

Pre-TROA Planning Model: At the start of the Planning Model development effort, the Truckee River Operating Agreement (TROA) had been approved and signed by the parties, but was still being contested in the courts. The existing basin policies, now known as the Pre-TROA operating policies, were still in effect. The model was therefore initially constructed to model the current, Pre-TROA, operating policy.

In addition to simulating the current operating policy, the model is designed to be a long-term planning and management tool. Unlike the existing and more mature Operations model, the Planning model cannot be overly dependent upon the user to control operations on a daily or even an annual time frame. This required an increased level of detail and more comprehensive operational logic than in the short-term daily operations model, which was already being used within the basin. The participating members of the Planning Model development team were tasked with providing detailed operational polices for their individual systems sufficient enough to allow the model to operate under all operational and hydrologic conditions without requiring additional input from the user.

Although the Planning Model will continue to be developed as basin policies change and stakeholders' operational policies evolve, the Pre-TROA version of the Planning Model was largely completed in 2014. The Pre-TROA version of the model was the foundation for the TROA Planning Model.

TROA Planning Model: Under the 1990 Settlement Act, the Secretary of the Interior was directed to negotiate an operating agreement for the Truckee River Reservoirs. The purpose of the policy is to improve operational flexibility and efficiency of Truckee River Reservoirs while satisfying water rights in conformance with existing decrees. TROA was officially signed into law in 2008, but court challenges have delayed its implementation. TROA is currently expected to be implemented in 2015.

As the TROA operating policy came closer to being implemented, the Planning Model development group began the process of incorporating the new operating policy within the framework of the existing Planning Model. In 2013 the Planning Model development team began the implementation of TROA within the Planning Model with the goal of using the model to support the Truckee River Basin Study in 2014. The Truckee River Basin Study was a Bureau of Reclamation study that identified and quantified potential impacts to the Truckee Basin due to climate change. An updated version of the Planning Model referred to as TROA-Lite was completed in mid-2014 for use in the Truckee Basin Study. This model simulated the most fundamental elements of TROA for water and supply. Model development work is ongoing to incorporate additional, more flexible operating policies such as complex water exchanges

involving instream flows below reservoirs in California, and voluntary exchanges between parties under a variety of conditions.

TROA operating policy allows parties to hold back unneeded, but entitled flows to establish credit water in the reservoirs. It also allows for a multitude of possible exchanges between the water right holders. Along with the increased flexibility and efficiency, TROA adds a lot of complexity to the system which needs to be captured by the modeling tools. The basin stakeholders are continuing to refine policies for their individual operations under the operating agreement as part of the model development

MODEL COMPONENTS

A RiverWare model workspace consists of objects, each representing a specific component of the modeled system, linked together to simulate the storage, flow, diversion and consumption of water in a system. The primary model components in the Planning Model include the seven upper Truckee River reservoirs, the Truckee Meadows section of the river between Farad gage and Derby Dam, the Truckee Canal and Lahontan Reservoir, and the lower Truckee River below Derby Dam and including Pyramid Lake. These four sections are each discussed in more detail below. A schematic diagram of the model components is provided as Figure 2.

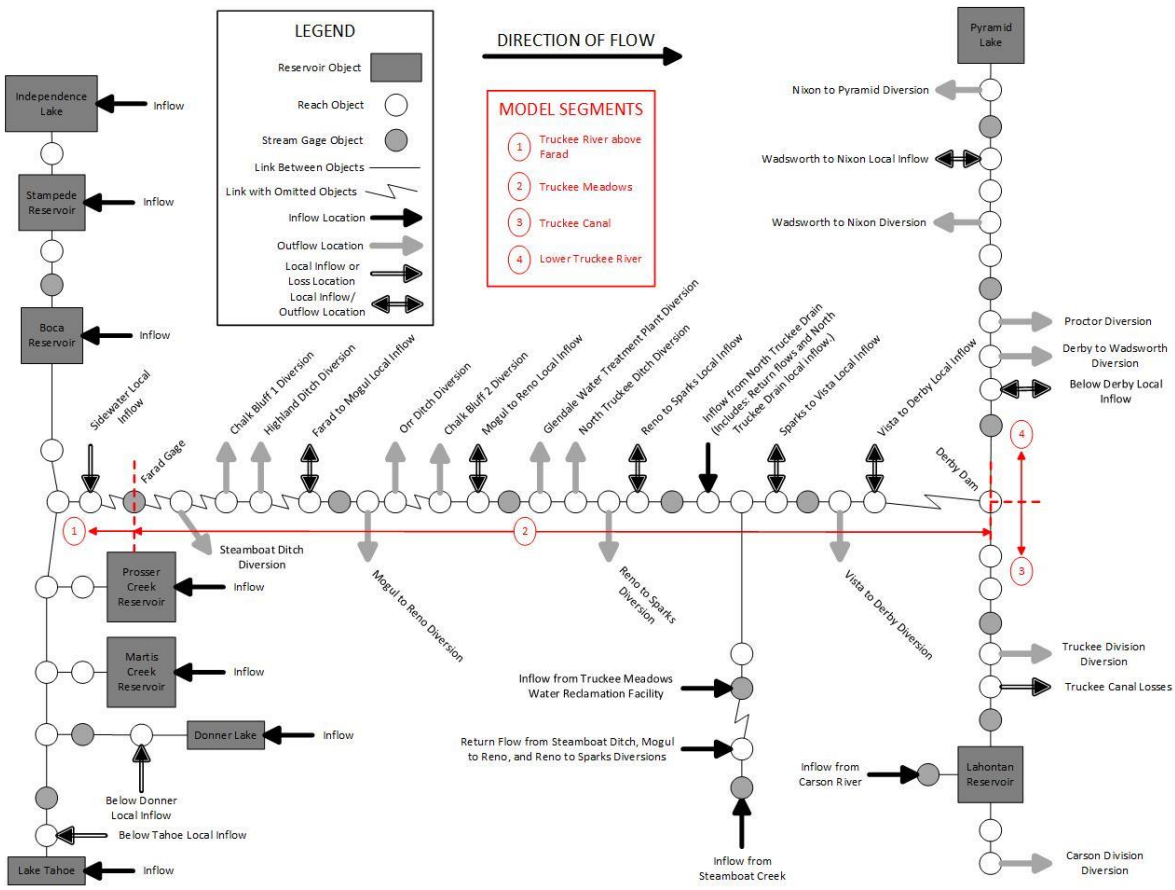

Figure 2 Schematic showing the reservoirs, reaches, outflows, and inflows for the Pre-TROA Truckee-Carson RiverWare Planning Model

Truckee River above Farad (1): The Truckee River above Farad section of the model is everything upstream of the gage at Farad. This section contains seven reservoirs: Lake Tahoe, Donner Lake, Martis Creek Reservoir, Prosser Creek Reservoir, Boca Reservoir, Stampede Reservoir, and Independence Lake. The majority of the water in the Basin originates within this section of the basin. The reservoirs regulate the flow of the water in the river. The system is operated to meet flow targets at Farad Gage, referred to as the Floriston Rate target flows.

Truckee Meadows (2): The Truckee Meadows represents the reach of the Truckee River between the gage at Farad and Derby Dam. This portion of the model contains: agricultural diversions, municipal diversions, industrial diversions, return flows from the Truckee Meadows Water Reclamation Facility, inflows from tributaries, and system losses.

Truckee Canal (3): The Truckee Canal portion of the model represents diversions at Derby Dam through the Truckee Canal to Lahontan Reservoir and its downstream water users. This portion of the model also includes an inflow point representing the inflow to Lahontan Reservoir from the Carson River. This portion of the model represents the entire Newlands Project. The Newlands Project includes agricultural diversions taken directly from the Truckee Canal as well as agricultural diversions taken downstream of Lahontan Reservoir.

Lower Truckee River (4): The lower Truckee River represents everything below Derby Dam flowing to the terminus at Pyramid Lake. For this reach of the river the model currently contains: agricultural diversions, environmental flow targets, and system losses. In the future, conditions in this reach are expected to include municipal diversions as well as the before mentioned demands.

MODEL APPLICATIONS

The following section includes descriptions of past and future model uses. The Planning model is intended for use by system operators to analyze existing Basin policies and to develop future operational strategies and Basin policies. It is also intended for use by individual stakeholders to develop their own operational strategies and perform reliability testing on their water supply and current policies. The following examples are just a handful of the possible applications of the Planning Model tools.

Newlands Project Planning Study: The Newlands Project Planning Study (Study) was conducted by Reclamation to formulate, develop, and evaluate a range of alternatives to reliably deliver water to Newlands Project water rights holders while also reducing risk to local communities from operating the Truckee Canal. Reclamation describes the impetus for and purpose of the Study in the report, *Newlands Project Planning Study Special Report*, as:

> The Newlands Project is one of Reclamation's first irrigation projects and nearly as old as the agency itself. Reclamation began the Project in 1903 to provide irrigation water to the Lahontan Valley, near Fallon, Nevada, and to lands in the Truckee Basin near Fernley, Nevada.

In the early morning of January 5, 2008, a 50-foot portion of the Truckee Canal embankment failed about 12 miles downstream from Derby Dam, releasing water that inundated a residential development in the City of Fernley, flooding 590 properties. No fatalities occurred, but more than $1 billion in tort claims were filed against the Federal government, local governments, and the Truckee-Carson Irrigation District (TCID), and have now been consolidated into class action lawsuits.

Although the damaged portion of the canal embankment was soon repaired, evaluations of the canal revealed a high potential for future failure. In response, Reclamation imposed restrictions on the water surface elevation allowed in the canal and the amount of water allowed to flow through the canal. The flow restrictions were reinforced by the Federal District Court for Nevada. If not lifted, these restrictions could complicate the long-term ability of Reclamation to provide Newlands Project water rights holders with reliable supplies.

Federal authorization for the Study was provided in the Omnibus Appropriations Act of 2009 (Public Law 111-8, 123 Statute 609), which directed Reclamation to determine the actions necessary to rehabilitate the Truckee Canal so restrictions on its operation can be removed.

The modeling effort for the Newlands Project Planning Study included the modeling of 24 preliminary alternatives, a no action alternative, and a desired reliability alternative. After thorough review of the modeling results, environmental and regulatory review, engineering and cost estimates, and financial and benefits analysis were performed, seven final alternatives were identified. These seven alternatives were then modeled using the Planning Model and reviewed to develop the study's key findings.

Truckee River Basin Study: The Truckee River Basin Study (Basin Study) is a part of Reclamation's response to the Department of the Interior's WaterSMART Program to enact the SECURE Water Act of 2009. The Basin Study was kicked off in late 2012. The RiverWare modeling effort was performed in 2014. The Basin Study is part of a program "to evaluate and report on risks and impacts from a changing climate and identify appropriate adaptation and mitigation strategies in conjunction with stakeholders." (Bureau of Reclamation Mid-Pacific Region Lahontan Basin Area Office, October 2013)

The Basin Study Team worked with key Basin stakeholders as part of the Project Steering Team and Technical Advisory Group to develop the study components and analyze the potential impacts of the Basin Study's hydrology and demand scenarios on the Truckee Basin water users and environment. The Basin Study Team engaged the community at multiple public meetings throughout the process.

The Basin Study Team developed a broad range of potential climate change hydrology scenarios to capture the possible effects of climate change on the region. The Team also developed three

demand scenarios to encompass possible future development within the Basin. The Planning Model was used to perform model runs combining these various hydrology and demand scenarios. The results from these model runs were analyzed collectively to identify system vulnerabilities due to climate and demand changes. Once the vulnerabilities in the system were identified, the Basin Study team were able to evaluate tradeoffs between different mitigation strategies and develop robust operational strategies for the future. These strategies were modeled using the Planning Model and the improvements were quantified and reported in the Basin Study.

Boca Reservoir Study: As part of a larger study, an alternative was performed to analyze the impacts of introducing a reduced water surface elevation limit on Boca Reservoir. Six runs of the Planning Model were performed to model three reservoir storage limit scenarios with two different demand scenarios. The purpose of the study was to determine the impacts on the remainder of the Truckee Basin as a result of altering the storage limits at Boca. The demand scenarios were meant to provide a range for the impacts given that basin demand levels remain near current levels or demand levels are increased to represent future water use.

Future Model Uses: Future use of the Planning Model will include the Truckee Canal Environment Impact Statement, and subsequent policy revision studies. Additionally, it is expected that individual Basin stakeholders will use the model to perform their own private studies. The implementation of TROA will necessitate these private studies as parties work to determine the most efficient and robust operating policies with the framework of the new flexible operating system.

SUMMARY

The Truckee-Carson Planning Model was developed through a collaborative effort between several of the significant basin stakeholders. Currently there are two versions of the Planning Model, one containing only the Pre-TROA operating policies and one under development which contains both the Pre-TROA and TROA operating policies. The Planning Model has been used by several federally funding planning studies to date, including the Newlands Project Planning Study and the Truckee River Basin Study. The model is slated for use in future federally funded planning studies as well as private studies to be performed by individual Basin stakeholders.

REFERENCES

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