

# Forecast Informed Reservoir Operations: Screening Process Guide



Center for Western Weather  
and Water Extremes  
SCRIPPS INSTITUTION OF OCEANOGRAPHY  
AT UC SAN DIEGO



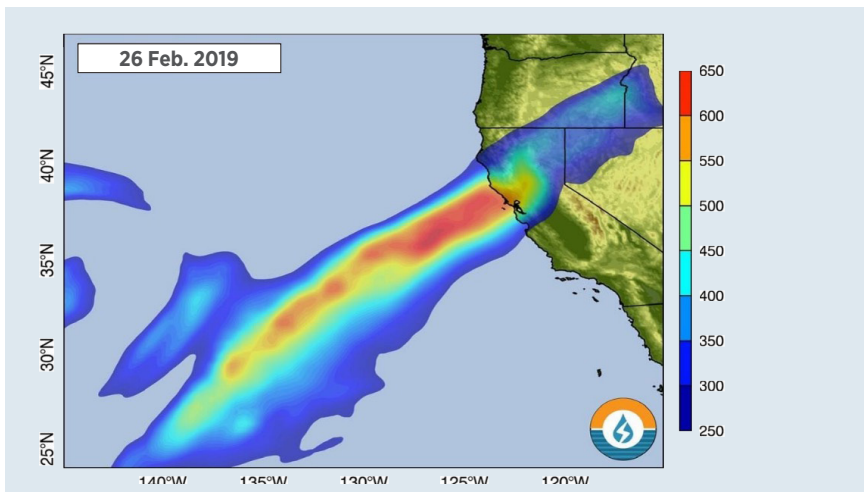
US Army Corps  
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## 1 | Understanding Forecast Informed Reservoir Operations

Forecast Informed Reservoir Operations (FIRO) is a reservoir management approach that uses modern technology and forecast improvements to mitigate the impacts of droughts and floods without requiring expensive new infrastructure.

Within the U.S. Army Corps of Engineers (USACE), FIRO is a research and operations partnership that capitalizes on scientific improvements in weather and hydrologic forecasting and modeling to selectively store or pre-release water in anticipation of future conditions. FIRO viability is assessed at a site by evaluating alternative operations compared to existing operations. If viable, FIRO offers reservoir managers increased flexibility and resilience to droughts and floods.

### Forecast Improvements: The Key to FIRO



*Pioneering work on atmospheric rivers (ARs) by the Center for Western Weather and Water Extremes (CW3E) has improved forecast skill for this storm type. Here an AR is making landfall in the Russian River Basin. Red shades indicate high AR strength.*

**Forecast Skill** - The FIRO Screening Process estimates the lead time needed to safely store and release flood water for each site and compares lead time requirements to the current forecast skill. These estimates serve as an initial indicator of whether forecast skill is reliable enough for FIRO. Sites will be placed into one of three categories: forecast skill appears adequate; forecast skill is not adequate; or forecast skill may be adequate/further study is needed. This assessment will help determine where further work is needed to improve forecast skill and will largely depend on dominant storm types in a given area.

## What's in this Guide?

### 1 | Understanding FIRO.

An overview of what FIRO is and advancements in forecast skill.

**2 | Demonstrating FIRO Potential through FIRO Pilot Sites.** Success at Lake Mendocino and other ongoing pilot sites have demonstrated that significant potential benefits can be achieved, including economic benefits.

**3 | National Pathfinder: The FIRO Screening Process.** The FIRO Screening Process provides a low barrier point of entry to determine suitability for FIRO at sites nationwide.

**4 | Looking Ahead: From Screening to WCM Updates.** The FIRO Screening Process will identify sites that are good candidates for FIRO and will recommend next steps to pursue FIRO based on site-specific considerations.

## 2 Demonstrating FIRO Potential through FIRO Pilot Sites

The FIRO program began with pilot studies to demonstrate FIRO as a viable reservoir management approach. A Final Viability Assessment was completed at Lake Mendocino, in the Russian River Watershed (available [here](#)) and the Water Control Manual (WCM) has been updated to incorporate FIRO. Under a major deviation, operators at Lake Mendocino stored approximately 20% more water (equivalent to water for about 22,000 homes for a year) during the dry 2019-2020 season (Figure 1). FIRO at Lake Mendocino and Lake Sonoma combined yielded about 30,000 acre-feet of additional storage in Spring of 2023 (equivalent to water for about 60,000 homes for a year). Seven other FIRO pilot studies are underway with high potential for flood risk management and water conservation benefits.

### Lake Mendocino Storage

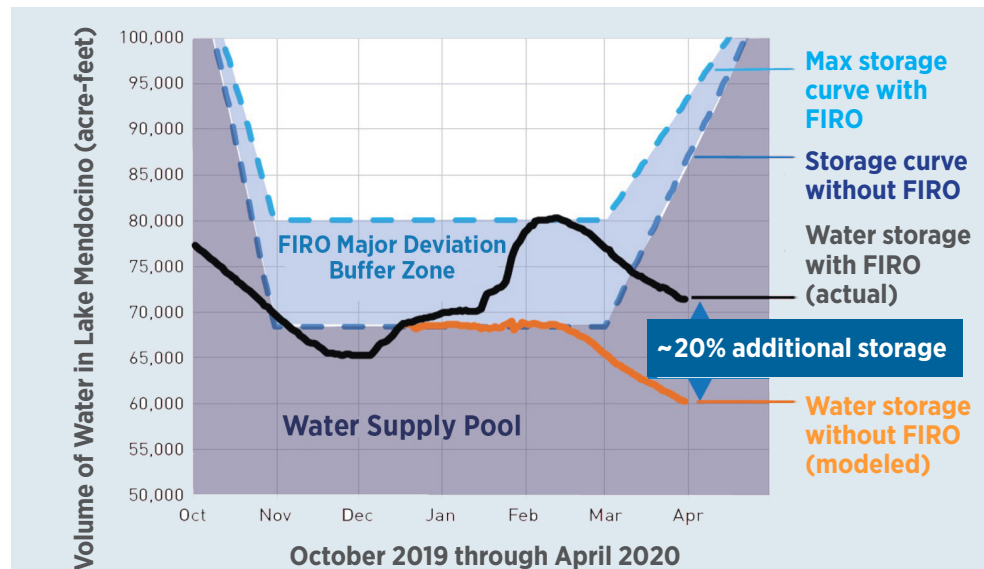
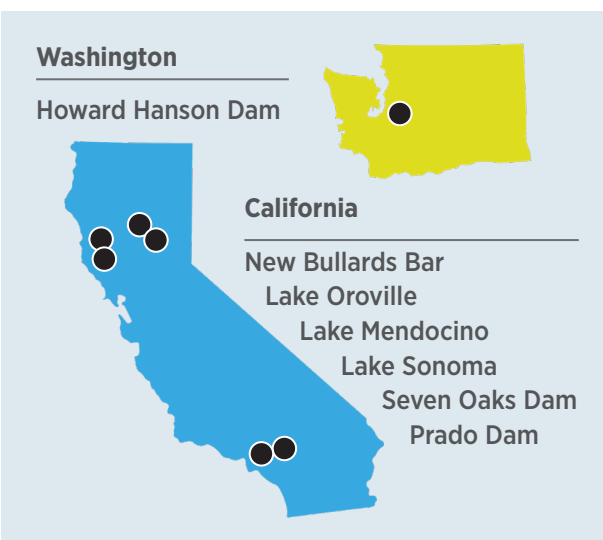


Figure 1: Lake Mendocino storage under a FIRO major deviation. Source: Lake Mendocino Final Viability Assessment

### FIRO Pilot Sites



### National FIRO Leadership Team

Bringing FIRO benefits to regions across the U.S. is an undertaking that requires significant research and operations collaboration. Leading the effort are engineers and scientists.

- **Sean Smith**, Principal Hydrologic & Hydraulic Engineer, United States Army Corps of Engineers (USACE) Headquarters
- **Cary Talbot**, FIRO National Lead, USACE Engineer Research and Development Center (ERDC)
- **Dr. F Martin Ralph**, Chief Scientist of FIRO Phase III, the National Expansion Pathfinder, CW3E
- **Joe Forbis**, Water Management Integration Lead, USACE ERDC

### 3 National Pathfinder: The FIRO Screening Process

#### Assessing FIRO Suitability

The FIRO Screening Process is designed to be a low barrier point of entry to the FIRO program. Through the three-stage screening process, USACE regulated dams will be assessed to identify those with high potential for FIRO success. Sites are evaluated in collaboration with USACE District staff across a range of suitability criteria, resulting in recommendations for next steps.

In addition to forecast skill and lead time, evaluation factors include collaboration potential, environmental concerns, hydraulics and operations constraints, and perceived need.

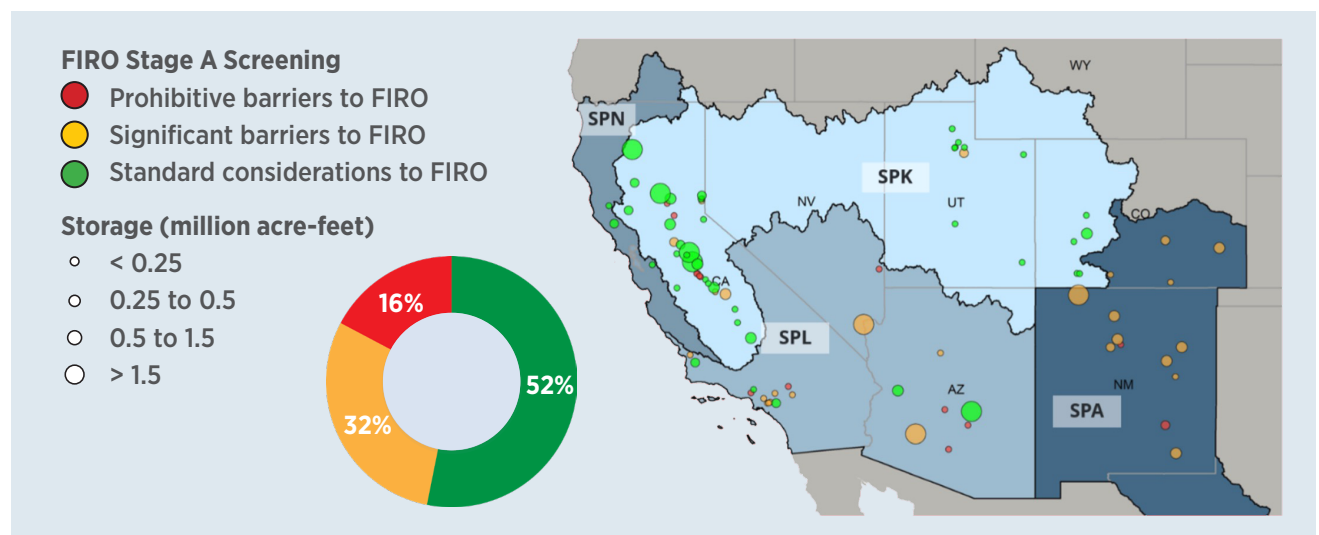
#### Three Stages of the Screening Process

**Stage A:** Sites categorized based on potential barriers to FIRO. Sites with prohibitive barriers do not progress to Stage B.

**Stage B:** Site suitability across different dimensions is assessed based on detailed site information.

**Stage C:** USACE District Water Management staff and FIRO experts discuss screening process outcomes and determine appropriate next steps.

#### FIRO Screened Reservoirs in the USACE South Pacific Division



*The screening process was beta-tested with the South Pacific Division. Initial Stage A results indicate that more than 80% of sites in the Division may be suitable for FIRO (sites do not have prohibitive barriers). Stages B and C are underway to further evaluate FIRO suitability at these sites.*

#### Implementing the FIRO Screening Process Nationwide

The Stage A evaluation of nationwide FIRO suitability will be completed by the end of 2024. Following the Stage A evaluation, Stage B will be completed in the South Pacific Division and undertaken across the rest of the United States with timing guided by forecast skill, stakeholder motivation, and at sites nominated by Districts. The FIRO Screening Process Steering Committee is developing the roll-out schedule (see text box on page 4 for more information on the Steering Committee). Stages B and C will be completed nationally for all eligible sites by September 2027.



## 4 Looking Ahead: From Screening to WCM Updates

The FIRO Screening Process identifies which sites have potential for FIRO suitability and the appropriate corresponding next steps based on the level of suitability determined through the FIRO Screening Process. Stage A can usually be completed across a District in a matter of a few weeks. Stages B and C take longer to complete as they include a more detailed assessment of FIRO suitability and result in recommended next steps.

A comprehensive FIRO Viability Assessment, consisting of five steps, has been used at pilot sites (see Figure 3). An expedited assessment process is being developed for sites where this is appropriate, such as those where potential FIRO suitability appears high.

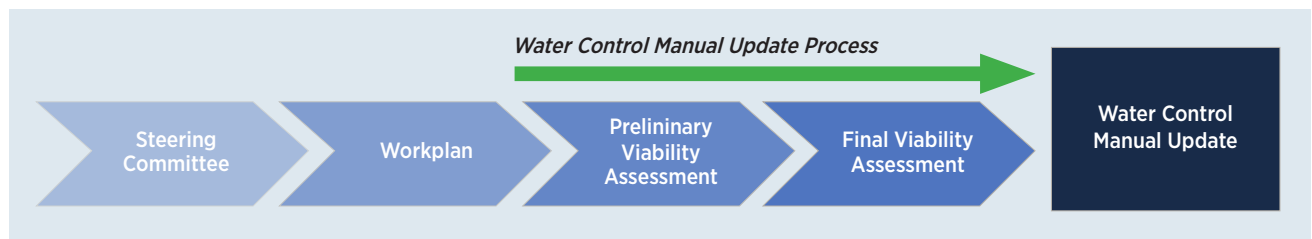


Figure 3: Overview of the FIRO Viability Assessment Process at FIRO pilot sites

If the viability assessment demonstrates that FIRO results in better outcomes compared to existing operations, then implementation of FIRO is pursued via a WCM update. The WCM update can occur concurrently with the viability assessment when funding is available.

**The Water Control Manual (WCM) is a USACE document that governs reservoir management at a specific site. FIRO seeks to update the Water Control Plan (WCP) portion of the WCM, which stipulates reservoir operations. If FIRO is found to be viable at a site through a viability assessment, the FIRO project-specific Steering Committee recommends changes to the WCP to codify FIRO at the site.**

WCM updates for FIRO-viable sites take place under the authority of USACE, informed by the results of the Viability Assessment process. In accordance with its flood risk management mission, USACE will only make changes to WCMs that do not negatively impact flood risk management performance.

### FIRO Screening Process Steering Committee

Steering Committee includes a diverse range of expertise including engineers, meteorologists, and hydrologists. Elissa Yeates, USACE ERDC, is the principal investigator for the FIRO Screening Process.

- Cary Talbot (co-chair), USACE ERDC
- F. Martin Ralph (co-chair), CW3E
- Jay Jasperse, CW3E
- Joe Forbis, USACE ERDC
- Andy Martin, USACE Portland District
- Chris Frans, USBR
- Arleen O'Donnell, ERG
- Rob Hartman, Robert K. Hartman Consulting Services