

**Assessing the Capability to Discharge Excess Lake
Okeechobee Water South: Review of System Operations
(January through mid-June 2013)**



**Prepared by
Office of Everglades Policy & Coordination,
Water Control Operations Bureau and Applied Sciences Bureau
South Florida Water Management District**

Final Report, October 2013

EXECUTIVE SUMMARY

This report provides a detailed retrospective review and assessment of the capability of the water control system to discharge excess Lake Okeechobee water south to the Water Conservation Areas (WCAs) during the period from January 1–June 17, 2013—the most recent period that the federal operating rules for Lake Okeechobee allowed regulatory discharges to the WCAs. This comprehensive review demonstrates that the South Florida Water Management District, on behalf of the U.S. Army Corps of Engineers and as the local sponsor for the Central and Southern Florida Flood Control Project, operated the water control system consistent with the federal Water Control Plan and applicable State of Florida permit requirements.

For the January–June analysis period, Lake Okeechobee regulatory discharges were made to the WCAs at maximum practicable amounts, consistent with the 2008 Lake Okeechobee Regulation Schedule (2008 LORS). While the 2008 LORS allowed regulatory discharges to the WCAs for 14 weeks during the analysis period, regulatory releases occurred in 10 of the 14 weeks. During week 1, the SFWMD assessed the hydrologic and environmental conditions of the system and, for three weeks (weeks 8, 9, and 19), releases were suspended due to rainfall events. Lake regulatory release volumes to the WCAs via the Everglades Stormwater Treatment Areas (STAs) totaled approximately 34,000 acre-feet (ac-ft), more than four times the volume of excess Lake Okeechobee water discharged to the St. Lucie Estuary. The following table summarizes the Lake Okeechobee regulatory release volumes and associated reductions in lake water levels from January 1–May 31, 2013:

Lake Okeechobee Regulatory Discharge to:	Volume (ac-ft)	Equivalent Depth (in)	Percent of Total
Caloosahatchee Estuary via S-77*	183,900	4.9	80%
WCAs via STAs	34,000	0.9	15%
Lake Worth Lagoon via L-8 & C-51	4,500	0.1	2%
St. Lucie Estuary via S-308	7,400	0.2	3%
Total	229,800	6.1	100%

*Note: Base flow releases to the Caloosahatchee Estuary were within the acceptable flow range.

During the analysis period, STA-1E and STA-1W were not recommended for lake releases due to prior nutrient and hydraulic overloading and ongoing construction, and STA-2 had downstream WCA constraints. As the only STA originally designed to treat a limited volume of Lake Okeechobee regulatory discharge, STA-3/4 was the only viable option for treating lake regulatory releases. A review of the STA response to inflows from Lake Okeechobee indicated that the target stages in the available STA-3/4 cells were exceeded each day the STA received lake regulatory releases. The approximately 34,000 ac-ft treated by STA-3/4 was considered by agency staff as the maximum safe volume of lake regulatory releases that could be treated. After treatment, this water was routed to the northwest corner of WCA-3A to improve ecological conditions and protect the peat in this higher elevation portion of the conservation area and to avoid harm to protected nesting birds in the eastern portion of WCA-3A.

Current system conveyance infrastructure was capable of discharging additional lake water. However, recognizing that the Everglades STAs are vegetated, shallow water treatment areas and are not designed

for water storage, additional inflows would have caused further damage to STA vegetation and resulted in a subsequent reduction in water quality treatment performance.

Looking ahead, increased water storage and treatment infrastructure that are proposed under Restoration Strategies and Central Everglades Planning Project efforts are expected to improve the capability to discharge more lake regulatory releases to the WCAs. Overall, the goal is to design and build storage and pumping infrastructure to discharge into STA-3/4 and STA-2 at lower and more continuous flow rates. This would provide longer durations of steady flow conditions and stage profiles within the STAs, thereby improving future treatment capability and vegetation sustainability.

1.0 INTRODUCTION

This retrospective analysis identifies and describes the conditions and constraints that existed during the period from January 1–June 17, 2013, when the Lake Okeechobee release guidance allowed regulatory releases to be made to the Water Conservation Areas (WCAs). This information is prefaced by a brief description of the Central and Southern Florida Flood Control Project (C&SF Project) and its evolution from a drainage plan to a multi-purpose water management system. Modifications to the system that affect the ability to move water to the WCAs are also described to provide the context for the current decision process.

1.1 Brief History of the Central and Southern Florida Flood Control Project

In South Florida, water historically flowed naturally from the headwaters of the Everglades ecosystem in the Kissimmee region to Lake Okeechobee (**Figure 1**), which would contract and expand in response to extreme weather patterns. Water from the lake would spill into the massive southern Everglades “River of Grass” wetland and eventually make its way to Florida Bay. For more than 150 years, public demand for flood control and development opportunities have ultimately shaped the landscape and identified a need for water management. The earliest modifications to the South Florida landscape were constructed in the 1880s by Hamilton Disston with the dredging of the Caloosahatchee River and the creation of drainage canals in the Kissimmee Upper Chain of Lakes. The dredging was conducted in order to drain the land to facilitate agricultural production and urban development.

In the center of the state, Lake Okeechobee historically overflowed its natural banks, sending a sheet flow of water south through the expansive Everglades. A low levee and three drainage canals running south from Lake Okeechobee, the Miami, North New River, and Hillsborough canals were constructed between 1913 and 1917. In 1930, during the aftermath of the infamous Storm of 1928 which pushed water out of the shallow lake and drowned thousands of people, the federal government authorized the U.S. Army Corps of Engineers (USACE) to build the Herbert Hoover Dike. Over the next seven years, the USACE built a series of levees, culverts, and locks to contain the lake, including 67 miles of dikes along the southern shore. In 1938, the USACE began to regulate lake levels, and lake inflows and outflows were altered to include structures and channelization to more effectively move water in and out of the lake. Modifications to the outlets on the east and the west sides of the lake made the St. Lucie and Caloosahatchee rivers the primary outlets from the lake.

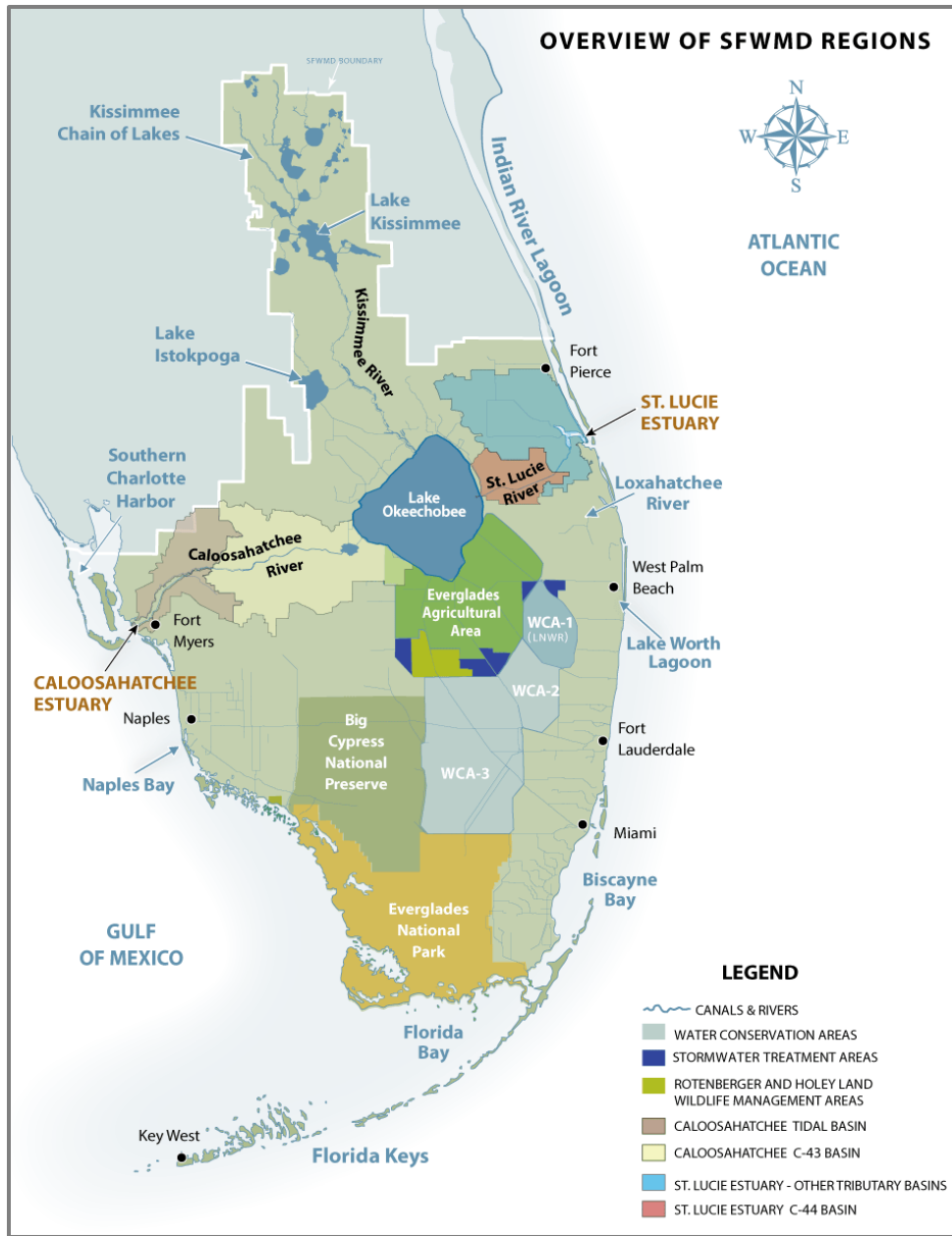


Figure 1. Overview of South Florida Water Management District region.

However, due to a series of back-to-back hurricanes in 1946 and 1947 and resulting significant flooding in South Florida, the need for additional features to manage excess water became evident. In response to these conditions, the State of Florida requested assistance from the federal government. As a result of that request, the Central and Southern Florida Flood Control Project (C&SF Project) was authorized by the U.S. Congress in 1948. Subsequently, the USACE produced a comprehensive water management plan that became the blueprint for the C&SF Project. It took approximately 20 years to implement the project features, canals, levees, pump stations, and other structures that were built in the 1950s and 1960s. The channelization of the Kissimmee River was completed in 1971.

The C&SF Project is a multi-purpose project, but flood control was the driving force in its design. The desire was to get the water off the land quickly and shunted to tide to allow for urban and agricultural development. The key drainage features of the C&SF Project begin in the north with the creation of hydrologic connections and management of lake levels in the Kissimmee Chain of Lakes to provide drainage for the urban/suburban areas around and north of Lake Kissimmee. The Kissimmee Basin (KB) covers approximately 2,300 square miles of south-central Florida and is divided into a 1,595-square-mile Kissimmee Upper Basin (KUB) and a 684-square-mile LKB. The divide for these basins is the S-65 structure located at the outlet of Lake Kissimmee. Thirteen water control structures regulate the flow of water through the KB. These water control structures are managed by the South Florida Water Management District (SFWMD or District) in accordance with regulations prescribed by the USACE.

The KB portion of the C&SF Project was constructed between 1960 and 1971. Between 1962 and 1971, the meandering Kissimmee River was channelized and transformed into a 56 mile (90 kilometer) long by 30 foot (9 meter) deep canal, varying in width from 90 to 300 feet (27 to 91 meters) and regulated by a series of six water control structures (S-65, S-65A, S-65B, S-65C, S-65D, and S-65E) (USACE, 1992). The Kissimmee Chain of Lakes project features were constructed between 1964 and 1970 and included dredging of canals between lakes and installation of nine water control structures (S-57, S-58, S-59, S-60, S-61, S-62, S-63, S-63A, and S-65) to regulate lake water levels and outflow (USACE, 1992). Several of Disston's original canals between the lakes were enlarged and new canals were dredged to connect Alligator Lake with Lake Gentry and to connect Lake Gentry with Lake Cypress. Currently, water control structures throughout the KB are operated in accordance with criteria codified in the USACE Water Control Manual for Kissimmee River – Lake Istokpoga Basin (USACE, 1994). The operating criteria for the KB define seasonal and monthly water level limits required to meet the flood protection, water supply, recreational, and environmental objectives of the C&SF Project.

Lake Okeechobee, located in the center of the C&SF System, is the largest freshwater lake in the southeast, covering an area of over 730 square miles. Although large in surface area, the lake is also relatively shallow compared with other large lakes, with an average depth less than 10 feet. Prior to the construction of the levee, in response to wet season rainfall, the lake would spread laterally and was surrounded by large areas of wetlands. After the levee was in place, management of Lake Okeechobee stages was developed to provide flood control and water supply for agricultural and urban needs. To accommodate the increase in volume and the speed with which water now moved south from the Kissimmee, modifications to the outlet structures diverted upwards of 85 percent of the discharge flows to the Caloosahatchee and St. Lucie estuaries. The outlets to the south of the lake were constrained by the drainage requirements of the Everglades Agricultural Area (EAA). In addition, the system was designed to bring excess stormwater from the northern half of the EAA back to the lake through pump stations S-2, S-3, and S-4 on the southern rim of the lake (see **Appendix A** for further details on S-2/S-3 flood control pumping). Management of Lake Okeechobee is regulated by a schedule developed by the USACE and approved through the National Environmental Policy Act (NEPA) procedures.

The east and west outlets from Lake Okeechobee are controlled by a series of structures at the lake (S-308 on the east side and S-77 on the west side) plus intermediate control structures along the C-44 and C-43 canals to address both changes in land elevation as well as local watershed discharges. For the

St. Lucie Estuary, the terminal structure on the C-44 canal or south fork of the St. Lucie River is the S-80 structure. For the Caloosahatchee Estuary, there are two structures, S-78 and S-79, which is the terminal structure on the C-43 canal or Caloosahatchee River. The amount of water discharged through these structures is based on a combination of lake level and outlet capacity, taking in to consideration the local watershed runoff. However, water quality problems in the receiving estuaries, noted as early as the 1950s, resulted in modifications to both the flow volumes and flow patterns, at least when the lake level was in low to intermediate stages.

Approximately 700,000 acres south of Lake Okeechobee has been designated as the EAA. The construction of the C&SF Project included the planning, design, and construction of levees and drainage improvements to provide both flood control and water supply to this area. A protective levee runs from northwest Palm Beach County south of Miami-Dade County.

The WCAs are located between the EAA and the east coast levee. They consist of five surface water management areas covering approximately 1,372 square miles. These areas of the Everglades were set aside for several purposes—to provide water storage, act as seepage barriers to protect urban development along the east coast, recharge regional groundwater and prevent saltwater intrusion, offer recreational opportunities, and serve as habitat for fish and wildlife. The WCAs are also operated according to regulation schedules developed by the USACE. These schedules are designed to provide both water supply and flood control for the lower east coast of Florida. The combination of the EAA and WCAs has resulted in both a decrease in areal extent of the remaining Everglades and reduced water storage due to the need for flood protection and compartmentalization of the ecosystem.

1.2 Evolving Operational Constraints

Beginning in the 1980s, a series of water quality and quantity programs and projects were initiated to reverse the decline of the South Florida ecosystem. The 1987 Surface Water Improvement and Management Act, promulgated by the State of Florida, identified and authorized planning and restoration of impaired surface waters, and specifically identified Lake Okeechobee, the Indian River Lagoon, and the Everglades as water bodies in need of assistance. The 1992 Water Resources Development Act (WRDA) authorized the USACE to begin a “restudy” of the C&SF Project and authorized the restoration of the channelized Kissimmee River. In 1994, the Everglades Forever Act (EFA; Section 373.4592, Florida Statutes) identified nutrient problems in the Everglades and initiated the process for construction of Stormwater Treatment Areas (STAs) to improve the water quality entering the Everglades Protection Area (EPA). In 2000, the U.S. Congress approved the WRDA bill that initiated the Comprehensive Everglades Restoration Plan (CERP) to restore the ecosystem impacted by the construction and operation of the C&SF Project. However, operational challenges associated with meeting the water quality and quantity goals as well as the ecological goals defined in CERP were an unintended consequence of the growing effort to restore the ecosystem. It was also clear that the water management system was not designed to deal with these constraints.

1.2.1 Upper Kissimmee Chain of Lakes and Kissimmee River Restoration Project

The current set of operating rules for the lakes north of the Kissimmee River were created in the mid-1980s by the USACE and SFWMD. These rules are being reevaluated by the USACE and SFWMD as part of the ongoing Kissimmee Basin Modeling and Operations Study. Structure operations for S-65 were reauthorized in 1992 as part of the Kissimmee River Restoration Program. Interim operations associated with the Kissimmee River Restoration Project were initiated in June 2001.

1.2.2 Lake Okeechobee

The regulation schedule for Lake Okeechobee has undergone several modifications since the construction of the Herbert Hoover Dike. Initially, the lake was managed in the range from 13 to 15 feet National Geodetic Vertical Datum (ft NGVD). In the 1970s, the dike was raised in some areas to allow for higher stages in response to concerns about water supply. In 1978, the schedule was increased in the range from 15.5 to 17.5 ft NVGD. Problems with water quality in the lake, including nutrient loads from the EAA, resulted in the operational changes described in the Interim Action Plan (SFWMD, 1979). This plan significantly reduced the volume of water pumped into the lake through the southern structures and redirected it southward. **Appendix A** contains additional information regarding the history of EAA flood control pumping. The higher lake stages also caused problems within the lake, drowning the nearshore vegetation and affecting the lake fisheries. Beginning in the 1990s, the next series of modifications to the regulation schedule were developed to incorporate climate forecasting and reduce the duration and level of high lake stages.

1.2.3 Herbert Hoover Dike

After the 2004–2005 hurricanes, increased safety concerns about the stability of the Herbert Hoover Dike resulted in the USACE determining that the aging infrastructure needed repairs. Approved in 2000, the Herbert Hoover Dike Refurbishment Project divided the 143-mile embankment into eight reaches, with the initial focus on Reach 1A between Port Mayaca and Belle Glade. Given the length of time anticipated to complete the refurbishment, the USACE elected to modify the Lake Okeechobee Regulation Schedule (LORS) to reduce the risk of a dike failure. The modified schedule, approved in 2008, reduced the high end of the management bands and effectively reduced storage in the lake by 1.25 ft, or approximately 580,000 acre-feet (ac-ft).

Repair work in Reach 1A included the construction of a cutoff wall to reduce the risk of dike failure by eliminating existing piping and preventing additional internal erosion through the dike and foundation. The cutoff wall is a seepage barrier extending into the limestone underlying the dike foundation. The Reach 1A 21.4-mile segment was completed in Fiscal Year (FY) 2013.

In 2011, the USACE changed its approach to fixing the dike. Instead of a reach-by-reach approach, the USACE decided to view the area as one large system and prioritize the implementation of projects that would have the largest impact in reducing the risk of dike failure. With construction of the Reach 1A seepage barrier under way between Port Mayaca and Belle Glade, the USACE determined the next projects that could provide the greatest impact in reducing risk were the replacement or removal of 32 water control structures (culverts) installed around the lake. These structures, which date back to the

1930s, provide a local source of water for irrigation and reduce impacts from flooding. Work began on the replacement and removal of these structures in 2011 and is scheduled for completion in 2018. Currently, one culvert has been removed, six are under construction for replacement, and four are scheduled for construction contract award in 2013.

While work is ongoing to replace water control structures, the USACE is determining the best solutions for the remainder of the dike. To adequately address the problems and develop alternatives, the USACE is conducting the Dam Safety Modification Study (DSMS). The DSMS is revising the geology and geometry of the dike in multiple locations and evaluating impacts from a full range of structural and non-structural alternatives that can be implemented to reduce risk. This study is scheduled for the NEPA review process in 2014, and the first project is anticipated for construction contract award in FY2017. At this time, no date has been established for completion of the rehabilitation project.

1.2.4 St. Lucie and Caloosahatchee Estuaries

The General Design Memorandum for the construction of the control structures along the St. Lucie and Caloosahatchee estuaries recognized that the estuaries would be subject to extreme high and low flows and would experience ecological impacts as a result of the C&SF Project (USACE, 1957). However, the priority of the system at that time was flood control and water supply. Research programs to investigate and document specific effects of discharges were initiated in the 1980s (Hauert and Startzman, 1980; Hauert and Startzman, 1985; Chamberlain and Doering, 1998). This research supported the development of graduated discharge thresholds that correspond to a progressively increasing spatial extent of damage. For the St. Lucie Estuary, these thresholds are based on total inflow that includes discharge from gauged water control structures on C-44, C-23, C-24, and Ten Mile Creek as well as estimates of groundwater inflow. For the Caloosahatchee Estuary, derivation of thresholds is based on measured flows at S-79.

The American oyster (*Crassostrea virginica*) and various seagrasses were selected as indicators of ecological health of the estuaries. The restoration goal for the St. Lucie Estuary is to reestablish viable oyster populations in the region between the US1 Bridge and A1A Bridge. When total monthly average discharge to the St. Lucie Estuary reaches 2,000 cubic feet per second (cfs), salinity at the US1 Bridge falls below target levels and oysters in this region begin to suffer. When flows exceed 3,000 cfs, salinity in the adjacent Indian River Lagoon is depressed sufficiently to impact seagrasses in this region.

High mean monthly flows to the Caloosahatchee Estuary greater than 2,800 cfs (measured at S-79) generally impacts seagrasses and oysters in the lower, Iona Cove region of the estuary just upstream of Shell Point. Flows greater than 4,500 cfs can cause loss of seagrasses in San Carlos Bay, located just downstream of the mouth of the Caloosahatchee Estuary.

1.2.5 Water Conservation Areas

Creation of the WCA areas through compartmentalization of the remnant Everglades created significant challenges in water management. Conditions in the WCAs ranged from significant drought events and muck fires in the 1960s and 1970s, followed by deepwater events and wildlife impacts in the 1980s and 1990s. Disruption in the natural flow patterns also resulted in major losses of tree islands in the WCAs,

especially in the northern reaches. Although modifications to the WCA regulation schedules have helped to moderate some of the over-drainage problems, areas of northern WCA-3A continue to be significantly drier than the interior, and the southern end of WCA-3A experiences increased water depths due to capacity constraints in the S-12 discharge structures and presence of protected species.

In addition to hydrological impacts to the WCAs, an unintended consequence of the redirection of flows that historically went to Lake Okeechobee from the northern EAAs was impacts due to the additional nutrient loads. Signs of nutrient impacts in the WCAs began to appear in the 1980s as indicated by the spread of cattail (*Typha* spp.) in WCA-2A and WCA-3A. The loss of other indicators of a low nutrient or oligotrophic system, such as periphyton and sawgrass, has also been noted. Improving the conditions within the WCAs, while still meeting the project purposes of water supply and flood control, limits the ability to move water into and out of these areas until the CERP project features are constructed.

1.2.6 Stormwater Treatment Areas

The overarching goal of the construction and operation of the Everglades STAs is to treat stormwater runoff from the EAA and other sources to achieve compliance with Florida's water quality standards for total phosphorus (TP) in the EPA. The redirection of EAA stormwater to the WCAs, as part of the Interim Action Plan to improve Lake Okeechobee water, resulted in nutrient impacts to the WCAs. Construction of the Everglades STAs was a requirement of the 1994 EFA and the federal Everglades Settlement Agreement. The 1994 Everglades Construction Project (ECP) included the construction of five STAs totaling approximately 40,000 acres of effective treatment area.

The STAs were also designed to treat runoff from several 298 Drainage Districts, which discharged into Lake Okeechobee under the Interim Action Plan. These areas comprise approximately 32,500 acres and include the East Beach Water Control District, South Shore Drainage District, South Florida Conservancy District, East Shore Water Control District, and agricultural lease 3420, and now generally discharge south to the STAs and EPA. The diversion of the 298 Districts reduced stormwater inflow volumes and nutrient loads to the lake and increased flow to the south. The ECP STAs, coupled with agricultural Best Management Practices (BMPs), were originally designed to reduce the long-term, flow-weighted mean (FWM) TP concentrations in discharges to an interim goal of 50 micrograms per liter ($\mu\text{g/L}$). Related efforts were successful in achieving this interim goal but not the more stringent 10 $\mu\text{g/L}$ TP criterion for the EPA.

In 2003, the Florida legislature amended the EFA to require implementation of a plan to achieve compliance with the Everglades water quality standards, known as the Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals (Long-Term Plan; Burns & McDonnell, 2003). The 2003 Long-Term Plan consisted of various structural and operational enhancements as well as a science-based STA optimization and research program. Through plan implementation, the District expanded the original STAs by an additional 17,000 acres, resulting in approximately 57,000 acres of effective treatment area (STA-1 East, STA-1 West, STA-2, STA-3/4, and STA-5/6) south of Lake Okeechobee as of 2010. To date, the STA expansions and Long-Term Plan enhancements have resulted in improved STA performance, but the STAs have not consistently achieved the 10 $\mu\text{g/L}$ TP criterion.

In June 2012, the State of Florida and the U.S. Environmental Protection Agency (USEPA) reached consensus on new restoration strategies for further improving water quality in the Everglades. Based on months of scientific and technical discussions, these strategies will expand water quality improvement projects to achieve an ultra-low TP water quality standard established for the Everglades. In August 2012, the District entered into two Consent Orders with the FDEP along with associated National Pollutant Discharge Elimination System (NPDES) and EFA Watershed Permits, as part of the consensus plan to achieve a Water Quality Based Effluent Limit (WQBEL) for discharges from the Everglades STAs into the EPA. The 12-year plan, which includes building additional features and STA expansions, is described in the Restoration Strategies Regional Water Quality Plan (SFWMD, 2012). These features will provide enhanced treatment and reduce the pulse effects of runoff and prolonged deepwater conditions in the STAs. However, until those features are constructed, the STAs continue to be adversely impacted by excessive flows and loads, as well as extended periods of deep water. In addition to creating more than 6,500 acres of new treatment area and 110,000 ac-ft of additional water storage, supplementary source controls will be implemented and the Science Plan for the Everglades STAs will focus research on further improving treatment area performance (SFWMD, 2013). The Restoration Strategies plan amends the Long-Term Plan and was incorporated by the Florida legislature into the 2013 EFA amendments.

1.2.7 Everglades Restoration Transition Plan

The overall objective of the Everglades Restoration Transition Plan (ERTP) is to maximize operational flexibility in order to improve conditions for the Everglade snail kite (*Rostrhamus sociabilis plumbeus*), wood stork (*Mycteria americana*), and other wading birds and their habitat. In addition, the ERTP will maintain nesting season requirements for the Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) in the Everglades National Park, along with C&SF project purposes of flood control, seepage management, and water supply. In order to achieve ERTP objectives, the USACE and USFWS lead a multi-agency team to develop performance measures and ecological targets based upon the USFWS Multi-Species Transition Strategy for each species and their habitat.

In a separate but parallel effort, stakeholders' concerns with prolonged high water levels within WCA-3A prompted the USACE Water Resources Engineering Branch to conduct a limited hydrology and hydraulics assessment. Based on review of WCA-3A design documents, and in conjunction with the hypothesis that the S-12s are not capable of achieving the original design discharge of 32,000 cfs, a two-phase analysis for WCA-3A high water events was proposed. Phase 1 consisted of identification and assessment of interim water management criteria for WCA 3A, including operational changes proposed as part of the ERTP efforts. The USACE, via the ERTP, reverted to the 1960 WCA-3A (9.5 to 10.5 ft NGVD) regulation schedule as interim measure water management criteria for WCA-3A Zone A (**Figure 2**). This regulation schedule modification reduced the maximum regulation stage by 0.25 ft during November–December and by 0.5 ft during February–September.

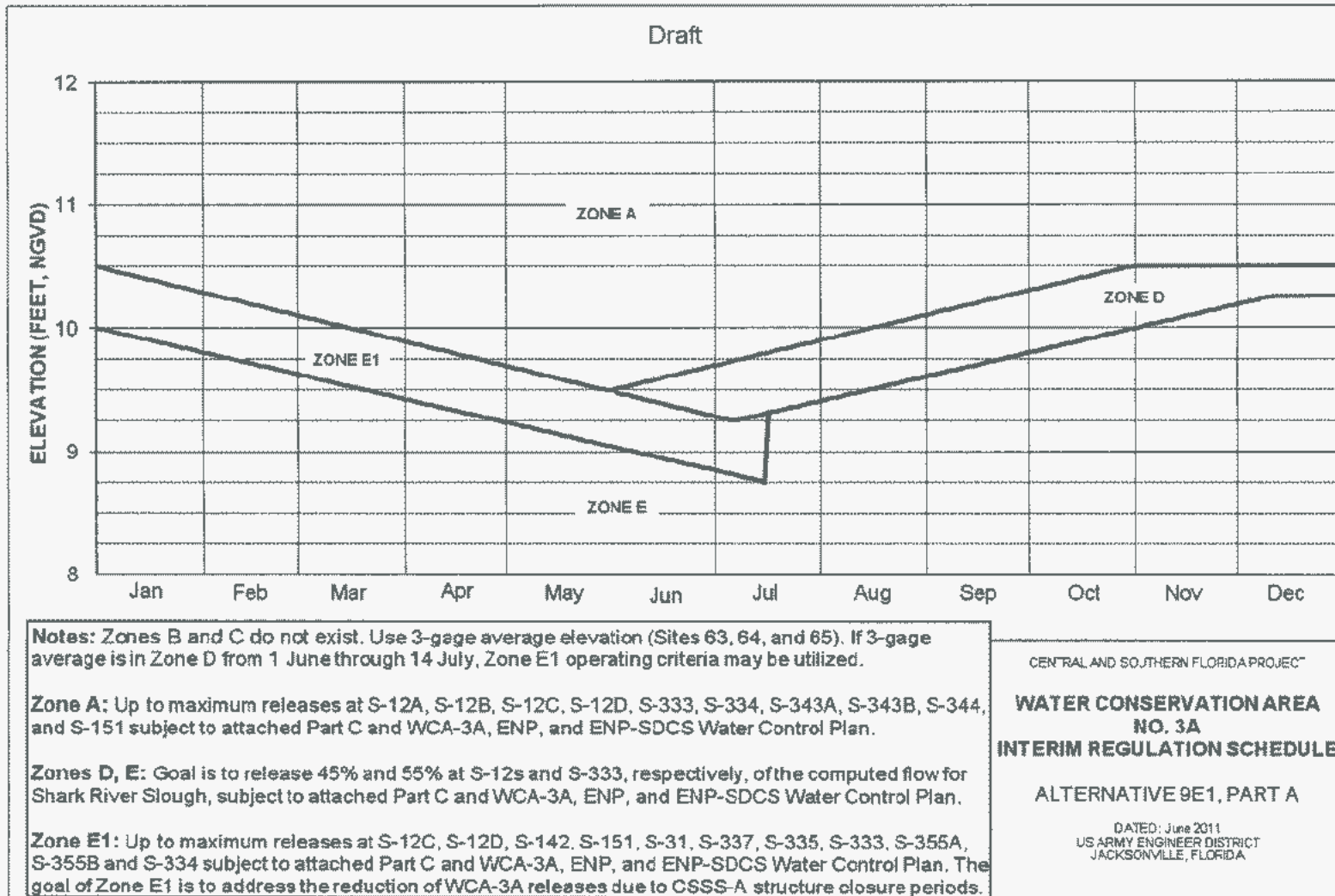


Figure 2. WCA-3A Interim Regulation Schedule Part A (from USACE, 2011).

The final array of alternatives for the ERTS was formulated using the South Florida Water Management Model (SFWMD, 2005) to incorporate both the WCA-3A interim high water management criteria and ERTS performance measures and targets. ERTS updates were incorporated into the WCAs, Everglades National Park, and Everglades National Park-South Dade Conveyance System Water Control Plan when the ERTS Record of Decision, including Appendix A-Operational Guidance, was executed on October 19, 2012. Phase 2 will require more detailed flood routing and hydraulic analysis of WCA-3A operations, as well as risk analysis of potential human health and safety concerns associated with WCA-3A stages. Additional NEPA analysis may be required to implement operational or structural changes that may result from future Phase 2 analyses.

1.2.8 Protected Species

Various protected fauna can constrain water operations throughout the District. These fauna are primarily protected by the federal Migratory Bird Treaty Act of 1918 (MBTA), federal Endangered Species Act of 1973 (ESA), and Florida Endangered and Threatened Species Act (FETSA).

1.2.8.1 Black-Necked Stilts and Other Ground-Nesting Migratory Birds

Toward the end of each dry season, hundreds of black-necked stilts (*Himantopus mexicanus*) are attracted to the Everglades STAs as well as many other shallow wetlands operated and maintained by the District. These medium-sized shorebirds use these areas as foraging and nesting habitat. As these wetlands dry down, portions of the wetlands typically become very shallow and, in many cases, mud flats or gravelly sediments are exposed within the wetlands. These shallow areas and exposed mud flats/gravelly sediments are ideal for black-necked stilts nesting directly on the ground (**Figure 3**). In shallow areas, they will construct nests that emerge about three to five inches out of the water. Their nesting typically is from late April–early July, and the average incubation period is 23 days.



Figure 3. Gravelly sediments in exposed wetlands (*left*) and black-necked stilt nesting (*right*) in the Everglades STAs (photos by the SFWMD).

Several other species of ground-nesting birds have been observed nesting in the STAs, including Florida sandhill cranes (*Grus canadensis*), mottled ducks (*Anus fulvigula*), common gallinules (*Gallinula galeata*), and pie-billed grebes (*Podilymbus podiceps*). Species such as killdeer (*Charadrius vociferous*), common nighthawks (*Chordeiles minor*), and Florida burrowing owls (*Athene cunicularia floridana*; note that technically this species nests underground) may nest in these wetland areas if the water level drops to extremely low levels that expose large areas of the underlying sediments. If the underlying sediments are somewhat sandy, then least terns (*Sternula antillarum*) also may be attracted to the exposed areas and nest in the sand or gravel. All these birds including the black-necked stilt are protected by the MBTA. Unlike the ESA, there are no takes allowed for migratory birds protected only by the MBTA. Least terns, Florida burrowing owls, and Florida sandhill cranes are additionally protected by the FETSA.

The District, in cooperation with the USFWS, finalized an Avian Protection Plan (APP) in 2008 for the Everglades STAs (Pandion Systems, Inc., 2008). Black-necked stilts and Florida burrowing owls are used as sentinel species for this APP. This means that by addressing these two species then impacts to other protected migratory bird species should also be minimized within the Everglades STAs. The APP characterizes the risks to ground-nesting migratory bird species from STA construction, operation, start-up, drought conditions, routine maintenance, and enhancement activities and outlines actions intended to minimize harmful impacts to migratory birds and their nests due to these activities. This plan is unconventional in that it has been developed to help manage the operation of constructed treatment wetlands, i.e., the STAs, which already provide important habitat, nesting, and foraging benefits to migratory birds as compared to the previous agricultural land use (Gawlik and Beck, 2010). Although the APP does not cover other shallow wetlands that are operated by the District or the STAs north of Lake Okeechobee, the District still surveys many of these wetlands so that regional impacts to ground-nesting birds are minimized to the greatest extent possible and the District remains in compliance with applicable federal and state wildlife permits and regulations.

The number of black-necked stilts that nest within each STA varies greatly from year to year (**Table 1**). Based on field observations, hydrologic conditions within the STAs during the nesting season appears to be a key determining factor in how many stilts will attempt to nest during a given season. At a minimum, routine surveys are conducted monthly in each STA between April and June each year to document nesting by black-necked stilts and Florida burrowing owls, while additional surveys are further conducted as necessary. When nests are observed, those nests and the water stages during observations are documented. Maximum stages in which an STA cell can be operated without inundating the observed stilt nests have been established and cells are operated below these levels unless there are flooding hazards (that could be a risk to human health and safety) in the region. These stage maximums limit the amount of water that can flow through STA cells and in some cases limit the amount of water that can travel through an entire STA.

Table 1. Avian Protection Plan survey results for black-necked stilt nesting attempts in each Everglades STA from 2006 to 2013.

Year	STA-1E	STA-1W	STA-2	STA-3/4	STA-5/6	Total Nests
2006	186	49	0	5	122	362
2007	102	236	74	55	147	614
2008	69	26	16	7	73	191
2009	102	360	237	69	105	873
2010	150	19	29	15	14	227
2011	42	105	39	142	11	339
2012	9	5	0	4	15	33
2013	22	13	12	4	45	96

1.2.8.2 Everglade Snail Kites

The Everglade snail kite (*Rostrhamus sociabilis plumbeus*) is a federally and state listed endangered raptor species protected by the ESA, MBTA, and FETSA. These birds nest in shallow marshes and their nests are constructed typically one to three meters high in emergent vegetation (e.g., cattail, sawgrass, or willow) over water. When these birds nest in non-woody emergent vegetation, their nests have a tendency to sink toward the water surface as the vegetation supporting the nest ages and the chicks gain weight. While the usual nesting period for Everglade snail kites is between March and August, nesting by these raptors in the STAs has been observed as early as January and as late as October.

The District consults with the USFWS when nesting snail kites are observed in Everglades STAs or other areas that require the management of water throughout the District. Operational envelopes are established with maximum and minimum stages as well as an ideal stage that water managers should attempt to maintain for nesting snail kites if possible. Maximum stages are established so that nests that have sunk toward the surface of the water are not inundated, which would cause nest failures. Maximum stages can greatly impact the amount of water that can be allowed to enter into an STA cell or flow-way. Minimum stages are established to help keep non-woody vegetation upright and reduce the possibility of nest predation by animals like raccoons. Of course, it is recognized that minimum water stages can only be maintained if water is actually available. Snail kites were first observed nesting in the Everglades STAs in 2010, with a total of 29 nests observed in STA-5 Cells 1A and 2A. Only one nest was observed in 2011 (STA-3/4) and in 2012 (STA-5). Notably, a record number of snail kites were observed nesting in the STAs during the 2013 nesting season.

1.2.8.3 Other Listed Species

The Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*)—an endangered species of bird that is protected by the ESA—nests exclusively within several subregions of Everglades National Park. The operation of the S-12 structures is performed with consideration for nesting sparrows in subpopulation A, south of S-12A, so that nests are not inundated, which would cause nest failures. This can limit the amount of water that can be discharged into this area. The sparrow nesting occurs from late February–early August.

Shallow marshes and STAs operated by the District normally have reflooding guidance associated with the eastern indigo snake (*Drymarchon corais couperi*). The guidance outlines that on project start-up or after prolonged droughts that have dried these areas completely, reflooding can only occur at a rate of 0.5 ft per day, so that snakes that may be using the dried marsh do not drown in underground burrows.

2.0 ANALYSIS OF LAKE OKEECHOBEE OPERATIONS, JAN-JUN 2013

This section reviews the Lake Okeechobee operations during the dry season months of 2013 when the federal operating schedule allowed regulatory releases to be made to the WCAs. Lake Okeechobee regulatory releases are defined as releases of excess water from the lake to regulate or manage its water levels. After an overview of operating authorities, the federal regulation schedule for Lake Okeechobee and the release decisions are described. A detailed daily review of the operations associated with lake regulatory releases to the WCAs via the STAs is then provided to ascertain if additional releases could have been made. This retrospective analysis identifies and respects the conditions and constraints that existed during all the days that the Lake Okeechobee release guidance allowed regulatory releases to be made to the WCAs.

2.1. Overview of Authorities, Responsibilities and Operating Constraints

The authorities that govern the operation of water control infrastructure for Lake Okeechobee, the EAA, and the STAs are briefly described in this subsection. An overview of the federal and state operating responsibilities is also provided, followed by a short description of the physical and operating constraints that limit Lake Okeechobee discharges to the WCAs.

2.1.1 C&SF Project Water Control Plan for Lake Okeechobee and the EAA

This federal Water Control Plan (WCP) contains the details of the operating rules and guidance used by the USACE for managing Lake Okeechobee water levels (USACE, 2008). These release rules and guidance are collectively known as the Lake Okeechobee Regulation Schedule (LORS), and the current regulation schedule is known as the 2008 LORS. The WCP was finalized in 2008 as part of the USACE's planning process and the NEPA process which produced the Final Supplemental Environmental Impact Statement (SEIS), Lake Okeechobee Regulation Schedule (USACE, 2007).

2.1.1.1 2008 Lake Okeechobee Regulation Schedule Summary

The 2005–2007 federal planning process evaluated alternative regulation schedules and selected the 2008 LORS as the operating plan that most appropriately balanced the multiple Lake Okeechobee management purposes. Note that issues regarding the structural integrity of the Herbert Hoover Dike led to lowering the upper limit of the lake regulation schedule from 18.5 ft NGVD to 17.25 ft NGVD. Simulation analysis in the SEIS shows the 2008 LORS would reduce lake stages by about one foot, on average. The reduction in the upper limit effectively reduced the storage capability of the lake by roughly 580,000 ac-ft. The lower limit of the LORS was also reduced and a Baseflow Sub-band was created to discharge excess lake water at relatively low rates to gradually lower the lake stage prior to the wet season. **Figures 4-6** show parts B, C, and D of the 2008 LORS release guidance, respectively.

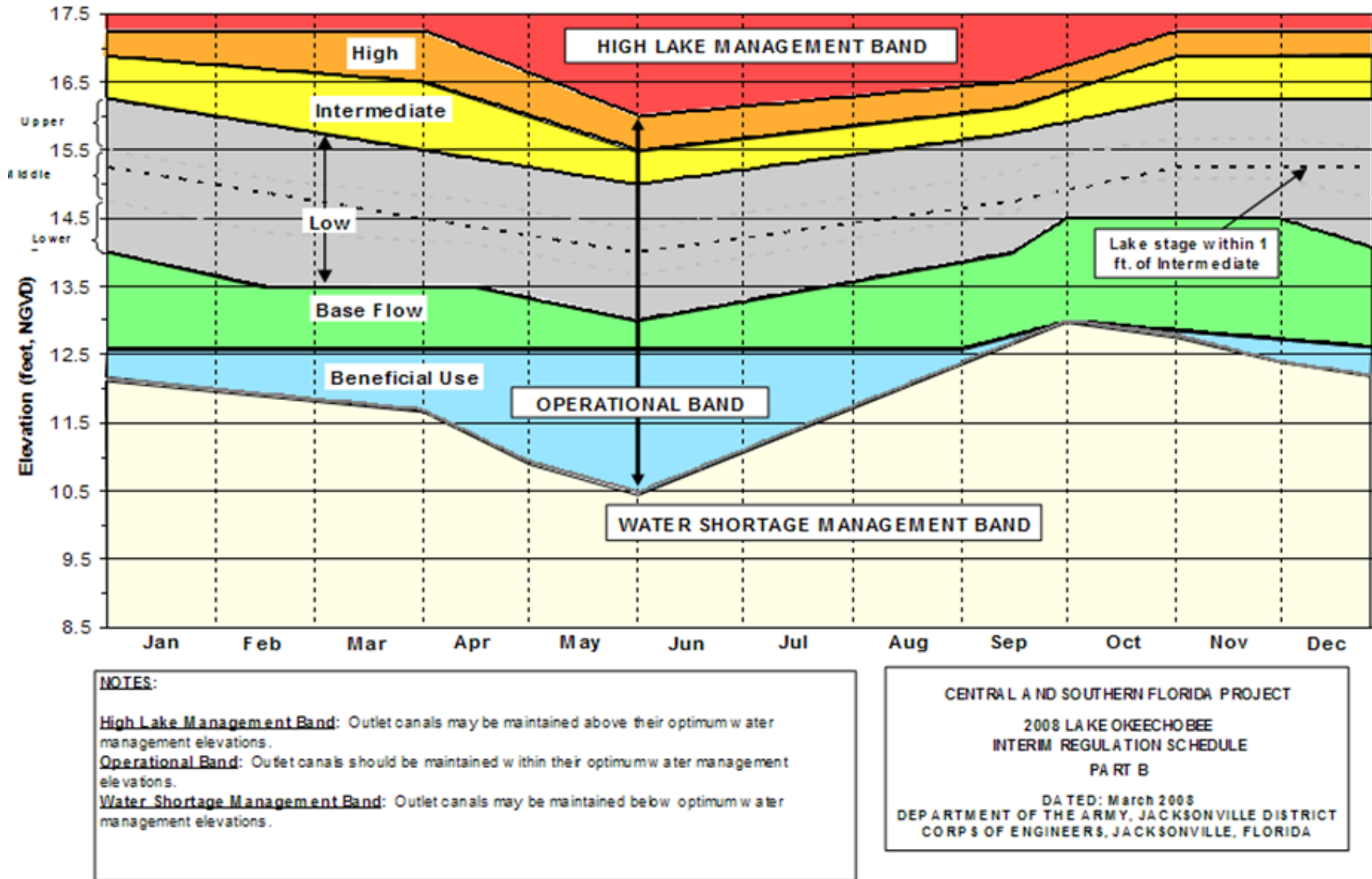


Figure 4. Part B, 2008 Lake Okeechobee Interim Regulation Schedule (2008 LORS).

2008 LORS

Part C: Establish Allowable Lake Okeechobee Releases to the Water Conservation Areas

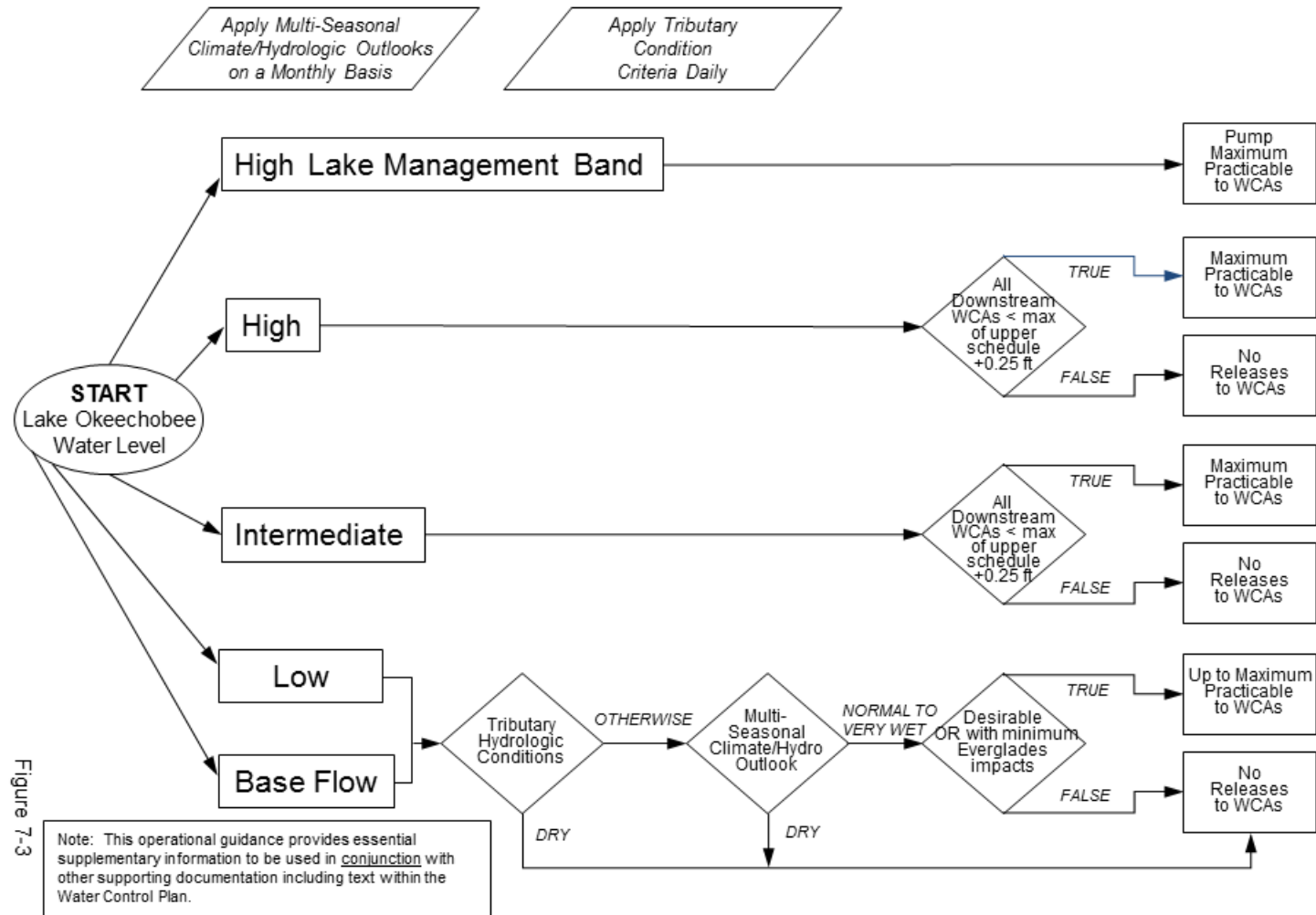


Figure 7-3

Figure 5. Part C of the 2008 LORS release guidance.

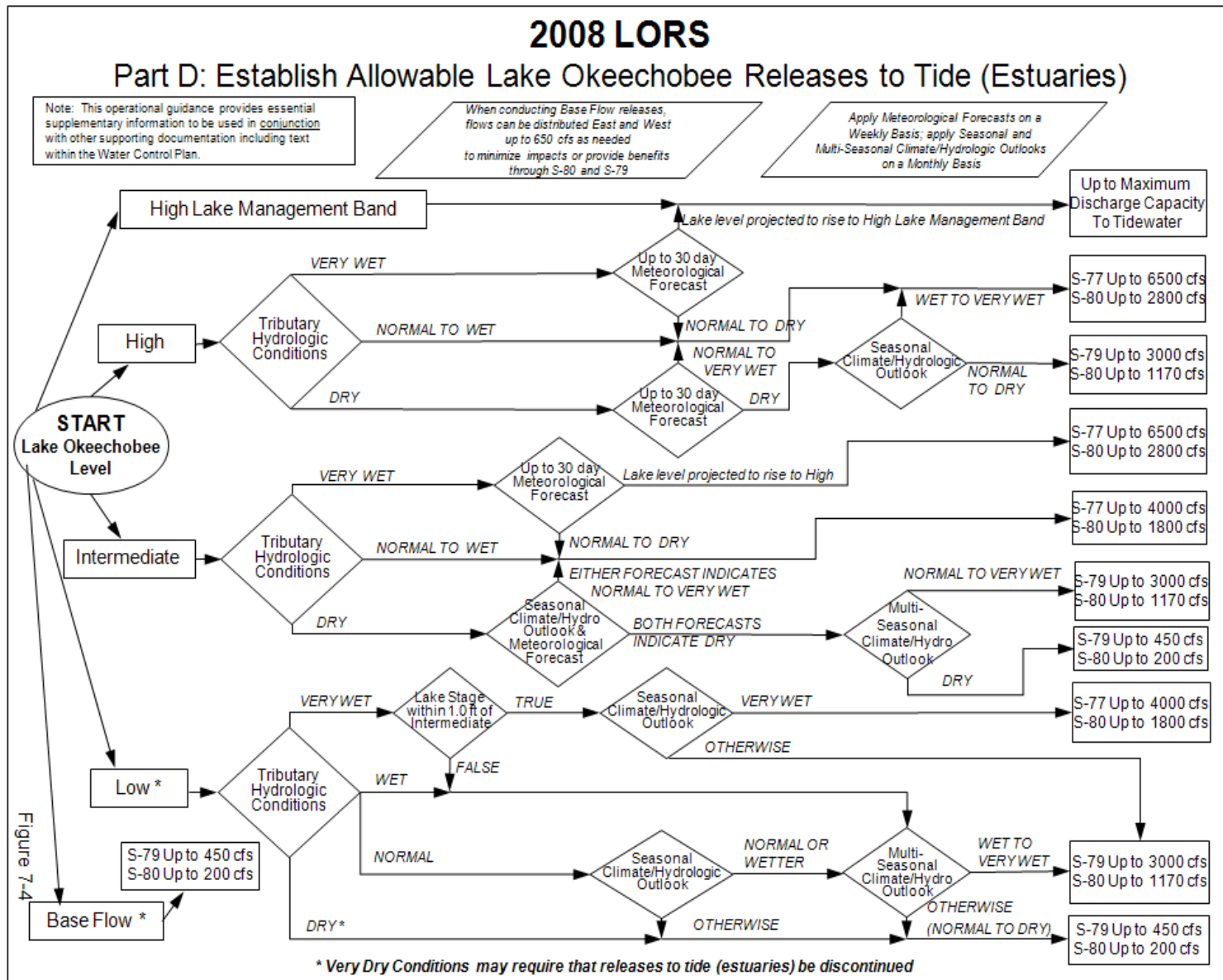


Figure 6. Part D of the 2008 LORS release guidance.

2.1.1.2 2008 LORS Part C

The release guidance flowchart (**Figure 5**) contained in the federal WCP provides guidance for determining the allowable Lake Okeechobee regulatory releases to the WCAs. When lake water levels are in the Low Sub-band or the Baseflow Sub-band, the release guidance may call for releases “Up to Maximum Practicable to WCAs if desirable or with minimum Everglades impacts.” Section 7-04,3.b.(a) of the WCP further describes the operation: “To WCAs-When Tributary Hydrologic Conditions and the multi-seasonal climate/hydrologic outlook are not in their dry classifications, then up to maximum practicable release to the WCAs are allowable if the release is beneficial to, or will result in minimum Everglades’ impacts. Both the quantity and quality of Lake Okeechobee water will be considered.”

2.1.1.3 Interpretation of Maximum Practicable

Although not explicitly defined in the WCP, it is important to recognize that “maximum practicable” in this context effectively means to release as much as possible subject to physical and operating constraints. The constraints for Lake Okeechobee regulatory discharges to the WCAs are discussed in the *Physical and Operating Constraints* sub-section.

2.1.2 Federal Water Quality Standards for the Everglades

As discussed previously, the construction of the Everglades STAs was a requirement of the 1994 EFA and the federal Everglades Settlement Agreement. The overarching goal of the construction and operation of the STAs is to treat stormwater runoff from the EAA and remove TP to the extent that discharges into the downstream Everglades would not cause an imbalance to native flora and fauna. The original STAs, coupled with agricultural BMPs, were designed to reduce the long-term, FWM TP concentrations in discharges to 50 µg/L. To date, BMPs and STAs have been successful in achieving this goal but not the 10 µg/L TP criterion established for the EPA.

In 2012, after extensive technical and policy discussions with the USEPA and the FDEP, the SFWMD entered into Consent Orders and associated NPDES and EFA permits with the FDEP. Specifically, the District, USEPA and FDEP developed a consensus plan, known as Restoration Strategies, to achieve a WQBEL for TP discharges from the STAs into the EPA which includes building additional STA treatment areas and water storage features over the next 12 years. The WQBEL, outlined as a two-part test, was derived from the 10 µg/L long-term geometric mean (LTGM) TP criterion and translated into a FWM TP concentration to be applied individually to the total discharge for each STA. Monitoring for the WQBEL compliance is done at the individual discharge points from each STA. The STAs are in compliance with the WQBEL when the TP concentration representative of the total discharge from each STA does not exceed 13 µg/L as an annual FWM in more than three out of five water years on a rolling basis (Part 1) and 19 µg/L as an annual FWM in any water year (Part 2). The two parts for the WQBEL were developed to allow for expected year-to-year variability in the STA discharge TP concentration, as observed at the marsh reference sites used to develop the TP criterion, while attaining the long-term TP criterion. Therefore, if the discharges from each STA meet the WQBEL, then phosphorus discharges from the STAs into the EPA are not expected to cause or contribute to TP criterion exceedances. Importantly, the Everglades STAs are the first attempt to achieve such an ultra-low discharge phosphorus concentration

using man-made wetlands based on known information. To achieve ultra-low TP concentrations, each STA must be in optimal condition as phosphorus is removed from the inflow water and is taken up by plants, microbiota, litter, and, ultimately, the accumulated sediment/soil of the STA.

2.1.3 STA Operations

STA operations are guided by the STA Operating Plans and daily and weekly monitoring of vegetation conditions, and phosphorus loads and concentrations, along with seasonal considerations and weather and climate forecasts. The original STAs were specifically designed and sized, with the exception of STA-3/4, to treat EAA stormwater. However, the completion of Compartment B at STA-2 in 2012 may allow limited Lake Okeechobee releases through that STA into WCA-2. Under Restoration Strategies, which includes increased upstream storage and treatment areas, the STAs are assumed to treat an average of 38,500 ac-ft per year of lake regulatory releases and still achieve the WQBEL. However, until that proposed plan is constructed and operational, the STAs will have limited treatment capability for lake regulatory releases.

It has been suggested that the STAs could be used to store water from Lake Okeechobee when the lake levels are high. It is important to recognize that the STAs are vegetated shallow water treatment areas and are not designed for water storage. Treating the STAs as a reservoir would result in damage to treatment vegetation and reduce their water treatment performance. They are intended to be operated most of the time in a flow-through fashion at relatively shallow depths to protect vegetation and best serve their intended function to remove phosphorus. Additionally, the presence of protected species often poses complications to STA operations.

2.1.4 2013 Avian Protection Plan and Snail Kite STA Nesting Season Review

No burrowing owls were observed during the 2013 nesting season in the Everglade STAs. An overview of black-necked stilt nesting in each of the Everglades STAs during this season is presented below.

- **STA-1E:** STA-1E experienced relatively few nesting black-necked stilts until the end of the 2013 nesting season. A single nesting black-necked stilt was observed in Cell 5 of STA-1E on May 10. A maximum stage of 17.6 ft was established to protect this stilt nest. The nesting at this one nest was determined to have been completed during a May 29 survey and the maximum stage was lifted. On June 17, 17 stilt nests were observed in Cell 2 of STA-1E. The number of nests grew to 21 nests by June 21. No maximum stage was established for STA-1E Cell 2 because it has been offline during 2013 due to USACE construction. Late in the 2013 nesting season, there were three nesting stilts in this cell as of the July 17 survey.
- **STA-1W:** Thirteen nesting black-necked stilts were observed in STA-1W Cells 2B and 4 during the 2013 nesting season. Four nests were observed on May 10. On May 31, there were nine additional nests observed. A maximum water stage of 11 ft was established in Cells 2B and 4 of STA-1W to protect all nesting stilts after the May 10 survey. Rainfall related to Tropical Storm Andrea in early June created high water levels throughout the region including the Everglades STAs. Rainfall directly into the STA caused the water stage to exceed 11 ft. Once this occurred,

maximum stages were lifted because it was determined that the nests had been rapidly inundated by rainfall.

- **STA-2:** Twelve black-necked stilts were observed within STA-2 during 2013. Four nests were observed in Cell 5 and one nest was observed in Cell 6 on May 14. During the May 15 survey, seven nests were observed in Cell 3. Maximum stages were established in Cell 3 (10.9 ft), Cell 5 (10.7 ft), and Cell 6 (10.7 ft). Rainfall related to Tropical Storm Andrea in early June created high water levels throughout the region including the Everglades STAs. Rainfall directly into the STA caused the water stage to exceed the established maximum stages. Once this occurred, maximum stages were lifted because it was determined that the nests had been rapidly inundated by rainfall.
- **STA-3/4:** Only four nests were observed in STA-3/4 during 2013. On April 22, a single nest was observed in the periphyton STA (PSTA) cell of STA-3/4. A maximum stage of 10.5 ft was established to protect this nest. This nest was not observed during the May 16 survey in STA-3/4 and the maximum stage for the PSTA cell was lifted. There were two stilt nests observed in Cell 2A and one stilt nest observed in Cell 3B during the May 16 survey. Maximum stages were established in Cell 2A (10.2 ft) and Cell 3B (11.1 ft) to protect these nests. On May 21, a survey was conducted to see if the stilt nest in Cell 3B was still present and it was not observed, so the maximum stage for this cell was lifted. The maximum stage in STA-3/4 Cell 2A related to nesting black-necked stilts was lifted after no nesting stilts were observed during the June 7 survey.
- **STA-5/6:** There were 45 stilt nests observed in STA-5/6 during 2013. The first nesting stilts were observed in STA-5/6 Cells 1B, 2B, 3B, and 5B during surveys on April 29–30. These nests resulted in the establishment of maximum stages in Cell 1B (12.5 ft), Cell 2B (12.5 ft), Cell 3B (13.6 ft), and Cell 5B (13.6 ft). During the May 22 and 24 APP surveys, nests were observed in Cells 1B, 2B, 3B, 4A, and 4B. These nests resulted in the establishment of maximum stages in Cell 1B (12.5 ft), Cell 2B (12.3 ft), Cell 3B (13.6 ft), Cell 4A (13.3 ft), and Cell 4B (13.2 ft). Nests in Cells 3B and 4B were observed during the June 12 and 14 surveys. This resulted in the establishment of maximum stages in Cell 3B (13.6 ft) and Cell 4B (13.2 ft), with the other maximum stages being lifted. No stilt nests were observed during the July 3 survey, at which time all maximum stages related to black-necked stilts were lifted.
- **STA-Wide:** As of July 17, 2013, 37 snail kite nests were observed in the STAs. STA-1E Cell 4N has had 19 nests, with the first nests observed in late January. STA-5 Cell 3B has had 18 nests, with the first nests observed in early May. As nests remain in both STAs, these two cells are still operating with maximum, minimum, and maintained stages (**Table 2**).

Table 2. Water stages maintained in the Everglades STA cells that contained one or more Everglade snail kite nests between January 28 and July 3, 2013.

[Note: Snail kites nested beyond July 3 at both STA-1E and STA-5;

* = as long as water is available; † = max stage caused by nesting black-necked stilts].

Date	Max Stage (ft NGVD)	Min Stage (ft NGVD)*	Maintain (ft NGVD)*
STA-1E Cell 4N (Average Elevation = 14.1 ft)			
01-28-13	17.4	15.1	15.4
02-11-13	16.6	15.1	15.4
03-03-13	15.9	15.1	15.4
04-04-13	16.4	15.1	15.4
06-28-13	16.7	15.1	15.4
STA-5/6 Cell 3B (Average Elevation = 12.4 ft)			
05-09-13	13.6†	13.4	13.6
07-03-13	14.4	13.4	13.7

2.1.5 Dispersed Water Management

The goals and objectives of the Dispersed Water Management (DWM) Program are to provide shallow water storage, retention, and detention to enhance Lake Okeechobee and estuary health by reducing discharge volumes, reducing nutrient loading to downstream receiving waters and expanding ground water recharge opportunities. The DWM Program is a multi-faceted approach to working cooperatively with public and private land owners to identify, plan, and implement mechanisms to retain or store water. The four main categories of projects under the District’s DWM Program include storage and retention projects on private lands, storage and retention projects on public lands, Northern Everglades Payment for Environmental Services Projects, and Water Farming Payment for Environmental Services Pilot Projects. The total storage, retention, and detention created by the DWM Program since 2005 is 61,261 ac-ft, including contributions from the U.S. Department of Agriculture, Natural Resources Conservation Service (USDA NRCS) Wetland Reserve Program (WRP) and other programs, the Florida Department of Agriculture and Consumer Services (FDACS) BMP Program, agricultural landowners, agricultural organizations, non-governmental organizations, and local governments.

2.1.6 Operating Decisions and Responsibilities

The USACE is responsible for managing Lake Okeechobee water levels and makes operational decisions about whether to retain water or release water based on their regulation schedule release guidance. As previously noted, the release guidance is described in the Water Control Plan, known as the 2008 LORS. The USACE makes lake release decisions taking into account the best available science and data

provided by its staff and partners, including the SFWMD. Each week, the SFWMD environmental operations team discusses the system-wide hydrologic, environmental, and water supply conditions, and evaluates the overall status of the water management system. The District also issues a weekly Operational Position Statement, which includes a recommendation to the USACE for lake releases. These detailed reports are posted on the SFWMD's web site at www.sfwmd.gov, under the *Scientists & Engineers, Operational Planning* tab.

The USACE has operation and maintenance responsibility for the major Herbert Hoover Dike culverts and the Lake Okeechobee waterway structures, including the primary lake outflow spillways: S-308 to the St. Lucie Canal (C-44) and S-77 to the Caloosahatchee River (C-43) (**Figure 7**). USACE locktenders located at each of the Lake Okeechobee waterway structures operate those structures at the direction of the USACE Jacksonville District Water Management Section and the South Florida Operations Office in Clewiston.

The SFWMD is the local sponsor for the federal Central and Southern Florida Project (C&SF Project) and has operation and maintenance responsibility for all the Lake Okeechobee structures not controlled by the USACE. Among the structures operated and maintained by the SFWMD are the southern gated spillways. The District operates the southern spillways: S-354 to the Miami Canal, S-351 to the North New River (NNR) and Hillsboro canals, and S-352 to the West Palm Beach Canal (**Figure 7**). Lake Okeechobee regulatory discharges via the southern spillways are made by the SFWMD Water Control Operations Bureau on behalf of the USACE. The District's operations staff manages the southern spillways according to both federal and state operating regulations, recognizing and respecting the multiple project purposes and system operating constraints.

The SFWMD is also responsible for operation and maintenance of the Everglades STAs. As previously noted, the STAs were constructed to improve the quality of water flowing to the WCAs. Regulations, water quality standards, and federal Settlement Agreement criteria require runoff from the EAA and Lake Okeechobee regulatory releases to be treated by the STAs. STA-3/4 was the only STA originally designed to treat a limited volume of Lake Okeechobee regulatory discharge, and its capability to receive and treat lake discharges has decreased over time as Everglades water quality standards have become more restrictive.

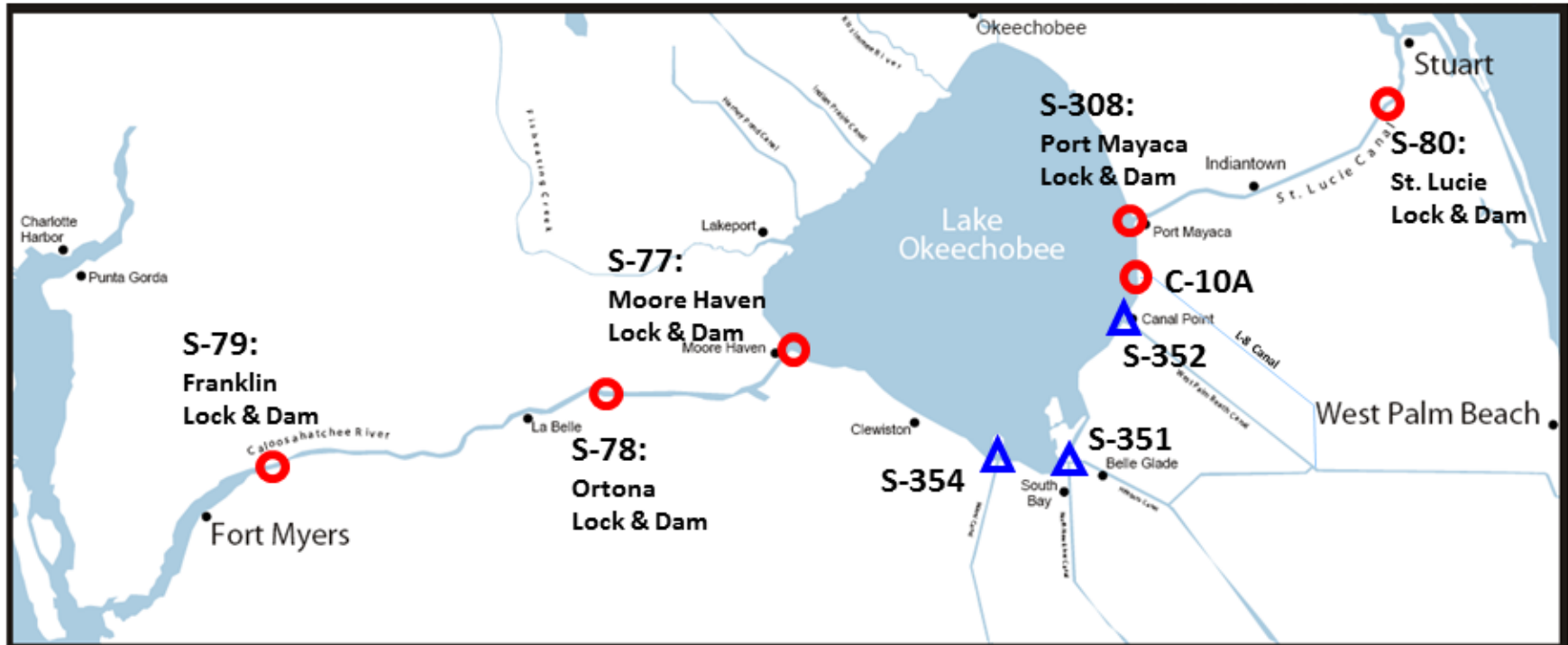


Figure 7. Lake Okeechobee structures managed by the U.S. Army Corps of Engineers (USACE) (shown as **red circles**) and the South Florida Water Management District (SFWMD or District) (shown as **blue triangles**).

2.1.7 Physical and Operating Constraints

Several physical and operating constraints limit the timing and amount of Lake Okeechobee regulatory releases that can be made to the WCAs (**Figure 8**). These constraints can be characterized by the following questions, which are always evaluated prior to making the decision to discharge lake regulatory water to the WCAs.

Do the WCAs have sufficient capacity to receive the Lake Okeechobee regulatory discharge?

Lake Okeechobee regulatory discharges to the WCAs are constrained by water levels in the conservation areas. Specifically, federal regulations contained in the Water Control Plan prohibit lake regulatory releases to the WCAs when WCA water levels exceed their respective regulation schedules. Therefore, lake regulatory discharges are not made to the WCAs if WCA stages exceed their regulation schedules.

Do the primary EAA canals have sufficient capacity to convey Lake Okeechobee regulatory discharge?

The EAA canals provide conveyance for water supply/irrigation and flood control. During the wet season, these canals operate primarily for flood control of the EAA basins, consistent with the WCP regulations and designed intent of the C&SF Project to provide central and southern Florida regional-scale flood control. During extended wet periods, typically during the May-October wet season, there are few opportunities to discharge lake regulatory releases through the EAA canals because they have limited flow-through conveyance capability. During the dry season, these constraints are not as limiting and, therefore, there are more opportunities for conveying lake regulatory discharge during that period.

Do the STAs have sufficient hydraulic and treatment capacity to receive the Lake Okeechobee regulatory releases?

Water levels in the STA treatment cells are important to both the hydraulic and treatment capability of the STAs. The STA treatment cells have target water depths that were designed to provide the best treatment capability without adversely affecting the health of the STA vegetation. Excessive flooding depths and durations can adversely affect the capability of the STAs to meet water quality criteria. Experimental and operational experience shows that as depths increase above target stages, cattail photosynthesis and root growth slows. Over the past several years, the District has invested significant effort and cost to rehabilitate cattail cells that have experienced prolonged deepwater conditions. Prior to recommending lake releases, District staff carefully assesses STA vegetation health and subsequent treatment capability.

It is important to recognize that even if all these constraints were theoretically relaxed, the capacity to convey large discharges through the EAA is limited by the physical hydraulic capacity of structures and canals. **Figure 9** shows the relative design capacities of the Lake Okeechobee outlet structures. Note that the design capacity south is only 14 percent of the total outflow design capacity. This reflects the 1950s C&SF Project design to convey most of the excess lake water to the Gulf of Mexico and Atlantic Ocean.

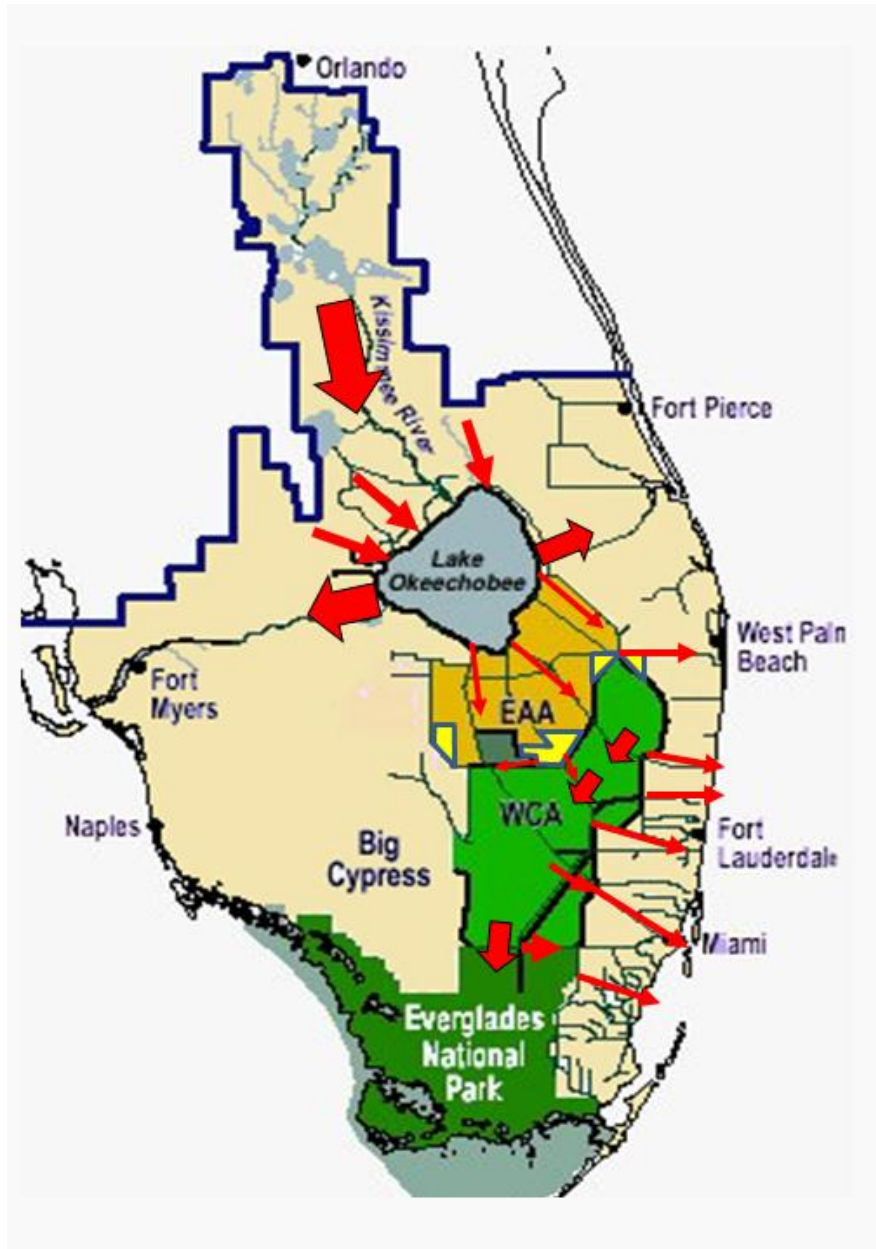


Figure 8. Multiple constraints limiting discharge of excess water from Lake Okeechobee: to the east/west, includes C-43 and C-44 basin runoff and available conveyance capacities; to the south, includes EAA runoff and available conveyance capacities, WCA storage capacities, WCA outflow limitations (e.g., coastal basin runoff/available conveyance capacity, S-12 discharge capacity, water levels in the northeast Shark River Slough, and protected species such as the Cape Sable seaside sparrow).

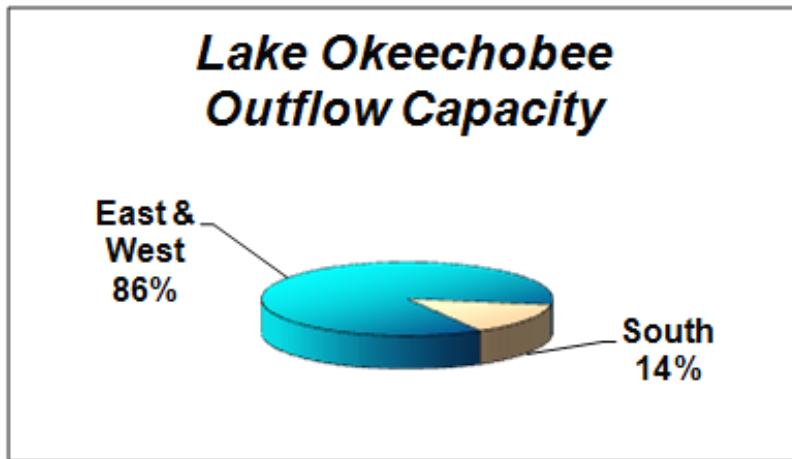
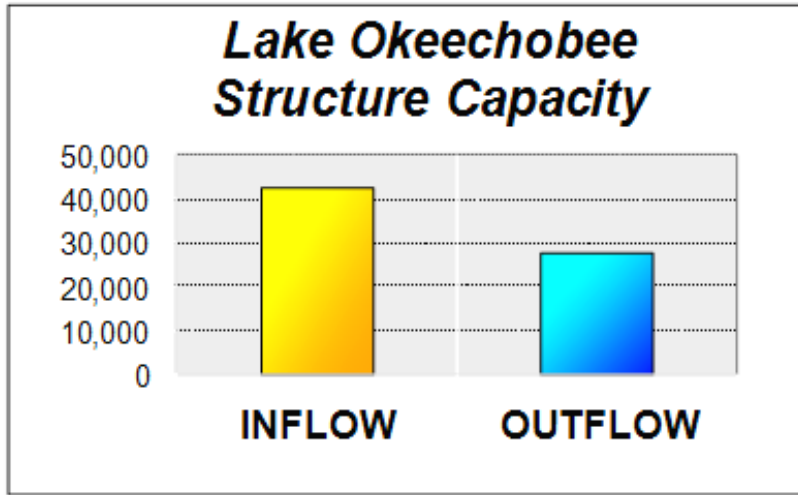


Figure 9. Lake Okeechobee inflow and outflow design discharge capacities. [Note: Design total inflow capacity exceeds total outflow capacity, and outflow capacity to the St. Lucie and Caloosahatchee estuaries far exceeds the outflow capacity to the Water Conservation Areas (WCAs)].

2.2 Lake Okeechobee Release Decisions

The weekly decisions to release lake regulatory discharges are reviewed in this section. The 2008 LORS release guidance specifications and the corresponding release decisions and actions are compared to display compliance and to identify specific days for more detailed investigation. A water budget summary was also prepared to help provide perspective on the relative release volumes during the period when the 2008 LORS allowed regulatory releases to the WCAs.

2.2.1 2008 LORS Release Guidance Outcomes and Actions

Table 3 summarizes the pertinent weeks that the 2008 LORS release guidance suggested Lake Okeechobee regulatory releases to the WCAs and the associated actions. **Figure 10** shows the 2008 LORS operating bands and the lake stages color-coded and annotated to document the release decisions and actions. As previously described, when lake water levels are in the Low Sub-band or the Baseflow Sub-band of the 2008 LORS, and the Tributary Hydrologic Condition (THC) and the multi-seasonal climate/hydrologic outlook are not in their dry classifications, then up to maximum practicable release to the WCAs are allowable if the release is beneficial to or will result in minimum Everglades' impacts. Both the quantity and quality of Lake Okeechobee water are considered. In other words, when the lake stage is below the Intermediate Sub-band and the THC is in the dry classification, then the 2008 LORS does not authorize Lake Okeechobee regulatory releases to the WCAs.

Table 3. 2008 LORS release guidance (Part C) outcomes and associated actions.

Week No.	Tuesday Date	2008 LORS Part C Release Guidance Outcome	WCA-3A stage < bottom RS?	WCA-3A stage < top RS?	Releases South?	Comments
1	1-Jan	Up to max practicable...	No	Yes	No	evaluating STA-3/4 treatment capacity
2	8-Jan	Up to max practicable...	No	Yes	Yes	via STA-3/4
3	15-Jan	Up to max practicable...	No	Yes	Yes	via STA-3/4 to NW WCA-3A
4	22-Jan	Up to max practicable...	No	Yes	Yes	via STA-3/4 to NW WCA-3A
5	29-Jan	Up to max practicable...	No	Yes	Yes	via STA-3/4 to NW WCA-3A
6	5-Feb	Up to max practicable...	No	Yes	Yes	via STA-3/4 to NW WCA-3A
7	12-Feb	Up to max practicable...	No	Yes	Yes	via STA-3/4 to NW WCA-3A
8	19-Feb	Up to max practicable...	No	Yes	No	suspended due to rainfall event
9	26-Feb	Up to max practicable...	No	Yes	No	suspended due to rainfall event
10	5-Mar	No releases to WCAs	No	Yes	No	LORS calls for no releases (dry THC)
11	12-Mar	No releases to WCAs	Yes	Yes	No	LORS calls for no releases (dry THC)
12	19-Mar	No releases to WCAs	Yes	Yes	No	LORS calls for no releases (dry THC)
13	26-Mar	No releases to WCAs	Yes	Yes	No	LORS calls for no releases (dry THC)
14	2-Apr	No releases to WCAs	Yes	Yes	No	LORS calls for no releases (dry THC)
15	9-Apr	Up to max practicable...	Yes	Yes	Yes	via STA-2 to WCA-2A
16	16-Apr	No releases to WCAs	Yes	Yes	No	LORS calls for no releases (dry THC)
17	23-Apr	No releases to WCAs	No	Yes	No	LORS calls for no releases (dry THC)
18	30-Apr	No releases to WCAs	No	Yes	No	LORS calls for no releases (dry THC)
19	7-May	Up to max practicable...	No	Yes	No	post-rain high stages in WCAs
20	14-May	Up to max practicable...	No	Yes	Yes	via STA-3/4 to NW WCA-3A
21	21-May	Up to max practicable...	No	Yes	Yes	via STA-3/4 to NW WCA-3A (if avail capacity)
22	28-May	Up to max practicable...	No	Yes	Yes	via STA-3/4 to NW WCA-3A (if avail capacity)
23	4-Jun	Up to max practicable...	No	No	No	WCA stage above regulation schedule
24	11-Jun	Up to max practicable...	No	No	No	WCA stage above regulation schedule
25	18-Jun	Up to max practicable...	No	No	No	WCA stage above regulation schedule

2008 LORS Part C language: "up to maximum practicable releases to the WCAs if desirable or with minimum Everglades impacts"

"Both the quantity and quality of Lake Okeechobee water will be considered."

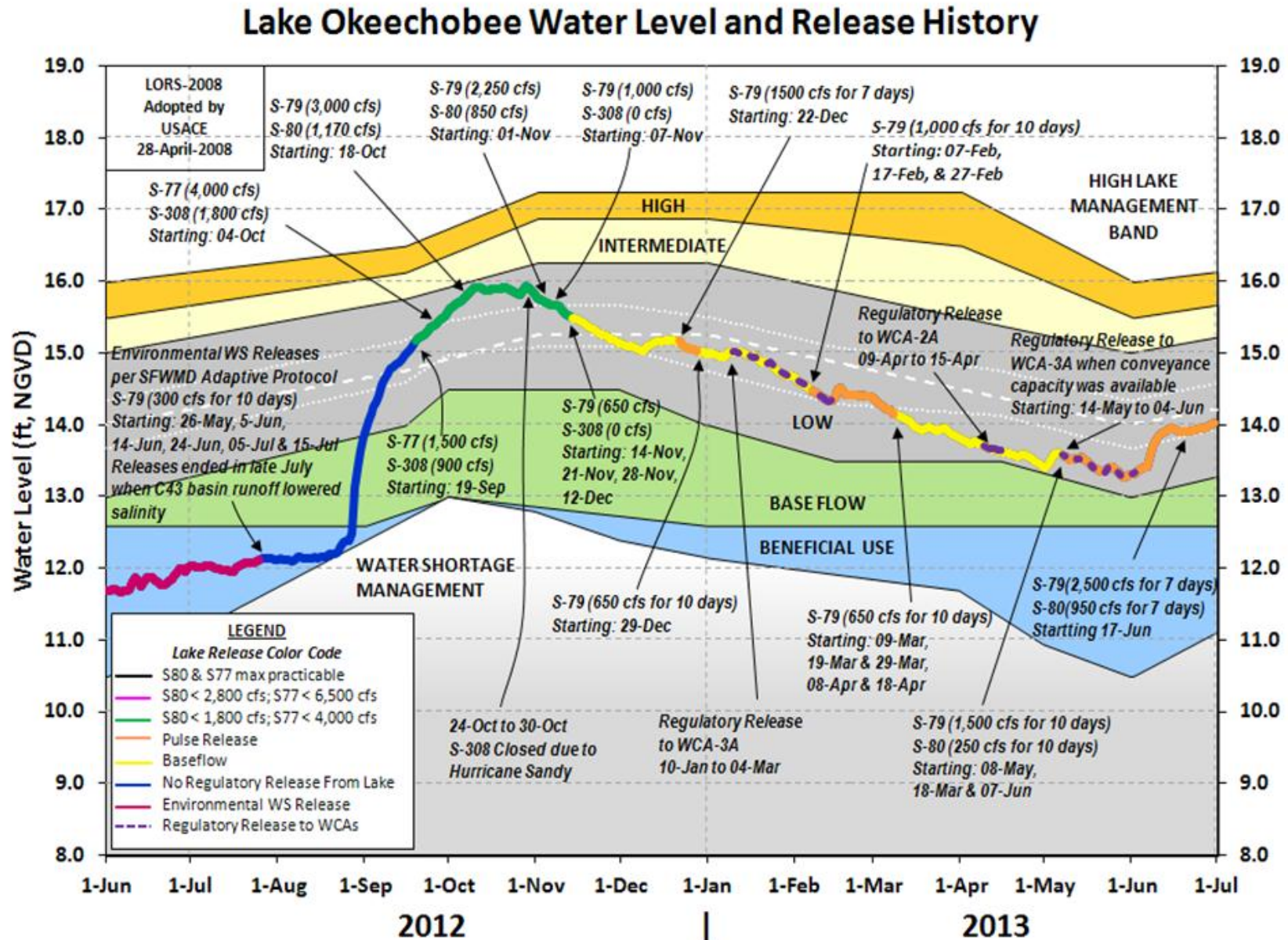


Figure 10. Lake Okeechobee water level and release history (June 2012—July 2013).

2.2.1.1. Initiation of Lake Regulatory Releases to WCA-3A

STA-3/4 is the largest and the only STA originally designed to receive Lake Okeechobee regulatory releases. STA-2 was expanded in 2012 with the completion of Compartment B and, as vegetation matures, it is expected to have some capacity to treat some lake releases prior to discharging to WCA-2A. However, during the January-June 2013 timeframe, WCA-2A stages were above its regulation schedule. Therefore, the District's focus was on the potential for STA-3/4 to receive lake water and convey it to WCA-3A. Until the third week in December 2012, the WCA-3A water level (three-gauge average) was above the top of its regulation schedule (**Figure 11**). The WCA-3A stage did not fall below the bottom of its regulation schedule until March 12.

Although the WCA-3A three-gauge average stage remained above the bottom of its regulation schedule in early January, northwestern WCA-3A water levels were receding rapidly and District scientists indicated the region would benefit from lake releases if directed to the northwest corner of WCA-3A. After the SFWMD determined that STA-3/4 had limited treatment capability, operations staff initiated lake regulatory releases to WCA-3A via S-354 and G-372 to STA-3/4 during the week of January 8. STA-3/4 outflows were subsequently directed to the northwest corner of WCA-3A via G-404.

2.2.1.2 WCA-1 and WCA-2A

Figures 12 and **13** show the stage hydrographs and regulation schedules for WCA-1 and WCA-2A, respectively. It is important to note that the WCA-2A marsh stage was above its regulation schedule throughout the dry season, so lake regulatory releases were not made per the 2008 LORS schedule and WCP. However, during the week of April 9 when STA-3/4 was not available, the SFWMD did attempt to make lake regulatory discharges via the STA-2 Compartment B north build-out area, even though WCA-2A stages were above regulation. The goal was to attempt to pass additional flows to tide to avoid impacting WCA-2A and WCA-3A stages. During the week of April 9, the District delivered approximately 900 to 1,000 ac-ft of lake releases into the north build-out of STA-2, but those deliveries were terminated when rainfall occurred in this area on April 15.

It should also be noted that although the WCA-1 stage was below its regulation schedule for portions of the dry season, there was no intent to discharge lake water to WCA-1 as the relevant STAs (STA-1W and STA-1E) were not designed to treat such lake regulatory discharges. Furthermore, these two STAs have been historically overloaded. Both STAs exhibited impacts from prolonged deep water and phosphorus loads. During the January-June 2013 period, STA-1E construction was under way by the USACE to repair all internal culverts and the Eastern Flow-way was off-line for re-grading and decommissioning of the former PSTA pilot in Cell 2. At STA-1W, over 17,000 hours of vegetation planting effort occurred between February and June 2013 in the Eastern and Northern flow-ways. TP loading rates for both STA-1E and STA-1W were nearly twice the annual target.

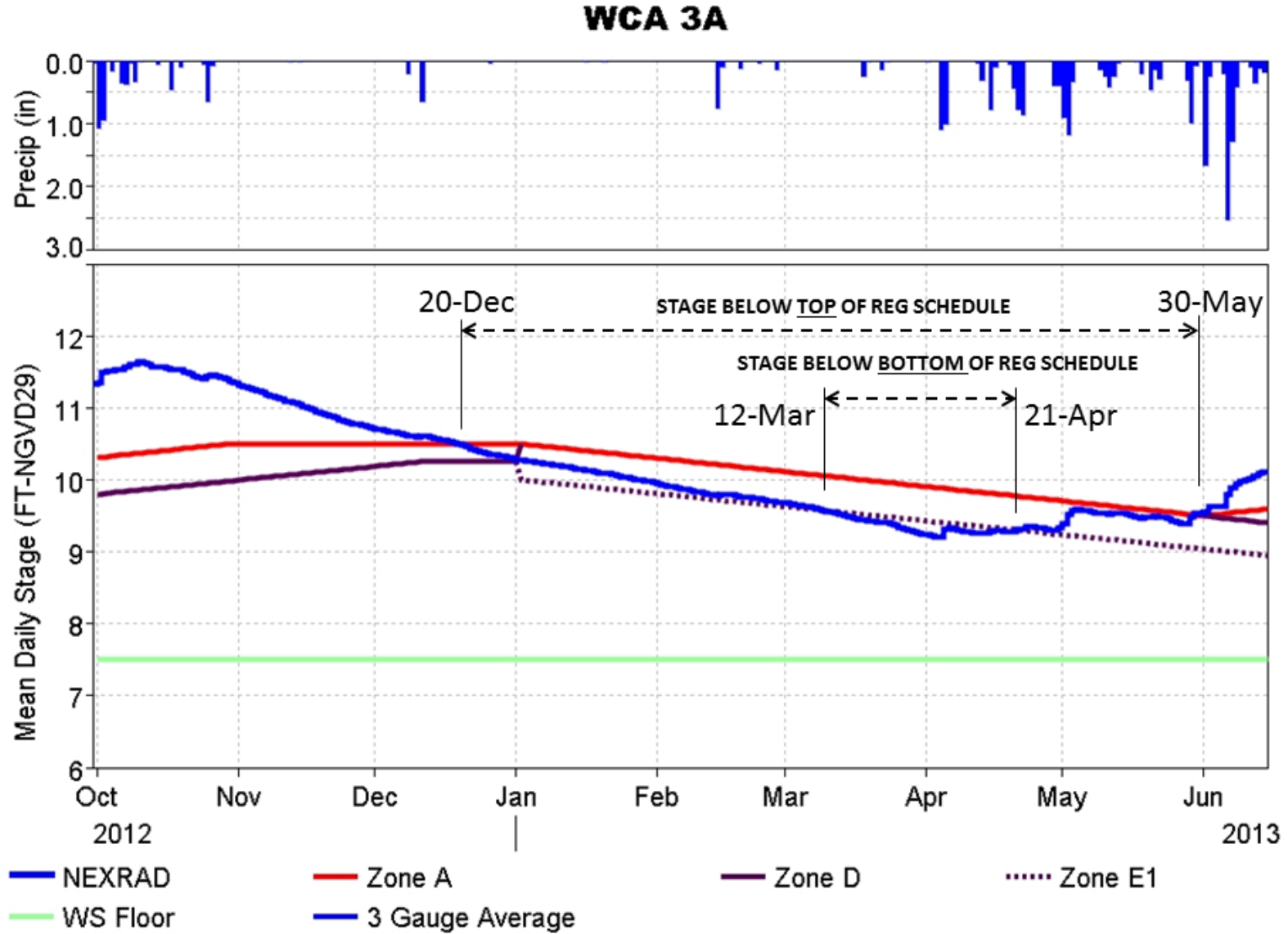


Figure 11. Lake Okeechobee regulatory releases to WCA-3A (October 2012–June 2013).

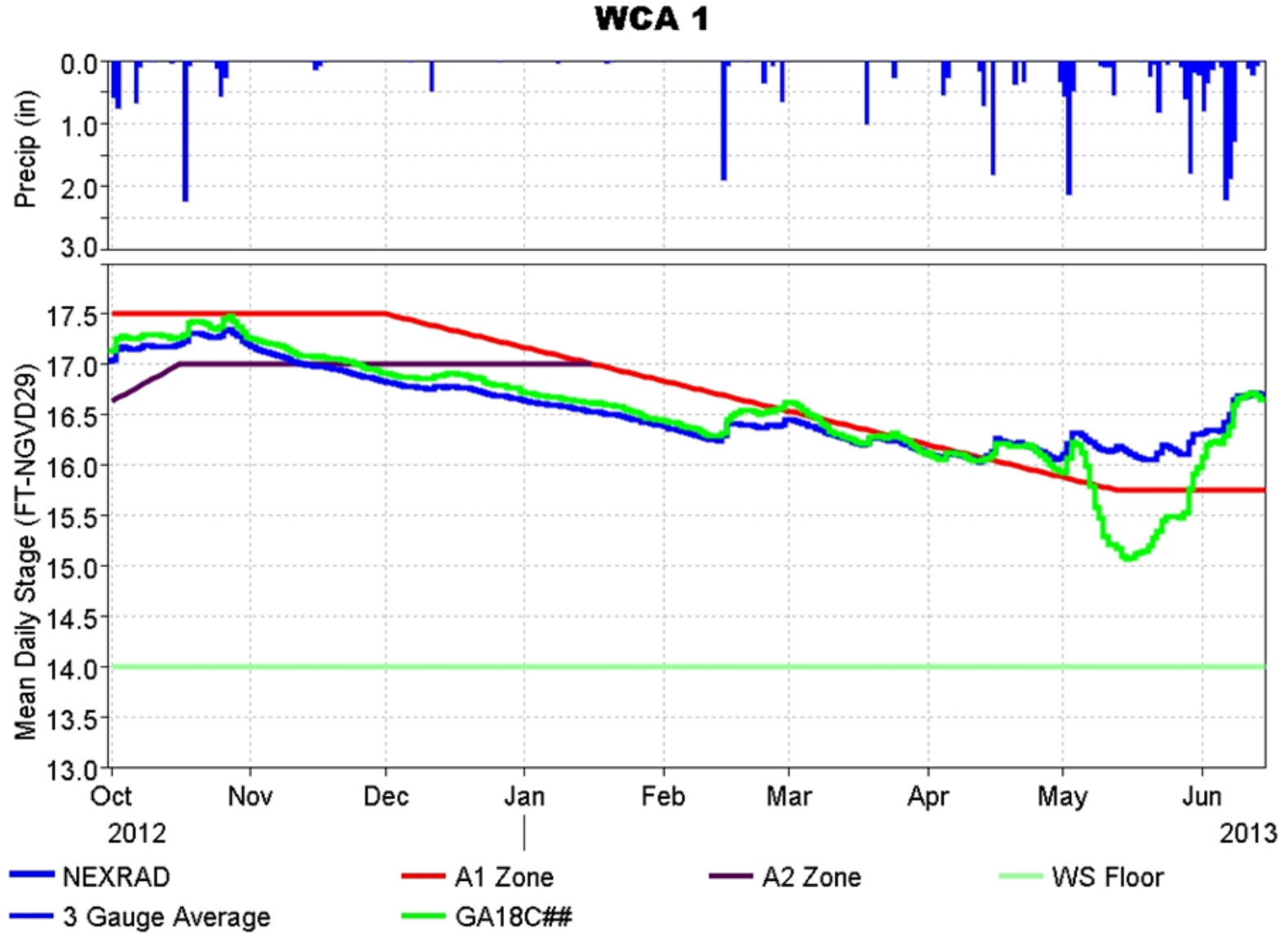


Figure 12. Stage hydrograph and regulation schedule for WCA-1 (October 2012–June 2013).

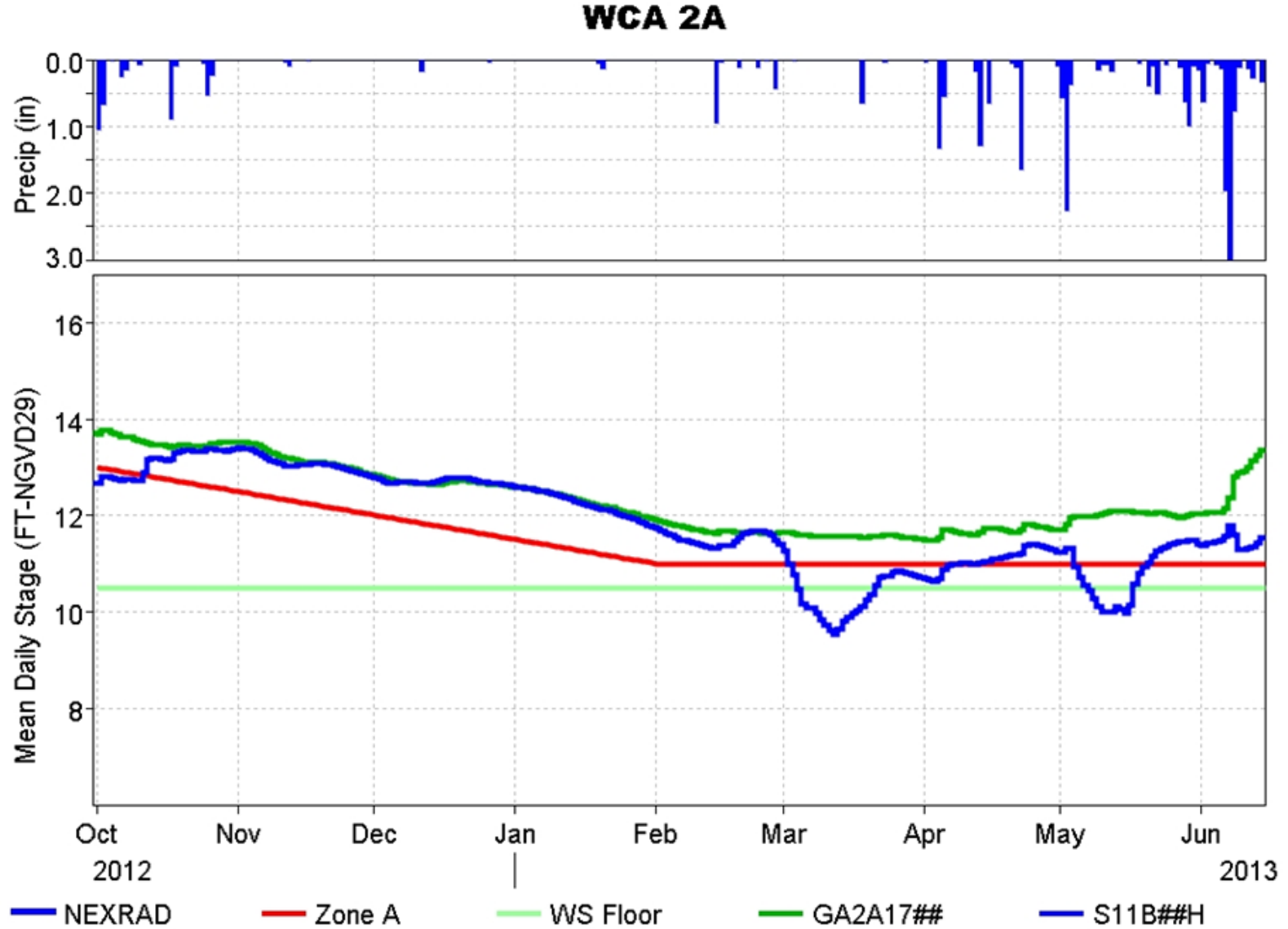


Figure 13. Stage hydrograph and regulation schedule for WCA-2A (October 2012–June 2013).

2.2.1.3 Summary of Lake Regulatory Releases to WCA-3A

The 2008 LORS Release Guidance (Part C) allowed lake regulatory releases to WCA-3A for 14 weeks (weeks 1-9, 15, and 19-22) of the 24-week period from January 1–June 17 (see **Table 3**). There was initial concern with WCA-3A water levels near the top of its regulation schedule that large lake regulatory discharges to WCA-3A would adversely affect the three-gauge average stage used to regulate WCA-3A. Therefore, lake regulatory discharges via STA-3/4 were directed to the northwest corner of WCA-3A and did not appear to directly influence or slow the recession of the three-gauge average stage.

Lake regulatory releases were actually made during 10 of the 14 weeks that the 2008 LORS allowed releases to be made to WCA-3A. Releases were not made during weeks 1, 8, 9, and 19. Week 1 was an evaluation week in which the SFWMD assessed the hydrologic and environmental conditions of the system and determined that STA-3/4 could accept limited lake regulatory discharge. Releases started January 10 after policy decisions and planning for the initiation of the operation were completed. Lake regulatory releases were suspended during weeks 8 and 9 because rainfall and corresponding flood control operations in the EAA required the use of primary canal conveyance to route basin runoff to STA-3/4. During week 19, another rainfall event caused reversals in WCA-3A stages, which led to staff recommendations to suspend lake regulatory releases until WCA-3A water levels began to recede again.

2.2.2 Lake Okeechobee Water Budget and Estuary Inflows

To provide perspective on the relative magnitude of the lake releases, a preliminary water budget for the analysis period (January–May 2013) was prepared. **Figure 14** shows the water budget flow volumes expressed as inches over the lake area. Rainfall and evapotranspiration (ET) were the largest components. Lake rainfall for this period was below average during January–March and above average April and May. Lake inflows were relatively low due to below-average lake watershed rainfall through April. Estimated water supply and irrigation release volumes (6.1 inches) were the same as lake regulatory discharges (6.1 inches). The largest lake regulatory discharge volume was to the Caloosahatchee Estuary (4.9 inches), but those releases were made at relatively low discharge rates from 450–650 cfs, which helped to maintain desirable salinities. The smallest regulatory discharge volumes were to the St. Lucie Estuary (0.2 inches) and Lake Worth Lagoon (0.2 inches). The Lake Okeechobee regulatory discharge volume to the WCAs (0.9 inches) was more than four times the volume to the St. Lucie Estuary. Lake regulatory release volumes and equivalent depths over the 700-square-mile lake surface area are summarized in **Table 4**.

Table 4. Summary of lake regulatory discharge volumes from January 1–May 31, 2013.

Lake Okeechobee Regulatory Discharge to:	Volume (ac-ft)	Equivalent Depth (in)	Percent of Total
Caloosahatchee Estuary via S-77*	183,900	4.9	80%
WCAs via STAs	34,000	0.9	15%
Lake Worth Lagoon via L-8 & C-51	4,500	0.1	2%
St. Lucie Estuary via S-308	7,400	0.2	3%
Total	229,800	6.1	100%

*Note: Base flow releases to the Caloosahatchee Estuary were within the acceptable flow range.

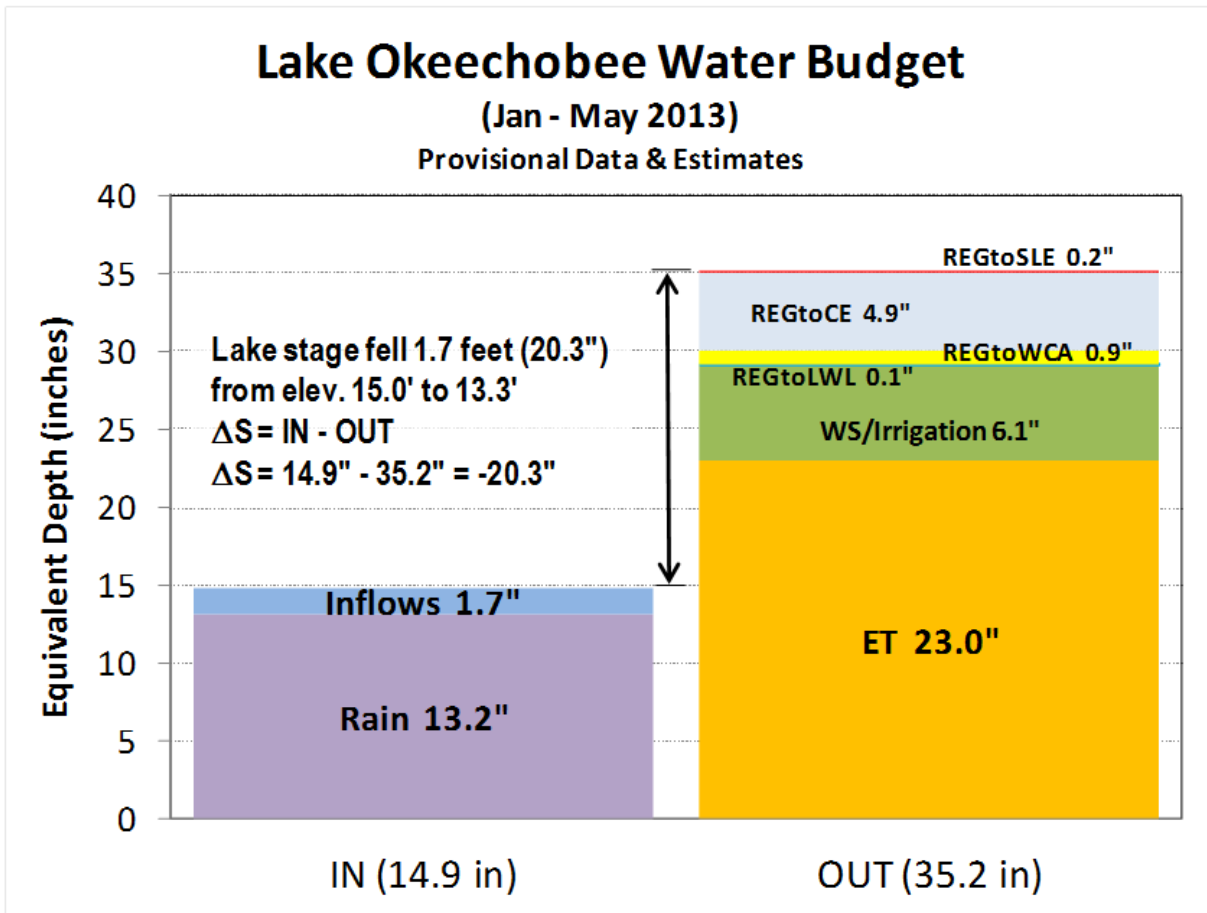


Figure 14. Lake Okeechobee water budget, provisional data and estimates (January—May 2013).

[Note: inflows = surface water inflows; REGtoSLE = lake regulatory discharge to the St. Lucie Estuary; REGtoCE = lake regulatory discharge to the Caloosahatchee Estuary; REGtoWCA = lake regulatory discharge to the WCAs via the STAs; REGtoLWL = lake regulatory discharge to the Lake Worth Lagoon; WS/Irrigation = lake releases to meet irrigation needs in the Lake Okeechobee Service Area; ET = evapotranspiration.]

Figure 15 illustrates the daily flows to the St. Lucie Estuary showing the contribution of basin runoff and Lake Okeechobee releases. Note that lake regulatory discharges were at relatively low rates and did not begin continuously until mid-June, about four weeks after the large discharges from basin runoff started. From January–June, there was no inflow to the St. Lucie Estuary until May. Lake releases represented about 9 percent of the total estuary inflow, with basin runoff contributing 91 percent. During the five-week period from June 1–July 8 when persistent wet season rainfall occurred, the estuary received approximately 137,000 ac-ft, about 2.5 times more than it received in the prior five months. The lake contribution during that period was about 16 percent, with basin runoff contributing 84 percent.

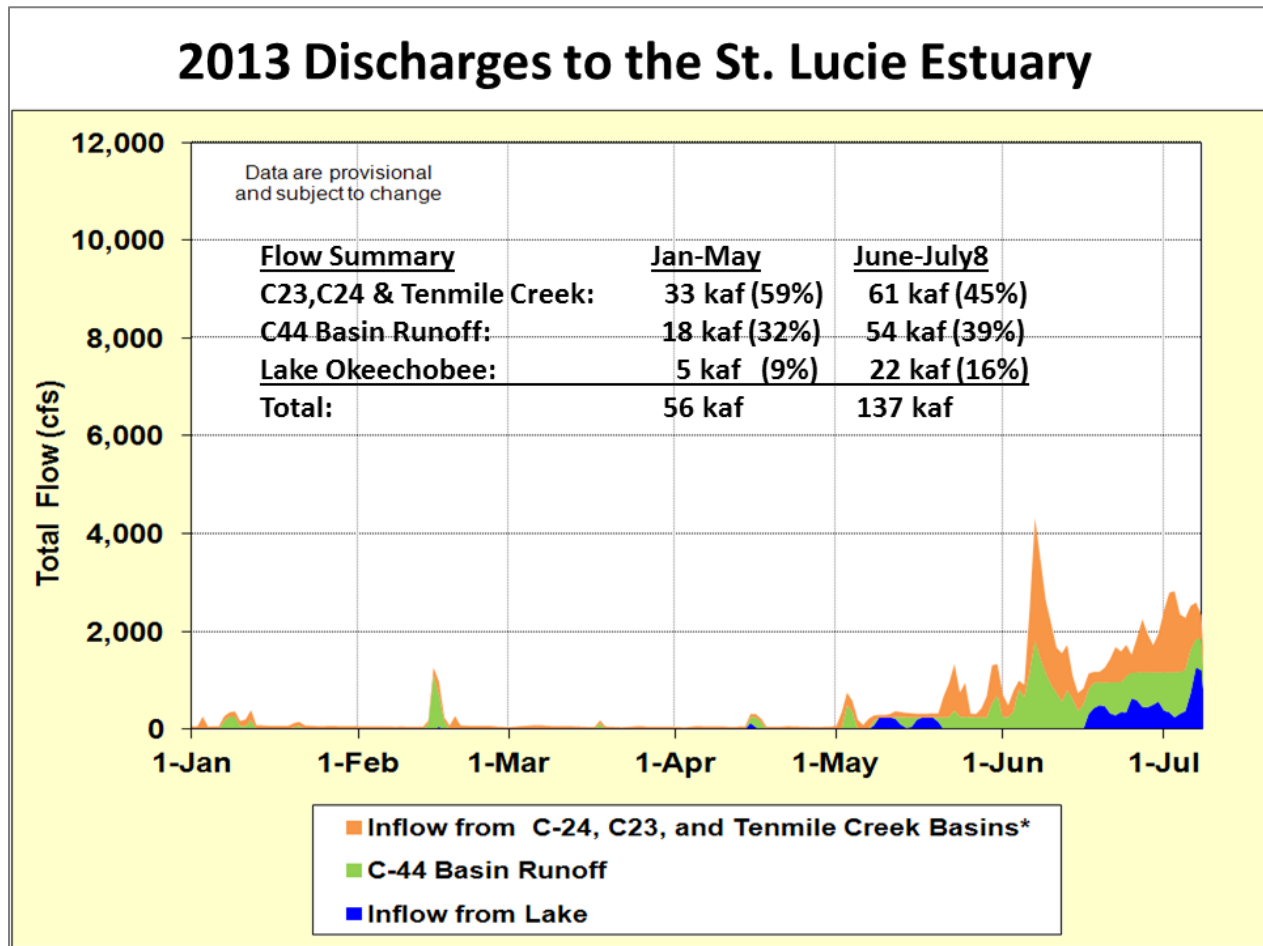


Figure 15. 2013 discharges to the St. Lucie Estuary (January 2013—July 2013).

Figure 16 shows the daily flows to the Caloosahatchee Estuary with the contributions from C-43 basin runoff both upstream and downstream of S-79. The flow summary on that figure shows the lake contribution to total flows was about 50 percent from January–May, and that lake release rates were typically within the acceptable flow range—rarely greater than the 650 cfs maximum baseflow release rate. Once the wet season began in June, C-43 basin and tidal basin runoff comprised 85 percent of the total estuary inflows, whereas the lake contribution was only about 15 percent.

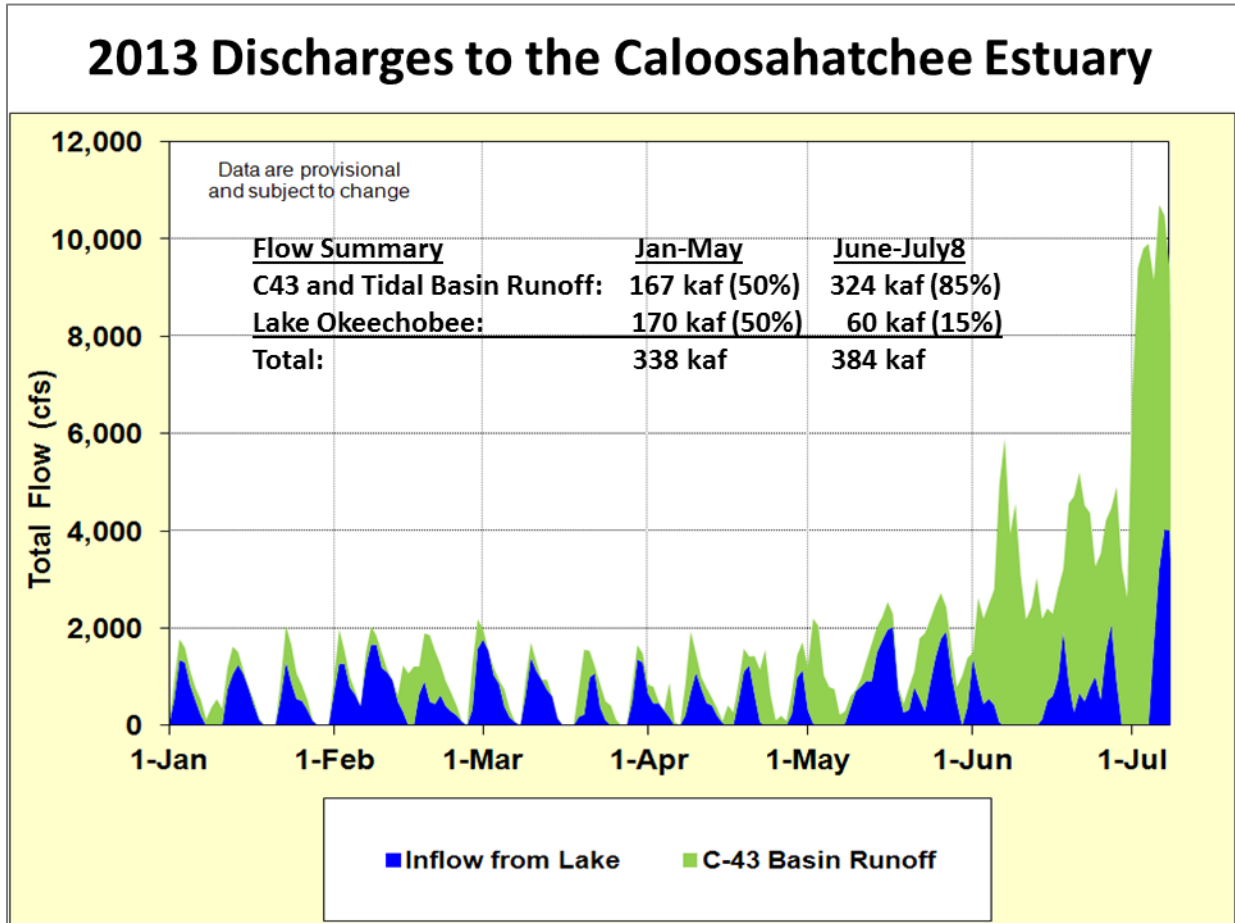


Figure 16. 2013 discharges to the Caloosatchee Estuary (January 2013–July 2013).

2.3 Review of Daily Operations for Lake Regulatory Releases to the WCAs

A closer look at 2013 operations is provided in this section. Analysis of daily operations is discussed in two steps to determine if the existing infrastructure was capable of conveying more lake regulatory discharge to the STAs and if the STAs could have received and treated additional lake regulatory discharges. This retrospective analysis identifies and respects the conditions and constraints that existed during each day that the lake release guidance allowed regulatory releases to be made to the WCAs.

2.3.1 Lake Regulatory Discharges through the EAA

The SFWMD operates the C&SF Project in accordance with the water control manuals provided by the USACE and in accordance with permits issued by the FDEP. A water control manual is the guiding document that specifies how the lake and WCAs are to be operated. Each project feature has congressionally mandated purposes, and these manuals are what the USACE uses to balance those purposes. They also provide details on the C&SF project's history, authorizations, watershed characteristics, data collection networks, forecasting methods, and stakeholder coordination. The most critical section is the WCP, which outlines the operational plan to meet all the reservoir's congressionally mandated purposes. It is important to note that updating the water control manuals does not allow the USACE to change the congressionally authorized purposes of the reservoirs. Any desire by a community to change storage allocation or purposes of a federal reservoir must seek congressional approval through a reallocation study <http://www.lrp.usace.army.mil/Missions/Planning,ProgramsProjectManagement/HotProjects/WaterControlManuals.aspx>.

Structures located on the south shore of Lake Okeechobee S-354, S-351, S352, and Culvert 10A allow discharge by gravity to the south for the project purposes of municipal, industrial, and agricultural water supply. Water releases from Lake Okeechobee are dependent on downstream capacity, which may vary through time and is depended on rainfall, soil moisture content, evapotranspiration rates, USACE requirements, irrigation need of agricultural areas, and drainage from municipal and agricultural areas. In addition to actual rainfall, a rainfall forecast may change the amount of water that is delivered south.

Water from the agricultural area flows to the south and southeast through four primary canals: North New River (NNR), Miami, Hillsboro, and West Palm Beach. The Miami and NNR canals are the source of inflow to STA-3/4. For the analysis period, additional details on the Miami and NNR canals are covered in the following sub-sections; the Hillsboro and West Palm Beach canals are not discussed further, as these canals were not used to convey Lake Okeechobee regulatory discharges.

2.3.1.1 Miami Canal — S-3 and S-8 Basins

Water is released from Lake Okeechobee to the Miami Canal via the S-354 spillway up to a capacity of 1,450 cfs when the canal level is below 11.0 ft NGVD and water is available in the lake and downstream capacity is available. Water is either used within the EAA or moved to STA-3/4 for maintenance of water levels within the STA or for treatment prior to being sent to the WCAs. The conveyance capacity of the Miami Canal may be influenced by water from the S-3 and S-8 basins, C-139 Basin, South Florida

Conservancy District, South Shore Drainage District, and Lake Okeechobee. Conditions in the Bolles Canal may also influence water levels in the Miami Canal.

Water in the Miami Canal can be moved south to WCA-2A and WCA-3A via STA-3/4. G-372 is a four-unit pump station with 925 cfs discharge capacity for each pump up to a maximum capacity of 3,700 cfs down to a minimum water level of 8.0 ft NGVD. G-372 pumps water from the Miami Canal into the STA-3/4 Supply Canal. The Supply Canal is 10.4 miles long and intersects the Inflow Canal at the northwest corner of STA-3/4. Further details for the Miami Canal are provided in **Appendix B**.

2.3.1.2 North New River Canal — S-2 and S-7 Basins

Water is released from Lake Okeechobee to the NNR Canal via the S-351 spillway up to a capacity of 1,500 cfs when the canal level is below 11.0 ft NGVD and water is available in Lake Okeechobee and downstream capacity is available. Water is either used within the EAA or moved to STA-2 via pump stations G-434 or G-435, or to STA-3/4 via pump station G-370 for treatment prior to being sent to the WCAs. The capacity of the NNR Canal may be influenced by water from the S-2 and S-7 basins and Lake Okeechobee. Conditions in the Bolles Canal may also influence water levels in the NNR Canal.

The NNR Canal was not the primary canal for moving Lake Okeechobee regulatory releases per 2008 LORS to WCA-3A via G-370. S-351 records for the analysis period (January 1–June 17, 2013) indicate that water was supplied to the EAA to meet water supply requirements. Records for G-434 indicate that water was supplied to STA-2 for maintenance of marsh water levels and for treatment prior to sending water to WCA-2. Further details for the NNR Canal are provided in **Appendix B**.

2.3.1.3 Monthly Summary for the Miami Canal

Graphs showing rainfall, rainfall forecast, water levels in the Miami Canal, flows from Lake Okeechobee via S-354, and flows to STA-3/4 via G-372 are provided in **Appendix B** to illustrate the operations. During the dry season period from January through May 2013, releases from Lake Okeechobee south were made for water supply within the EAA, water supply for the Seminole Big Cypress Tribe, water supply to the STAs, water supply to the Holey Land Wildlife Management Area, and regulatory releases from Lake Okeechobee to WCAs. If the daily water supply or regulatory release volumes can be achieved by operating the G-372 pump station with a normal shift (not extended), then a 925 cfs pump unit was run and the resulting time of operation calculated. For example, one pump unit running for a normal, eight-hour shift would result in an average daily delivery of about 300 cfs $[(925 \text{ cfs} \times 8 \text{ hours}) / 24 \text{ hours}]$. During this period, unless a special test or a rain event occurred, there was no pumping on the weekends.

JANUARY

In January, the EAA received 0.37 inches of rainfall, which was 22 percent of the normal rainfall for the month. This deficient rainfall resulted in water supply releases from Lake Okeechobee to the EAA for agricultural use and to the STAs (STA-1E, STA-1W, STA-2, and STA-3/4) to maintain target stages in the treatment cells. Lake regulatory releases were also made via STA-3/4, and ultimately went to the northwest corner of WCA-3A via pumping at G-404. Water was also delivered from Lake Okeechobee to the Rotenberger Wildlife Management Area to meet the regulation schedule for that area. Water

supply deliveries were made at G-409 to the Big Cypress Seminole Reservation pursuant to their entitlement right.

Normal water supply to the EAA took place from January 1–6 and no pumping occurred at G-372. On January 7, pump station G-372 was operated in a flood control mode as water levels in the Miami Canal were expected to exceed 11.5 ft NGVD. Flood control operations continued on January 8–9. On January 10, water supply was resumed from S-354 to the EAA and into STA-3/4 via G-372 on January 11. No pumping at G-372 was scheduled over the weekend (January 12–13). On January 14, water supply was resumed from S-354 to STA-3/4 via G-372.

On January 15, the District's Hydrologic & Environmental Systems Modeling (HESM) staff conducted the third of three hydraulic roughness field tests, with the goal of making significant advancements in understanding how the STA systems perform hydraulically under varying inflow and stage conditions. The test took place over the 14-day period from January 14–29. The test required water releases from Lake Okeechobee to STA-3/4 via the G-372 pump station. The flow was monitored and gate openings adjusted within Western Flow-way of STA-3/4 on a 24-hour basis. The test was designed to assist in developing operating protocols that will help the agency to balance the multi-objective water quantity and water quality objectives of the South Florida system. Results from the field test will provide a better understanding of how the STAs react, particularly during a storm, to large influx of rain and runoff. Water continued to be moved to STA-3/4 through January 31.

FEBRUARY

In February, the EAA received 2.4 inches of rainfall, which was 118 percent of the normal rainfall for the month. The bulk of that rain fell during February 13–14. The raindar indicated that the Miami Canal basin received over 4 inches in a short period, resulting in a rapid rise in water levels. Lake Okeechobee regulatory releases continued from S-354 to G-372 on February 1, no pumping over the weekend; February 4–8; and February 11–14. The SFWMD suspended lake regulatory releases to WCA-3A via STA-3/4 and G-404 on the February 14 due to rainfall in the lake service area. On that day, data indicated that operations shifted to flood control in the EAA with G-372 pumping over 3,000 cfs due to heavy rainfall. Early forecasts did not indicate a focus of rainfall directly on the EAA; therefore, a night shift was not called out at pumping station S-3. The operations log reflects the normal order for G-372 to pump a regular shift as of 8:39 pm with a limit of two pumps. At 10:39 pm, the restrictions for G-372 were lifted to pump as many units needed to maintain stages as water level had risen rapidly due to direct rainfall. For a period of several hours, the canal water levels exceeded the flood control limit as measured at the S-3 headwater. G-372 was able to make progress toward a recession in water level and, by the morning shift, it was determined that the forecast would allow the southern pump stations to maintain flood control operations for the Miami Canal. Flood control operations at G-372 continued through the morning of February 18. The records indicate that continued forecast for rainfall resulted in no releases from Lake Okeechobee and no pumping at G-372.

MARCH

In March, the EAA received 2.05 inches of rainfall, which was 69 percent of the normal rainfall for the month. Most of the rainfall occurred during two events, on March 19 and 25. The rainfall resulted in runoff which was treated in STA-1E, STA-1W, STA-2, and STA-3/4 and ultimately sent to the WCAs. Water from STA-3/4 was delivered to the northwest corner of WCA-3A via pumping at G-404. There was some inflow into STA-5/6 which helped to maintain target stages in the treatment cells. Water supply from the lake via S-354 occurred on various days; however, there were no regulatory releases to the WCAs because 2008 LORS did not call for releases south due to dry THC.

APRIL

In April, the EAA received 4.36 inches of rainfall, which was 182 percent of the normal rainfall for the month. The rainfall resulted in runoff which was treated in STA-1E, STA-1W, STA-2, and STA-3/4, and ultimately sent to the WCAs. Water from STA-3/4 was delivered to the northwest corner of WCA-3A via pumping at G404 and S8. There was some inflow into STA-5/6 which helped to maintain target stages in the treatment cells. The SFWMD made Lake regulatory releases to WCA-2A via STA-2 from April 9-15 per the release guidance (Part C), but discontinued the releases when the release guidance suggested no regulatory releases to the WCAs due to the dry THC. Water supply from the lake via S-354 occurred on various days; however, there were no releases to the WCAs because 2008 LORS did not call for releases south due to dry THC.

MAY

In May, the EAA-East rainfall basin received 5.93 inches of rainfall, which was 153 percent of normal for the month. The rainfall in May resulted in significant runoff which was discharged to the WCAs after treatment by STA-1E, STA-1W, STA-2, and STA-3 / 4. As much of the flow went through the STAs, it was possible to use some of the basin runoff for maintaining target stages in the treatment cells. Water from STA-3/4 was delivered to the northwest corner of WCA-3A via pumping at G404 as needed to maintain desirable recession rates and water depths. The Eastern Flow-way of STA-1E remained offline to accommodate decommissioning of the PSTA pilot project. The USACE continued refurbishment of treatment cell culverts in STA-1E. Flow through most of the STAs was constrained due to black-necked stilt and Everglade snail kite nesting. There was limited inflow into STA-5, which helped to maintain minimum water depths in the northern treatment cells.

JUNE

In June, the EAA-East rainfall basin received 3.10 inches of rainfall, which was 141 percent of normal for the month. The rainfall resulted in significant runoff, which was discharged to the WCAs after treatment by STA-1E, STA-1W, STA-2, and STA-3/4. There were no regulatory releases from Lake Okeechobee to the WCAs because water levels in the WCAs were above their respective regulation schedules.

2.3.2 Lake Regulatory Discharges through the STAs

Florida experiences distinct wet and dry seasons. During the wet season, flows to the STAs are generally greater and more variable than during the dry season and the STAs can experience damaging deepwater

conditions. At the same time, the STAs are challenged by taking in increased sediment and phosphorus loads. During the wet season, portions of the emergent vegetation cells—comprised predominantly of cattail (*Typha* spp.)—respond to these stressful conditions by exhibiting reduced photosynthesis and growth rates, decreased plant density, and in some cases mortality (**Figure 17**). During the dry season, the District conducts rehabilitation activities such as drawdowns to stimulate seed germination and allow vegetation planting in selected areas to reverse the effects of wet season flows and stages. During the winter and spring 2013, for example, the District conducted a drawdown of STA-3/4 Cell 2A to stimulate seedling growth in the northern 1,000 acres of the cell and implemented planting within the cell. At STA-1W, District contractors spent over 17,000 hours hand planting vegetation in areas that have been stressed by chronic deepwater conditions.



Figure 17. An example of vegetation mortality due to prolonged deepwater conditions at STA-1W (photo by the SFWMD, July 2013).

The impacts of excessive hydraulic and phosphorus loads and associated deepwater conditions can be harmful to STA treatment vegetation and performance but are not always apparent during or immediately following a loading event. Impacts can be delayed by weeks or months and are difficult to forecast. For example, in 2003, STA-1W appeared to be significantly impacted by a combination of high inflows from Lake Okeechobee along with EAA basin runoff. During that water year, approximately 61 percent of the TP inflows to STA-1W, nearly 68 metric tons, were associated with Lake Okeechobee releases. These deliveries were terminated in February 2003 when outflow TP concentrations indicated that the annual outflow concentrations from STA-1W might exceed the target of 50 µg/L (SFWMD, 2004). Following this period of heavy loading, emergent and submerged aquatic vegetation health declined significantly and the District spent millions of dollars in rehabilitation work over the next few years to rehabilitate vegetation and improve STA performance.

Experience indicates that the STAs need to be managed to minimize the impacts of excessive flows, depths, and phosphorus loads. The District attempts to balance flows and TP loads between flow-ways within STAs and between STAs, where possible. As a general guide, the District attempts to limit loading to less than 1 gram TP/meter²/year and monitors loading on a running 365-day basis for each STA and flow-way. Analysis of the STAs over the years indicates that the likelihood of achieving a 13 µg/L outflow concentration is low when inflow loads exceed 1 gram/meter/year.

2.3.3 Lake Regulatory Releases Treated by the STAs, January—mid-June 2013

The following paragraphs summarize the environmental and operational conditions in the STAs that affected potential lake regulatory releases during the January–June 2013 period. Due to the constraints and conditions described below, STA-3/4 provided the only viable option for lake regulatory releases and nearly all releases were directed through STA-3/4 to the northwest corner of WCA-3A to provide maximum downstream benefits.

2.3.3.1 STA-1E and STA-1W

STA-1E and STA-1W were not designed to accommodate lake regulatory releases and are typically overloaded during average rainfall years in terms of hydrologic and phosphorus inputs and often exhibit poor TP treatment performance. With the future Restoration Strategies project, an upstream Flow Equalization Basin will be constructed north of STA-1E and STA-1W, and STA-1W will be expanded by 6,500 acres to improve its performance.

From January–June 2013, STA-1E and STA-1W TP loading rates were approximately two times the desired 1 gram/meter²/year guideline. Lake release opportunities were further limited by construction activities under way by the USACE in STA-1E, vegetation rehabilitation activities under way in STA-1W in two of the three flow-ways, and by nesting birds. Everglade snail kites began nesting in Cell 4N of STA-1E in late January and additional nesting (37 nests) occurred during the entire study period. In May 2013, black-necked stilts began nesting in both STA-1E and STA-1W, further constraining operations. Both STA-1E and STA-1W had been adversely affected by Tropical Storm Isaac in August 2012 and are still recovering. For these reasons, the District recommended against sending lake regulatory releases to STA-1E and STA-1W.

2.3.3.2 STA-2 and STA-3/4

In contrast to STA-1E and STA-1W, annual loading rates in STA-2 and STA-3/4 were near the 1 gram/meter²/year guideline. The north build-out of STA-2 was recently completed and able to treat water from the lake during the January–June period. STA-3/4 had two of the three flow-ways in good condition, and the Central Flow-way needed rehabilitation work. Therefore, the District recommended accepting lake regulatory releases when allowed by the 2008 LORS. Opportunities for releases through STA-2 were limited because WCA-2A was above schedule from January–June. Also, black-necked stilt nesting in the north build-out in mid-May restricted operations during the latter portion of this study period. The majority of lake releases were through STA-3/4 using the Eastern and Western flow-ways (**Figure 18**). Cells 1A, 2A, and 3A are emergent vegetation cells that are most affected by deep water because they receive the inflows from the two pump stations G-370 and G-372.

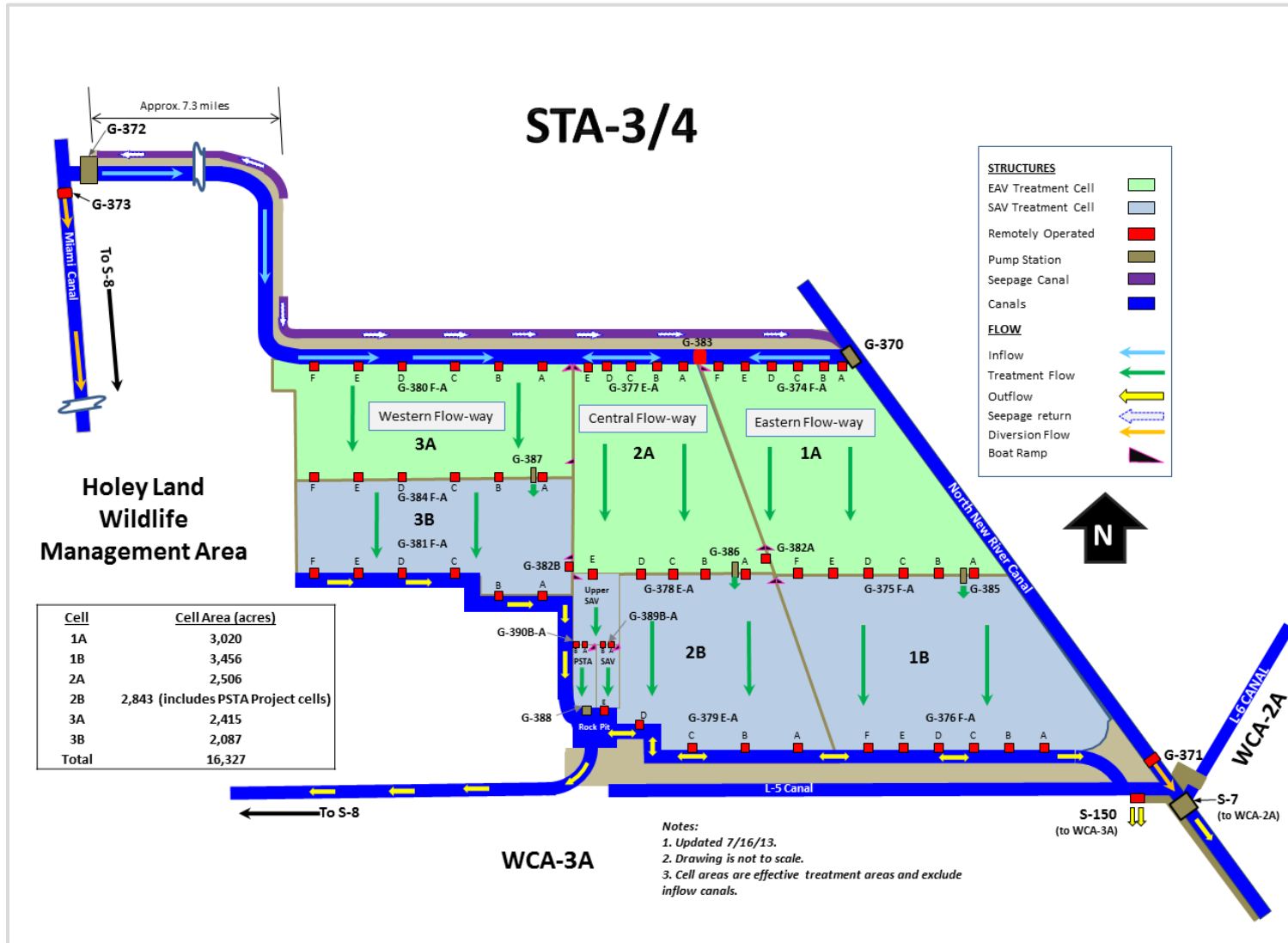


Figure 18. Schematic map of STA-3/4.

2.3.3.3 STA-5/6

STA-5/6 primarily receives runoff from the C-139 basin and cannot receive Lake Okeechobee releases due to lack of a conveyance pathway from the lake. No lake releases were made to STA-5/6 during the period from January–June 2013.

2.3.4 2008 LORS Releases

As previously noted, the 2008 LORS release guidance suggested that releases could be made during 14 of the 24 weeks from January–June (**Table 2**). Deliveries were made to northwest WCA-3A to avoid stage related impacts in other portions of WCA-3A. Under this approach, Lake Okeechobee regulatory discharges were made to the WCAs for 10 of the 14 weeks that the LORS schedule recommended. During three of those weeks, southward lake regulatory discharges were not made because conveyance capacity was limited in the primary EAA canals or high water levels existed in the WCAs. Releases could have been made during the first week of January but were not implemented. During that week, District staff assessed STA conditions, potential flow rates, downstream conditions, and status of proposed rehabilitation and construction efforts. The next week, a decision was made to initiate releases to STA-3/4 at an average of approximately 200-250 cfs per week. This flow rate was achieved by pumping one 925 cfs at G-372 generally during normal day shifts, five days a week, into STA-3/4.

The District attempted to send lake releases through the north build-out of STA-2 during the week of April 9, despite that stages were above regulation schedule in WCA-2. Pump G-434 delivered approximately 900 ac-ft to the STA.

Approximately 34,000 ac-ft of lake regulatory releases to the WCAs via the STAs were made from January 1–June 25, as follows:

- Water released January 10 to March 4 the NW corner of WCA-3A via STA-3/4;
- Water released April 9 to April 15 to WCA-2A via STA-2; and
- Water released intermittently via STA-3/4 to WCA -3A, between rainfall events and as canal conveyance allowed after May 7.

2.3.5. STA Stage and Flow Considerations

The 2008 LORS schedule indicates that releases to the WCAs can be made “when desirable or with minimal Everglades impacts.” The District considers the STAs to be part of the Everglades in this context and attempts to minimize impacts to them because the STAs provide critically important treatment for water flowing into the EPA.

Figure 19 illustrates water depth changes in one of the three emergent vegetation cell of STA-3/4 while lake releases were under way. It depicts the stage in ft NGVD of water in Cell 1A from January through June 2013. The target stage for this cell, which is depicted by a red horizontal line, is 10.6 ft NGVD. If the water in the cell is at the target elevation, the average water depth in the cell is 1.25 ft NGVD. The target depth is the depth that is considered desirable between storm events to minimize long-term damage to STA vegetation.

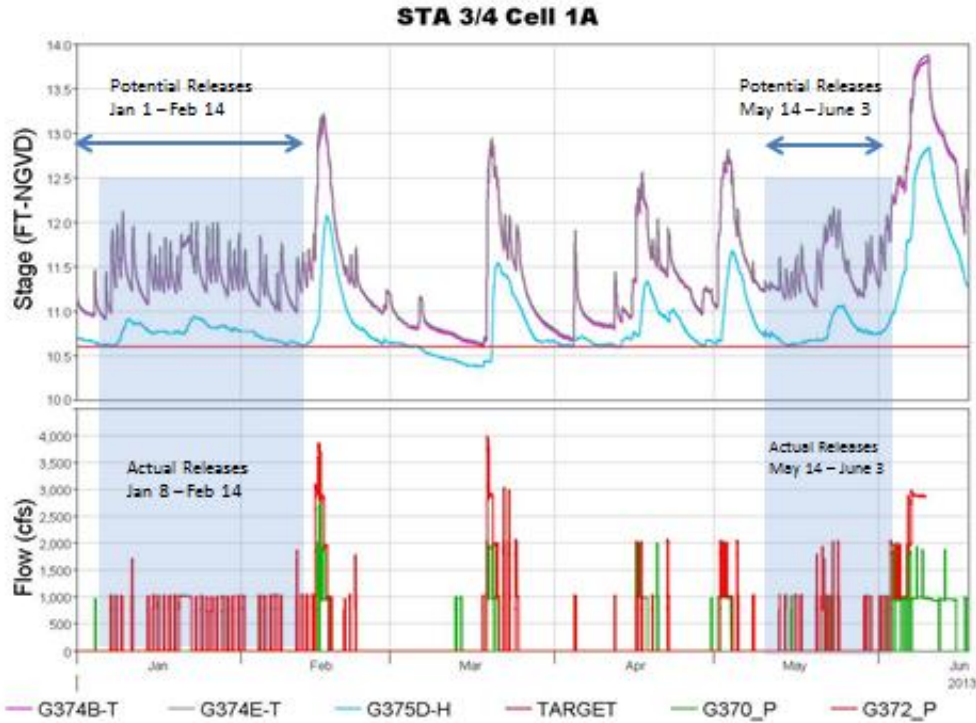


Figure 19. STA-3/4 Cell 1A daily water depths and pumping summary (January–June 2013).

As shown above in **Figure 19**, when lake releases were made to STA-3/4, the water depths in Cell 1A continuously exceeded the target depth. Releases began in the second week of January. Lake releases were delivered to the northwest corner of WCA-3A, because water depths were dropping rapidly in that area and the added water was considered beneficial. Water was released from Lake Okeechobee through S-354, down the Miami Canal, and was pumped into STA-3/4 through G-372. G-372 is equipped with four 925 cubic feet per second (cfs) pumps. After treatment by STA-3/4 the releases were conveyed into the L-5 canal and pumped using G-404 to the northwest corner of WCA-3A.

Figure 20 illustrates the change in stage in cell 1A of STA-3/4 during operation of a single 925 cfs pump over a one-week period. The inflow pump was operated during daytime work shifts and was generally not operated on weekends. Target depths are depicted by the red horizontal line. This graph illustrates that a single pump raises the average stage in the cell above the target depths. The upper lines on the graph depict the water stages at the north end of the cell where water enters and the light blue line depicts the stage at the outflow end of the cell. These depths are considered to have a negative effect on the cattail vegetation in the cell. Had two or three pumps been operated, as in mid-February due to a storm event, stages in Cell 1A would have increased to approximately 2 feet or more above target resulting in impacts to treatment vegetation. A summary of stages and inflow pumps operations are presented in **Appendix C** for each of the emergent vegetation cells that were online during the lake releases from January 1–June 25, 2013 at STA-2 and STA-3/4.

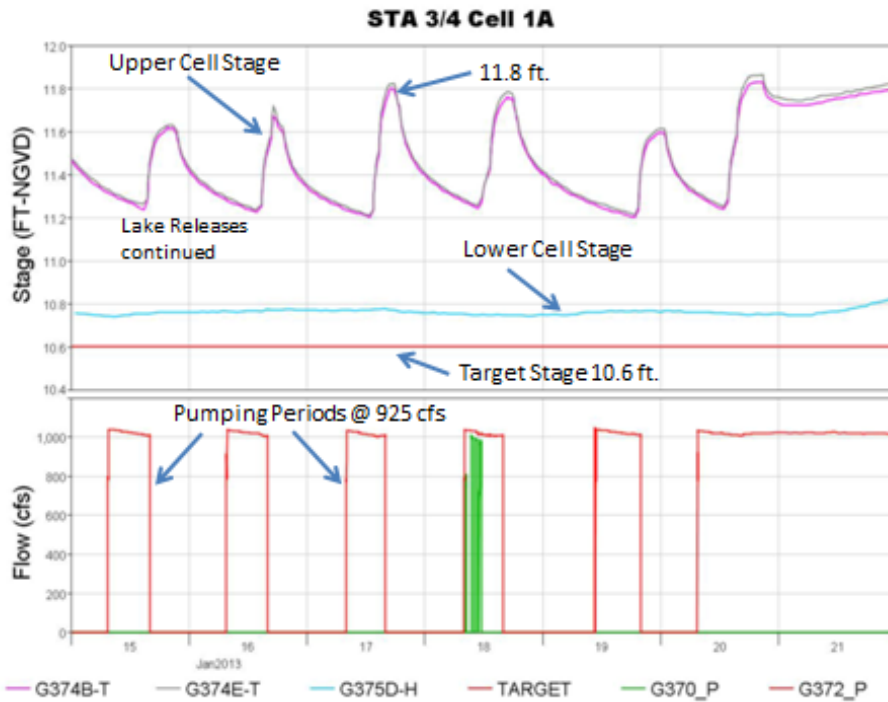


Figure 20. STA-3/4 Cell 1A daily water depths during lake release deliveries.

On January 29, Cells 2A and 2B of STA-3/4 were taken off line for dewatering and rehabilitation to reverse the effects of continuous deepwater conditions on treatment vegetation. The District continued to pump water from the lake into STA-3/4 until mid-February when heavy rains occurred in the upstream Miami Canal basin and additional pumps were operated at both G-372 and G-370.

From January–June 2013, STA-3/4 accepted the maximum safe volume of lake regulatory releases to assist in managing Lake Okeechobee stages. It is not possible to quantify the effect of these deliveries to the STAs, but the effect is considered to be negative and likely to contribute to cattail thinning, decreased stem density, and reduced treatment performance.

Under current conditions, the 925 cfs capacity pumps present a challenge with regard to maintaining moderate flows and depths in the STA. This situation will be improved when the A-1 Flow Equalization Basin is completed in 2015. The District will then be able to deliver water to STA-3/4 at a lower, continuous rate which will result in reduced deepwater impacts during portions of the water year.

Overall, it is thought that the quantity of releases to the STAs was appropriate for the existing conditions and in accordance with operational guidelines as summarized below.

- STA-1E and STA-1W could not have safely accepted lake regulatory releases without causing harm to existing flow-ways.
- STA-2 could not have been utilized more for lake regulatory releases because WCA-2A stages were above regulation levels during the January–June period.

- STA-3/4 was the only viable option for lake regulatory releases during the January–June period and accepted approximately 34,000 ac-ft of water. This water was routed to the northwest corner of WCA-3A to improve ecological conditions and reduce peat loss and to avoid harm to protected nesting birds in the eastern portion of WCA-3A.
- One 925 cfs pump, during normal work shifts, at either G-370 or G372, provides a reasonable maximum inflow rate for lake releases during the dry season to avoid harm to the STAs.
- STA-5/6 could not have accepted lake releases because a hydrologic connection is not available.

3.0 REFERENCES

- Abteu, W. and V. Ciuca. 2007. Water Budget Analysis for Stormwater Treatment Area 3/4 (October 1, 2003 to April 30, 2006). Technical Publication ERA #462, South Florida Water Management District, West Palm Beach, FL. November 2007.
- Burns & McDonnell. 2003. Long-Term Plan for Achieving Water Quality Goals in the Everglades Protection Area. Prepared for the South Florida Water Management District, West Palm Beach, FL.
- Chamberlain, R.H. and P.H. Doering. 1998. Preliminary estimate of optimum freshwater inflow to the Caloosahatchee Estuary: A resource-based approach. Proceedings of the Charlotte Harbor Public Conference and Technical Symposium; 1997 March 15-16; Punta Gorda, FL. Charlotte Harbor National Estuary Program Technical Report No. 98-02. 274 pp.
- Gawlik, D.E. and T. Beck. 2010. Assessment of the Environmental Lift of Stormwater Treatment Areas on South Florida Avifauna: Phase II Long-Term Study, Deliverable 4. Submitted to the South Florida Water Management District, West Palm Beach, FL.
- Godfrey, M.C. and T. Catton. 2011. River of Interests. Water Management in South Florida and the Everglades, 1948-2010. Prepared for the U.S. Army Corps of Engineers, Jacksonville, FL.
- Hauert, D.E. and J.R. Startzman. 1980. Some seasonal fisheries trends and the effects of a 1000 cfs freshwater discharge on the fishes and macroinvertebrates in the St. Lucie Estuary, Florida. Technical Publication #80-3, South Florida Water Management District, West Palm Beach, FL.
- Hauert, D.E. and J.R. Startzman. 1985. Some short term effects of a freshwater discharge on biota of the St. Lucie Estuary, Florida. Technical Publication 85-1, South Florida Water Management District, West Palm Beach, FL.
- Pandion Systems, Inc. 2008. Avian Protection Plan for Black-necked Stilts and Burrowing Owls Nesting in the Everglades Agricultural Area Stormwater Treatment Areas. Prepared by Pandion, Gainesville, FL, for the South Florida Water Management District, West Palm Beach, FL.
- SFWMD. 1979. Interim Action Plan. South Florida Water Management District, West Palm Beach, FL.
- SFWMD. 2004. 2004 Everglades Consolidated Report. South Florida Water Management District, West Palm Beach, FL.

- SFWMD. 2005. Final Documentation for the South Florida Water Management Model. Hydrologic and Environmental Systems Modeling Department, South Florida Water Management District, West Palm Beach, FL.
- SFWMD. 2012. Restoration Strategies Regional Water Quality Plan. South Florida Water Management District, West Palm Beach, FL. April 27, 2012.
- SFWMD. 2013. Restoration Strategies Regional Water Quality Plan, Science Plan for the Everglades Stormwater Treatment Areas. South Florida Water Management District, West Palm Beach, FL. June 2013.
- USACE. 1957. Central and Southern Florida Project for Flood Control and Other Purposes, Part IV, Lake Okeechobee and Outlets, Supplement 6 – General Design Memoranda, Caloosahatchee River and Control Structures (Canal 43 and Lock and Spillway Structures 77, 78 and 79) with Appendices, U. S. Army Corps of Engineers, U.S. Army Office of the District Engineers, Washington, D.C., April 24, 1957, Section I, p.41.
- USACE. 1992. Kissimmee River Restoration Study. Central and Southern Florida Project, Environmental Restoration of the Kissimmee River, Florida. Final Integrated Feasibility Report and Environmental Impact Statement. House Document 102-286, 102d Congress, 2d Session.
- USACE. 1994. Master Water Control Manual for Kissimmee River-Lake Istokpoga Basin. Jacksonville District, U. S. Army Corps of Engineers, Jacksonville, Florida.
- USACE. 2007. Final Supplemental Environmental Impact Statement Lake Okeechobee Regulation Schedule. Jacksonville District, U.S. Army Corps of Engineers, Jacksonville, FL.
- USACE. 2008. Central and Southern Florida Project Water Control Plan for Lake Okeechobee and Everglades Agricultural Area, Section 7.07.a. Jacksonville District, U.S. Army Corps of Engineers, Jacksonville, FL.
- USACE. 2011. Everglades Restoration Transition Plan, Final Environmental Impact Statement. Jacksonville District, U.S. Army Corps of Engineers, Jacksonville, FL. December 2011.

Appendix A: S-2/S-3 Flood Control Pumping History

S-2/S-3 Flood Control Pumping History

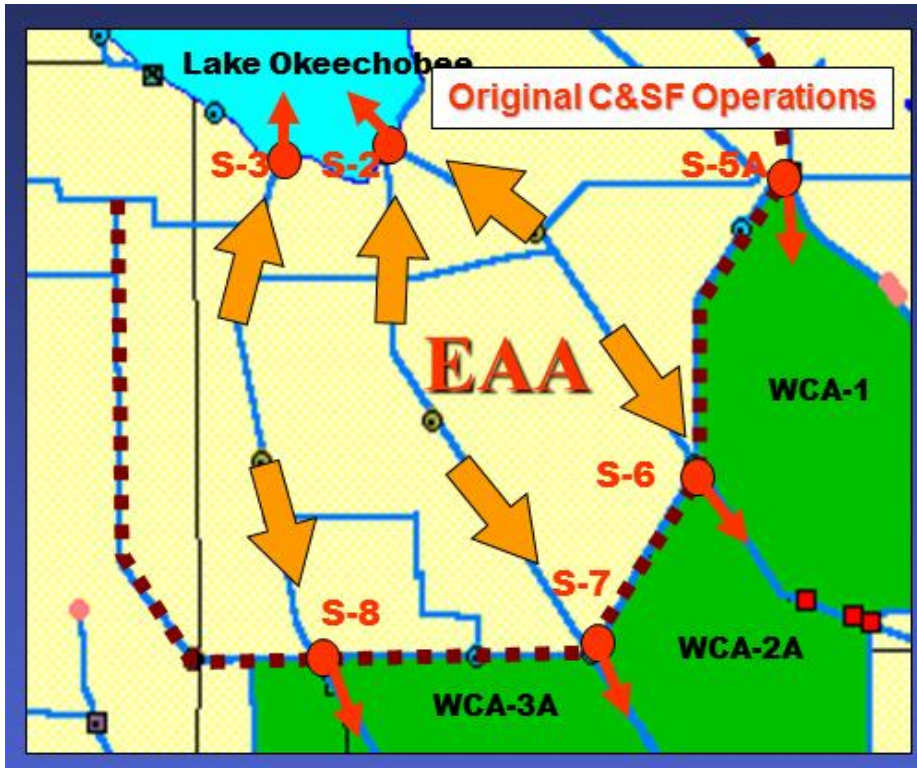


Figure A-1. EAA flow patterns under the original Central and Southern Florida Flood Control Project (C&SF) operations. [Note: The C&SF design discharged runoff from the northern portion of the EAA to Lake Okeechobee; only the southern EAA discharged runoff to the WCAs. The average annual runoff from the EAA was approximately 1 million ac-ft.]



Figure A-2. EAA flow patterns under the Interim Action Plan (IAP). [Note: Following IAP implementation in the early 1980s, most of the EAA runoff was directed to the WCAs in efforts to reduce nutrient impacts to Lake Okeechobee. EAA runoff discharged to the WCAs increased by about 190,000 ac-ft. Flood control operation of S-2 and S-3 occurs only when southern capacity is not sufficient.]

S-2/S-3 Flood Control Pumping History

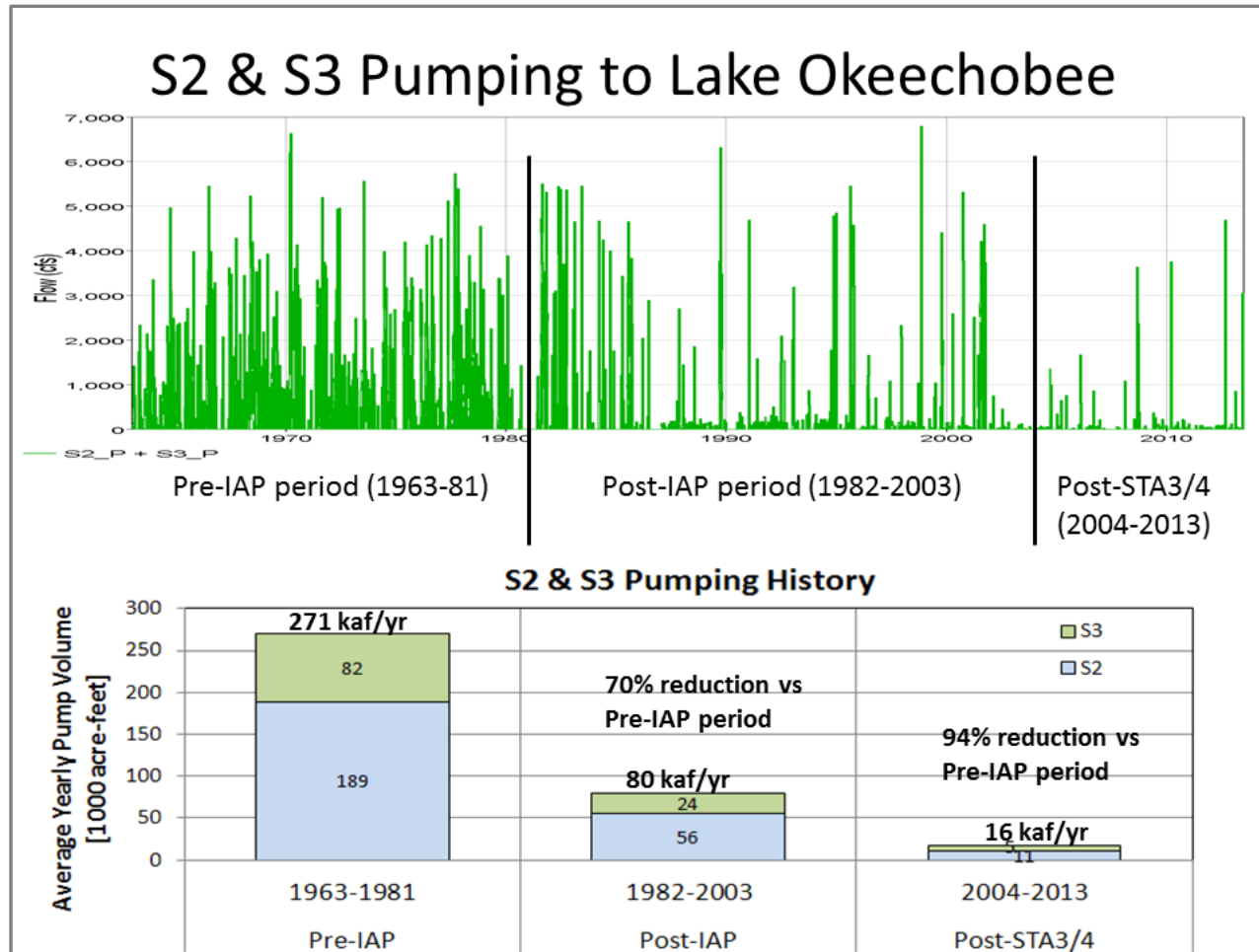
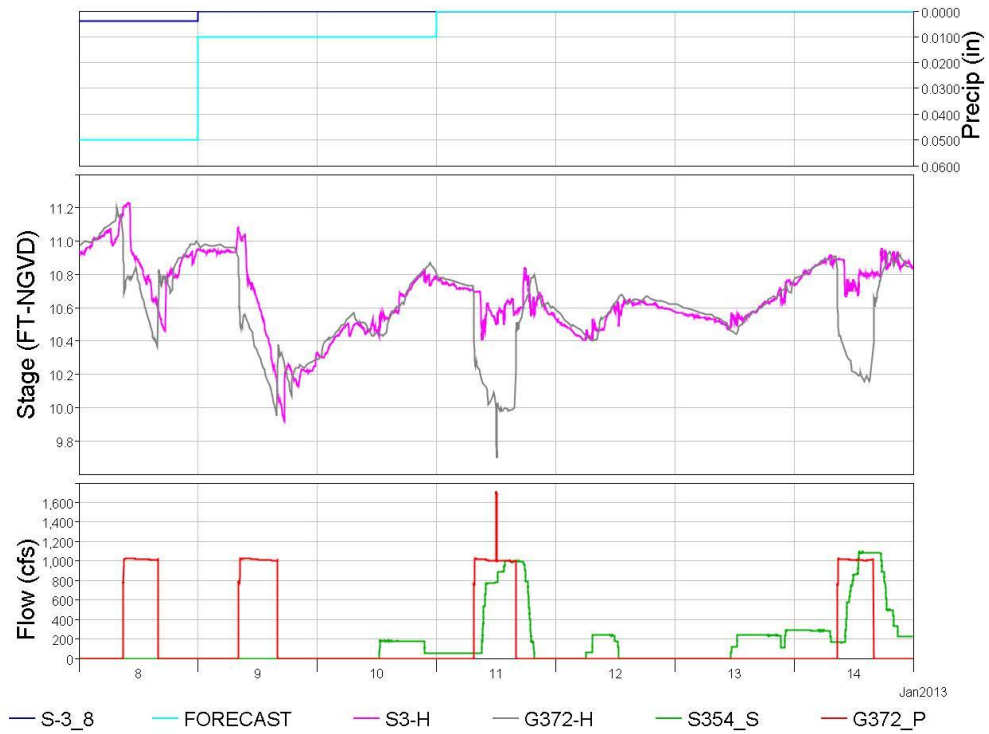
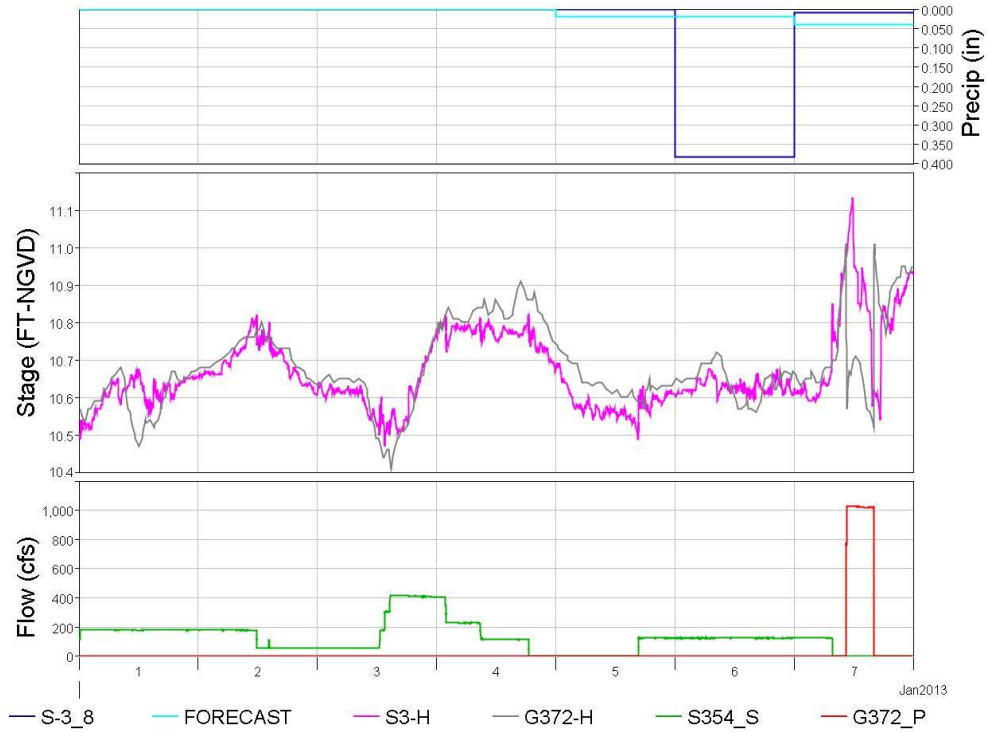


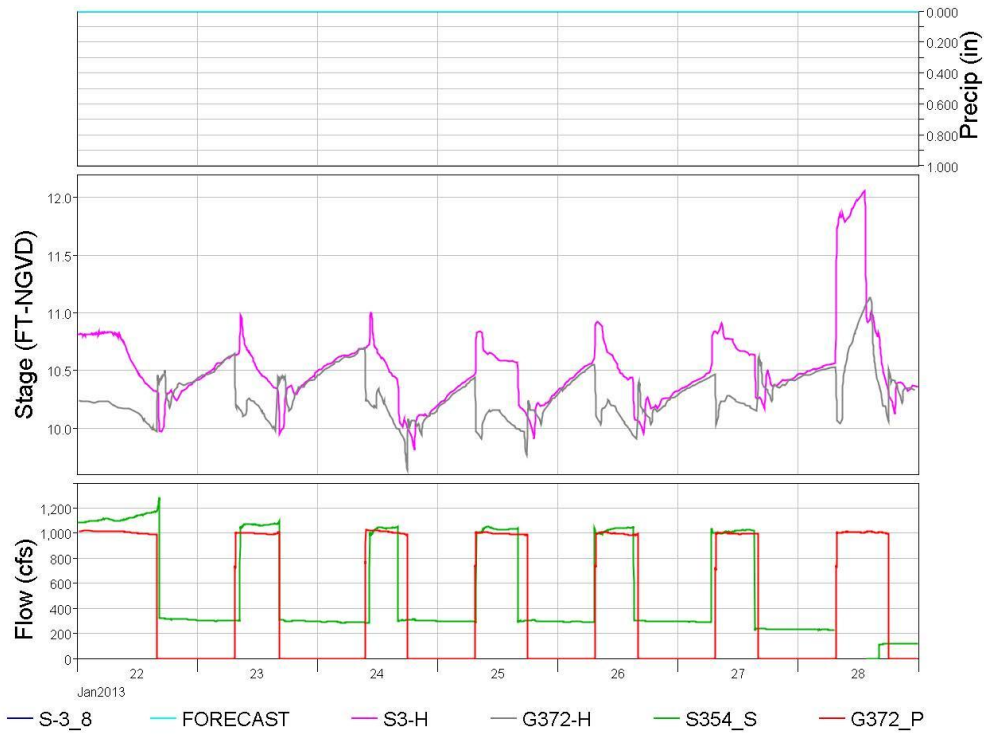
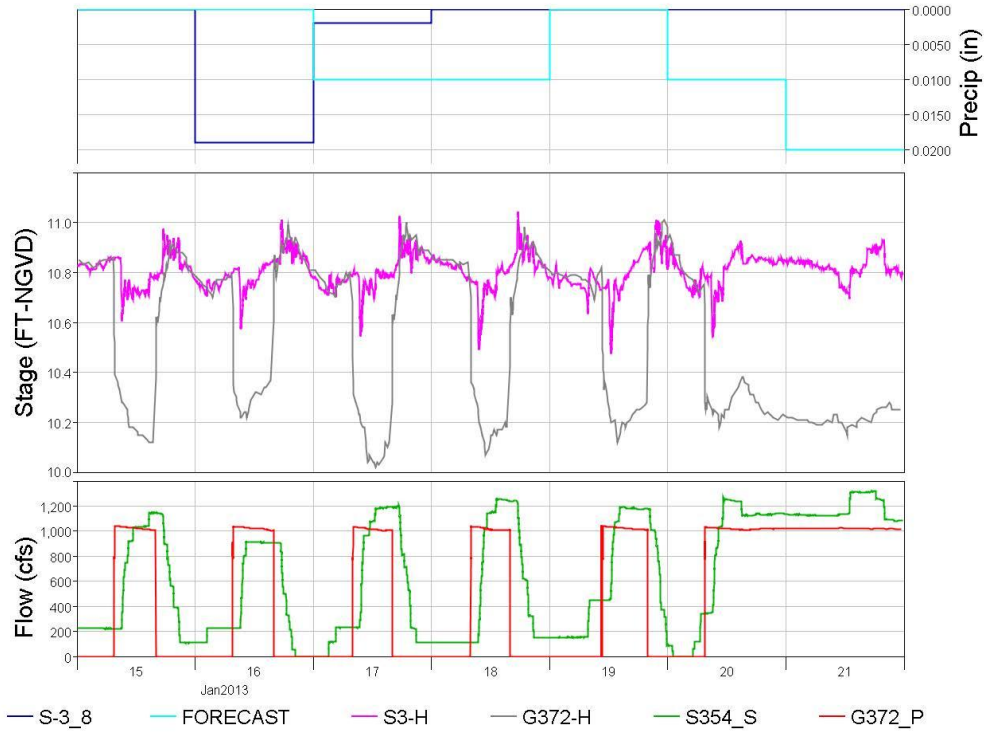
Figure A-3. Overview of S-2 and S-3 pumping history to Lake Okeechobee from pre-IAP period (1963–1981) through 2013.

**Appendix B:
Weekly Flows and Stages
for Miami Canal and
North New River Canal**

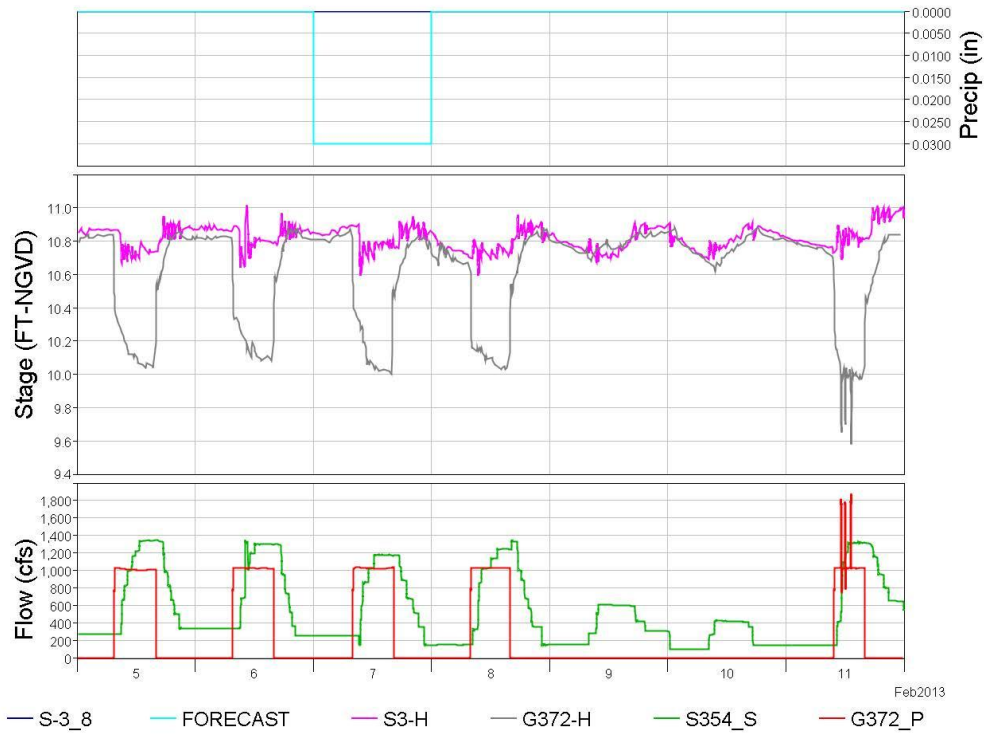
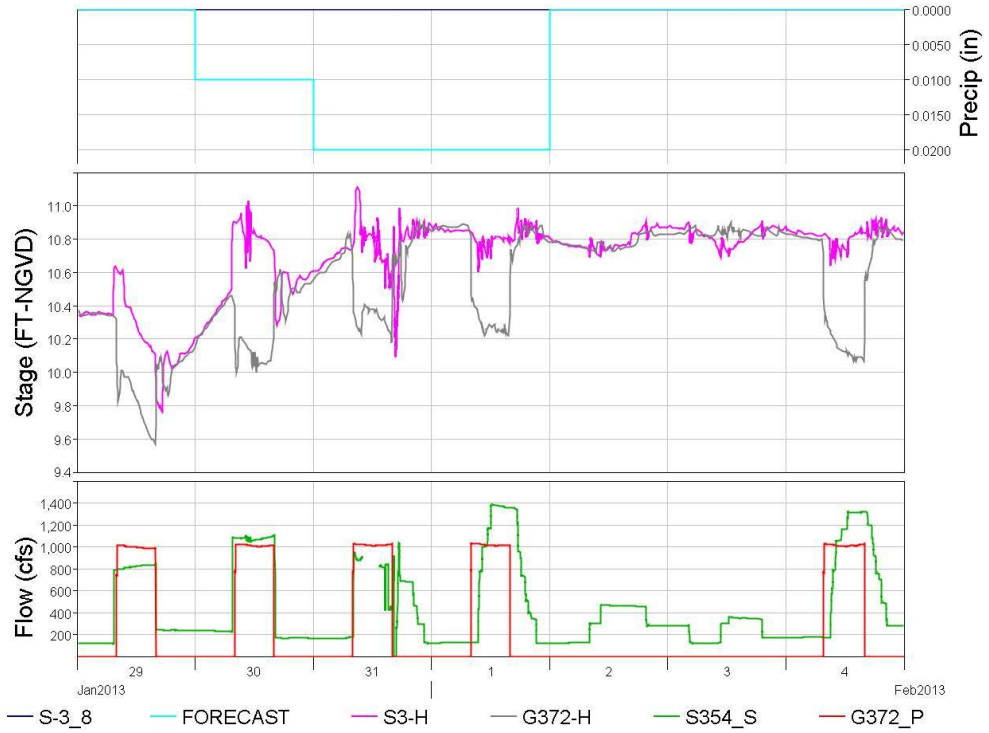
Weekly Flow and Stage — Miami Canal



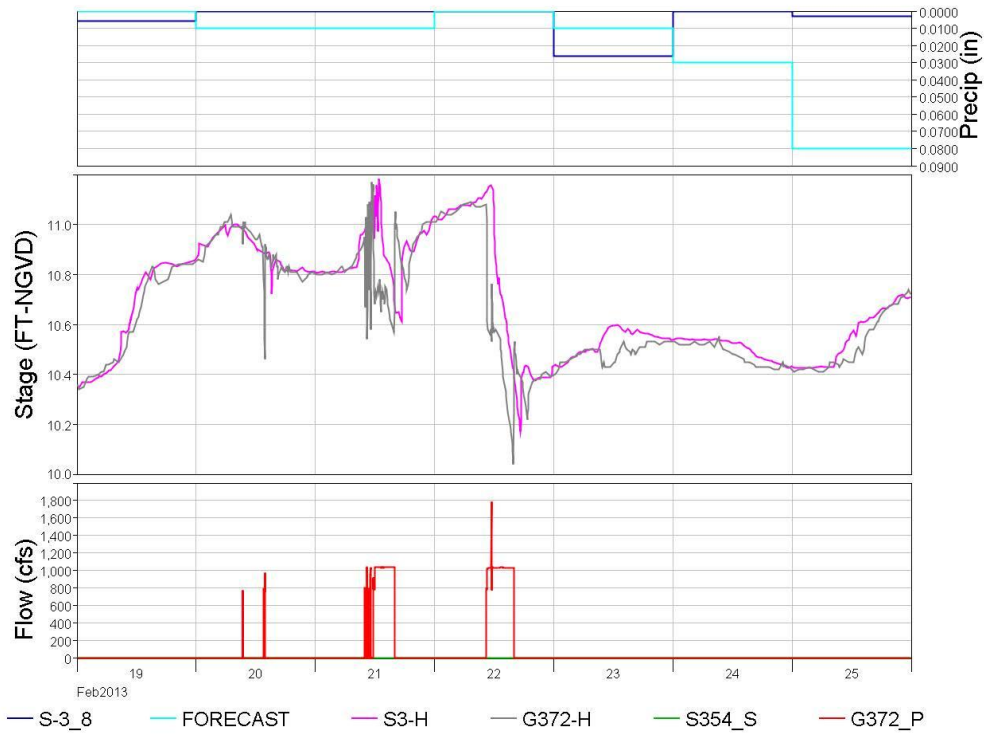
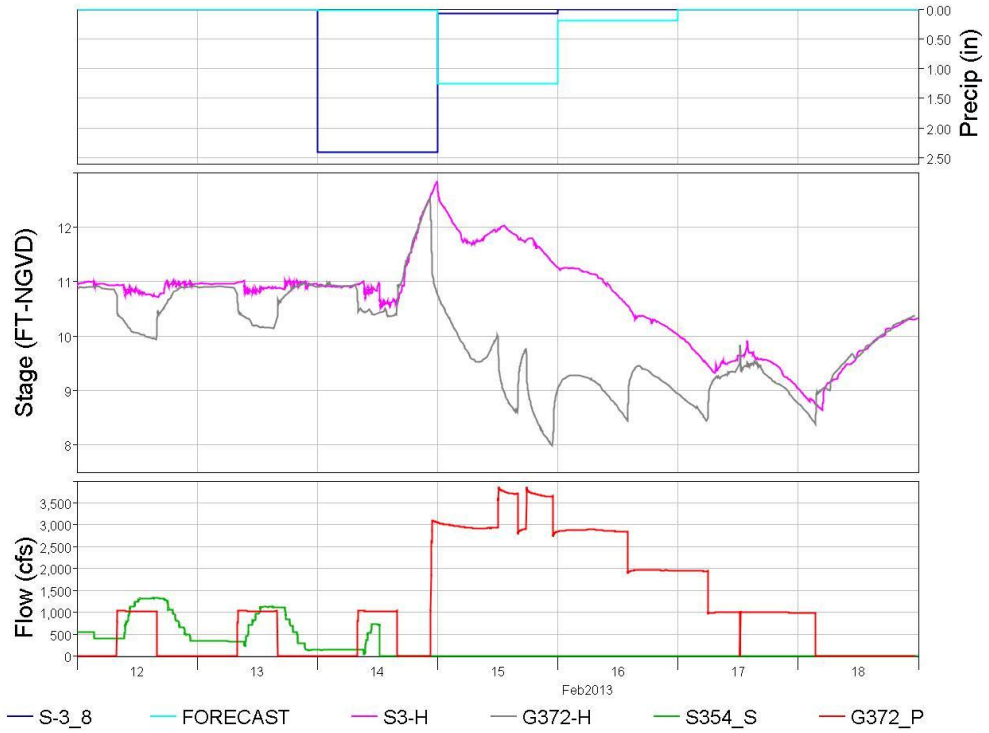
Weekly Flow and Stage — Miami Canal



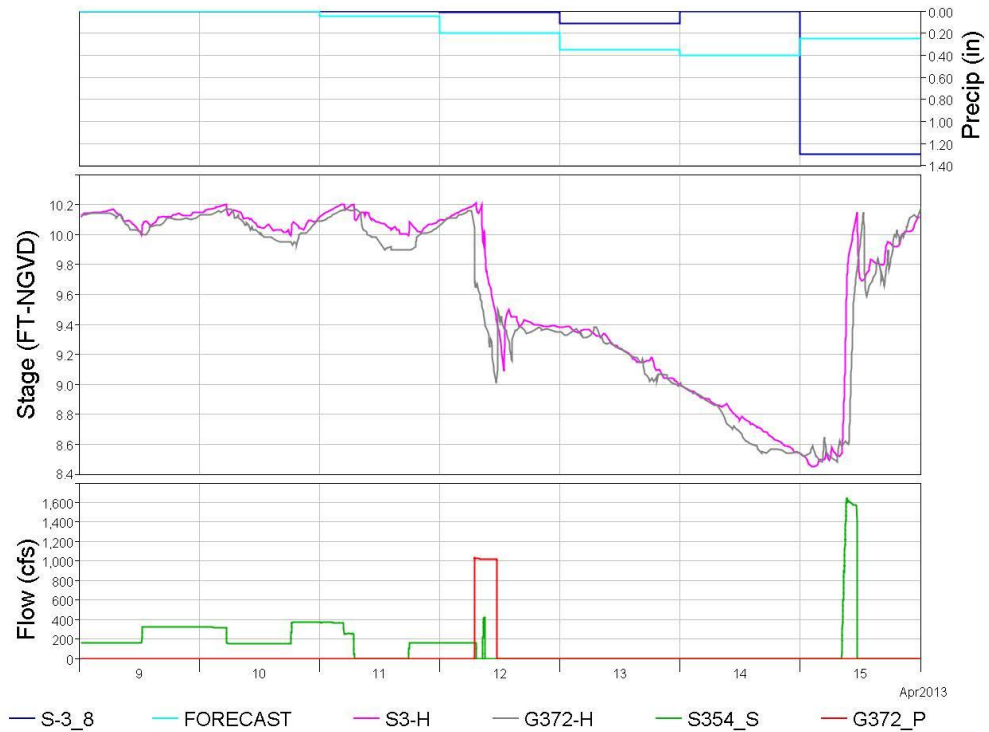
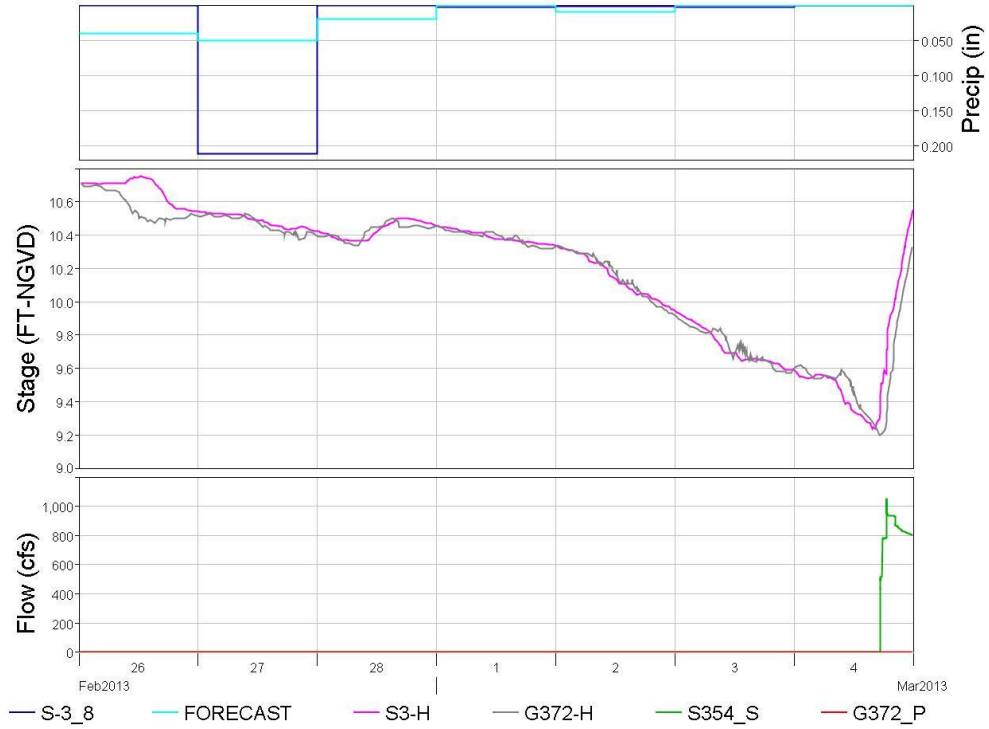
Weekly Flow and Stage — Miami Canal



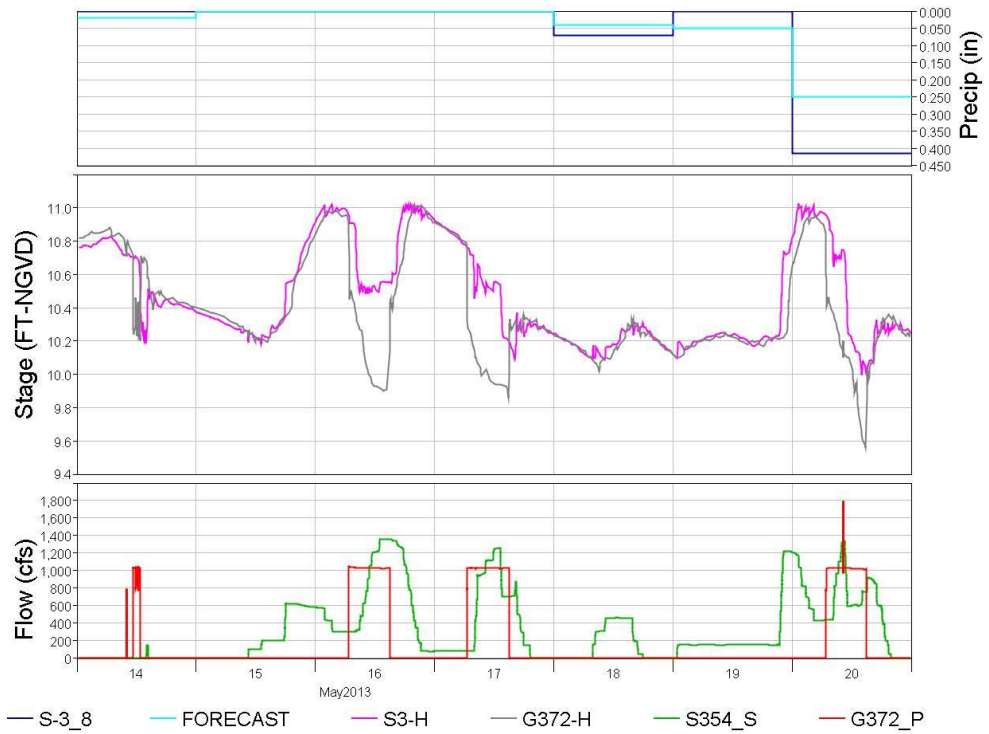
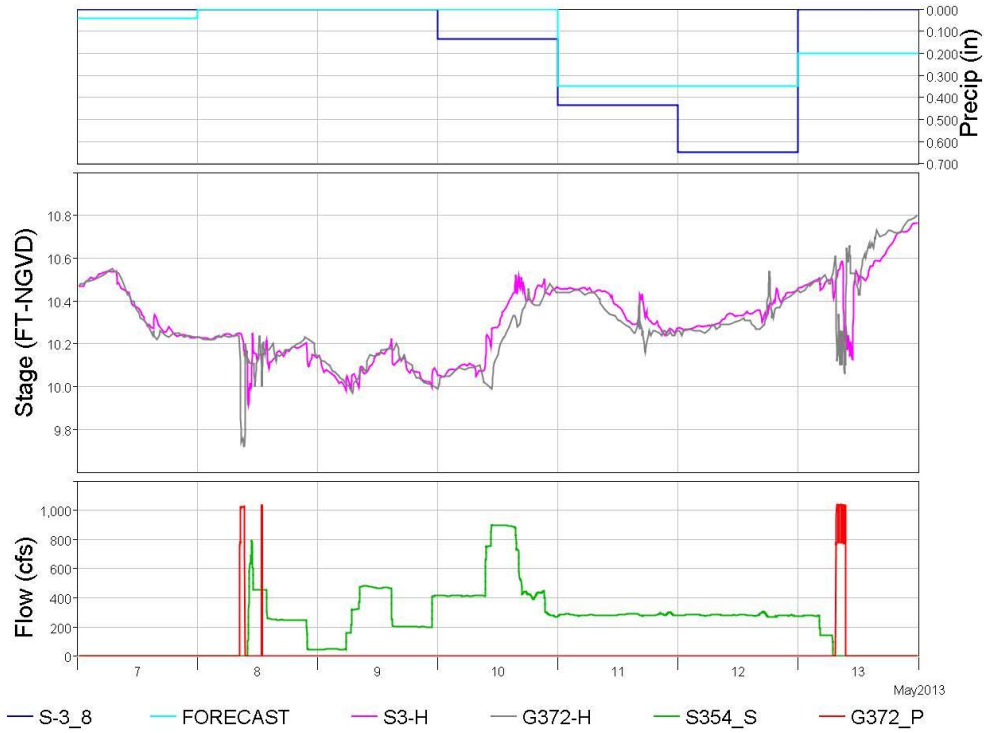
Weekly Flow and Stage — Miami Canal



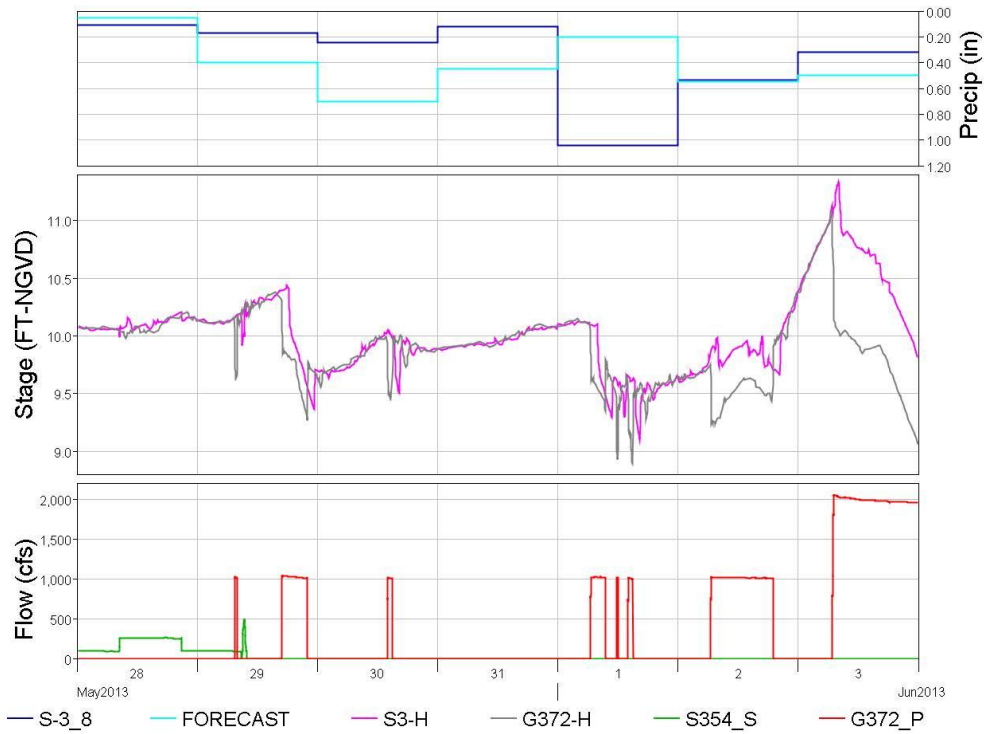
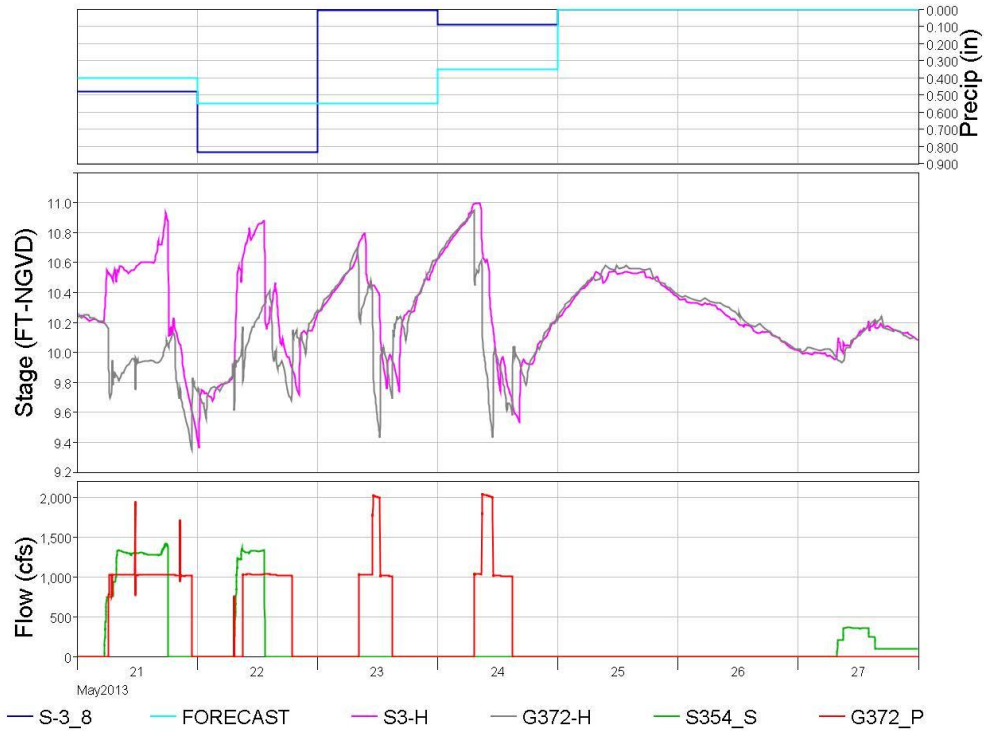
Weekly Flow and Stage — Miami Canal



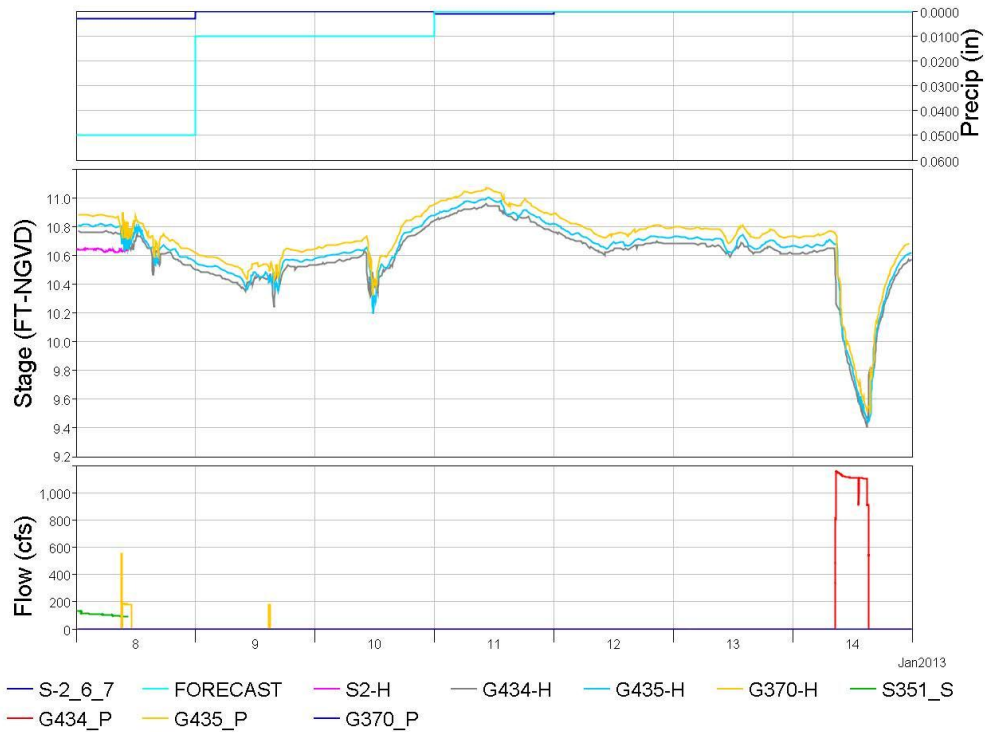
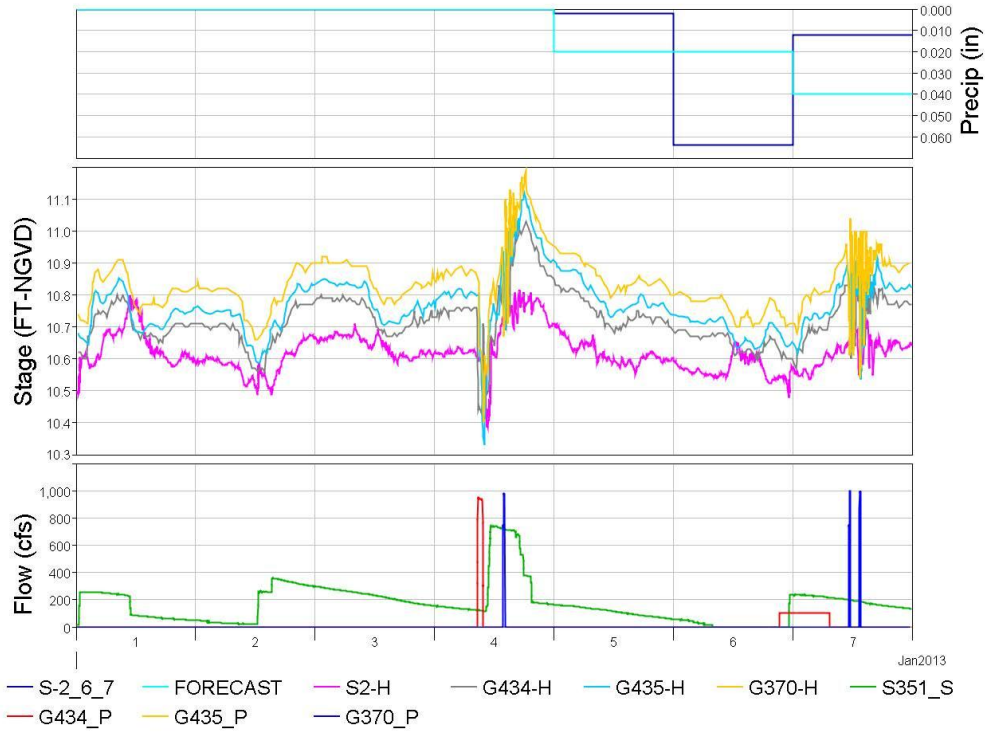
Weekly Flow and Stage — Miami Canal



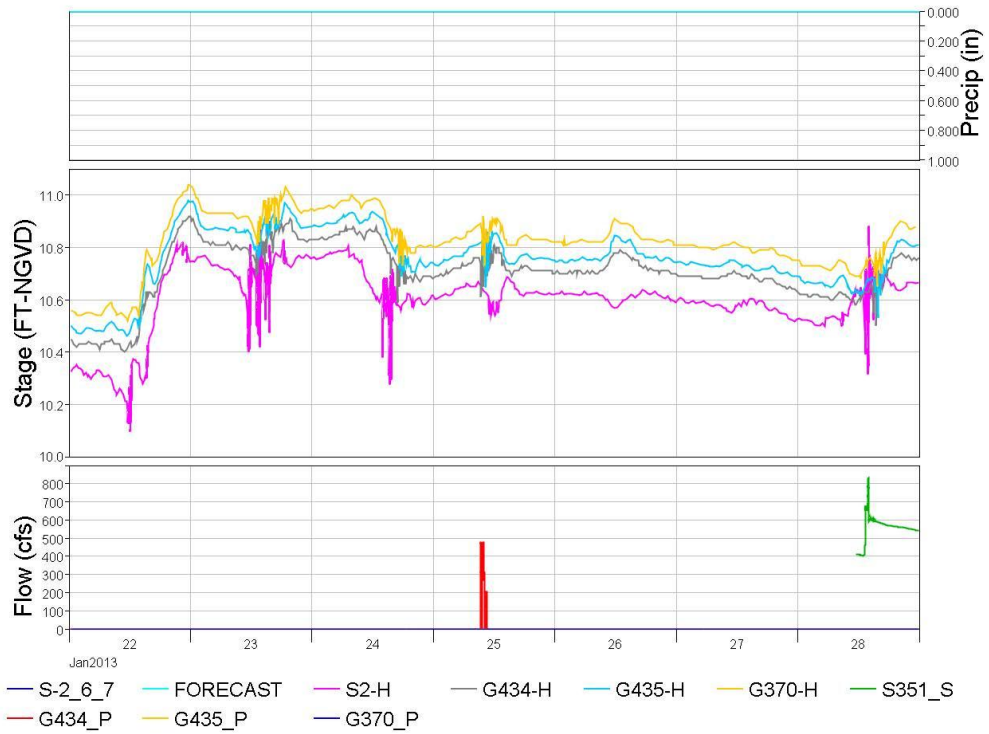
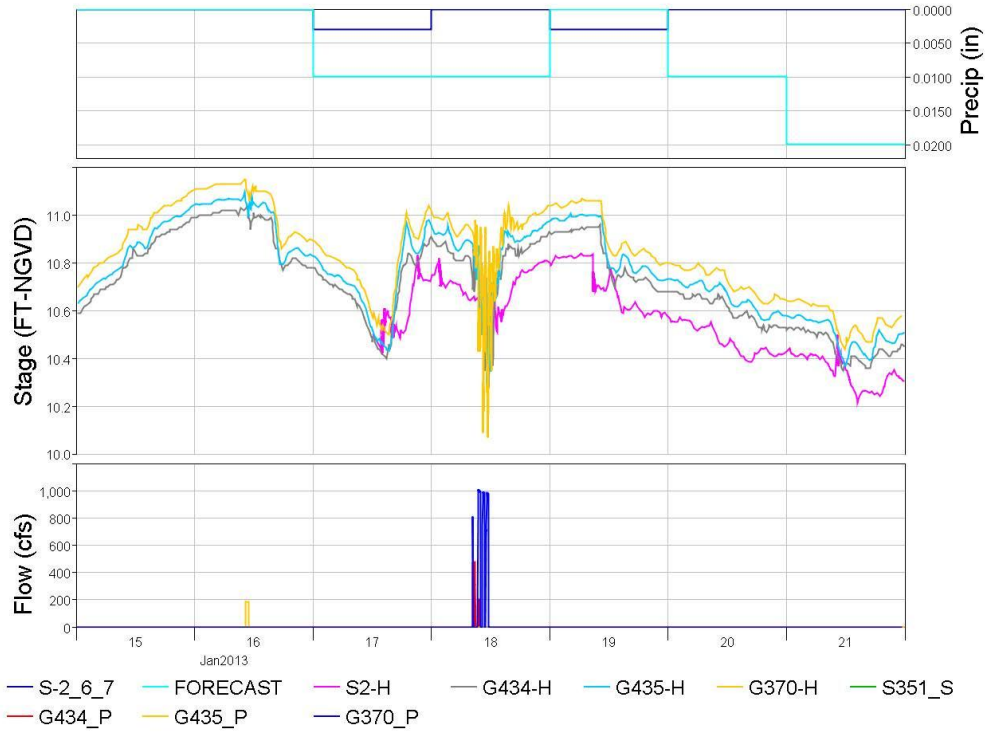
Weekly Flow and Stage — Miami Canal



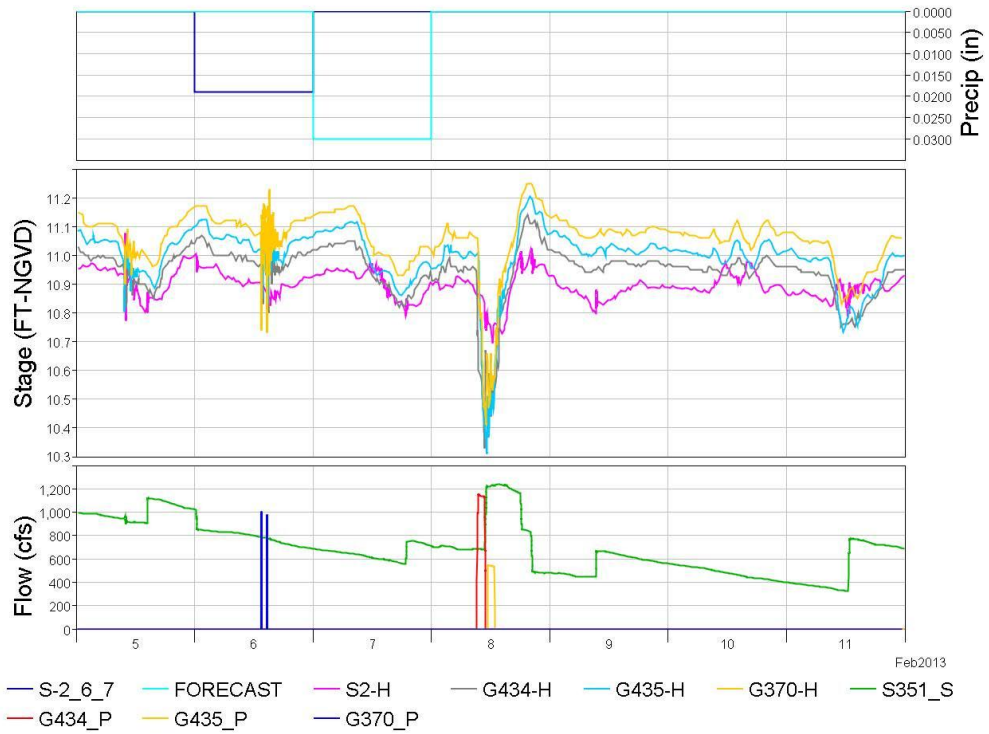
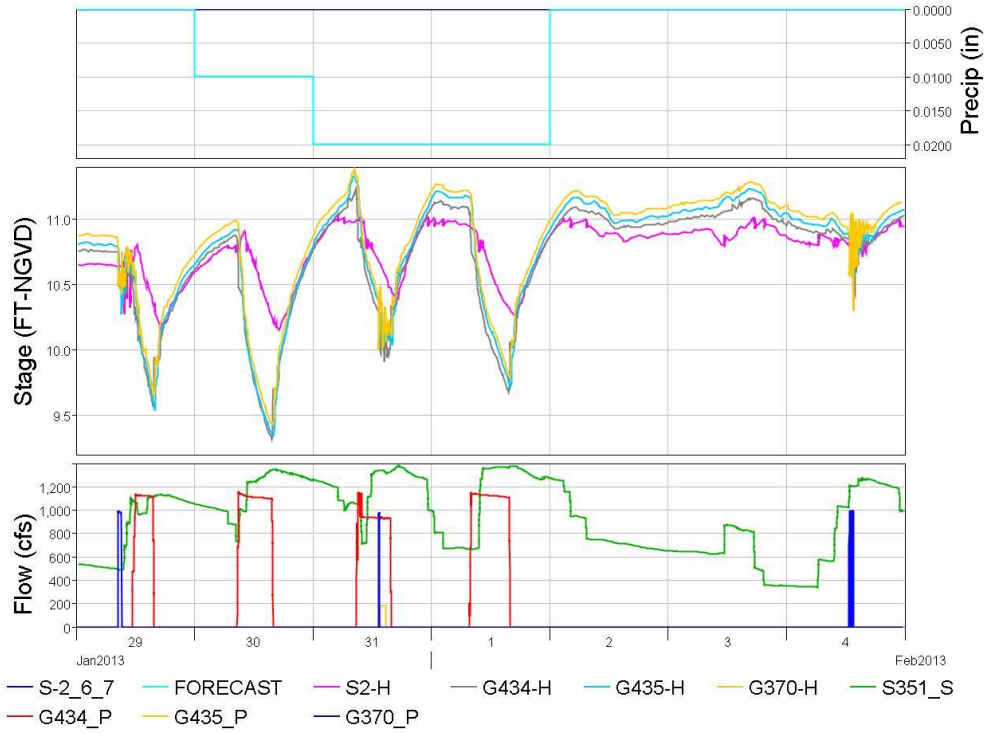
Weekly Flow and Stage — North New River Canal



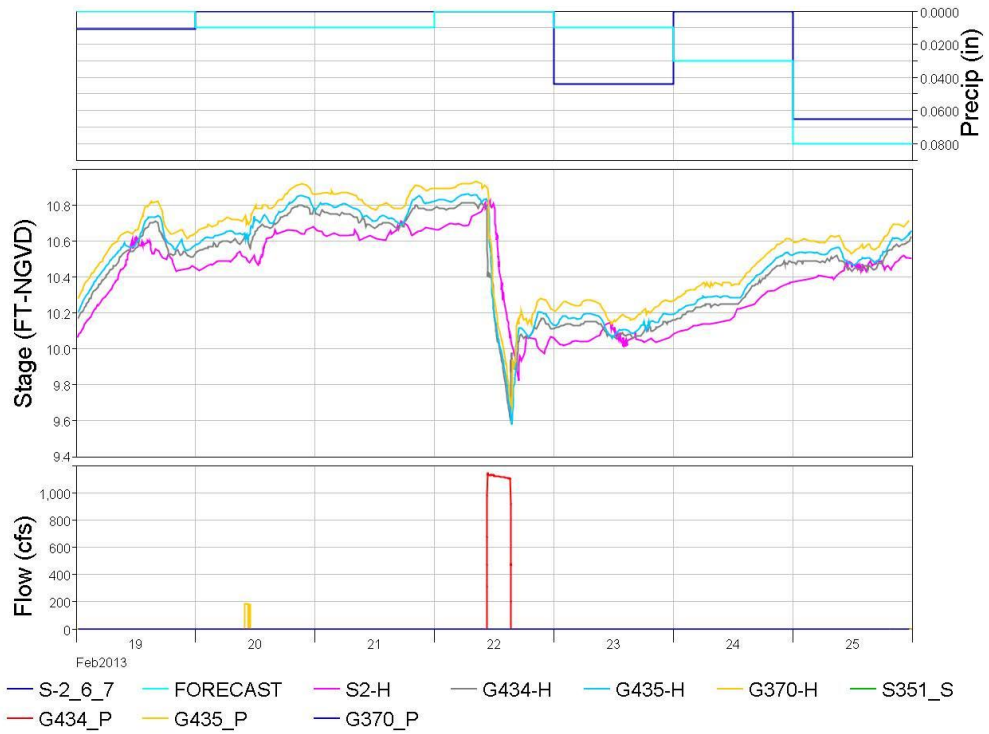
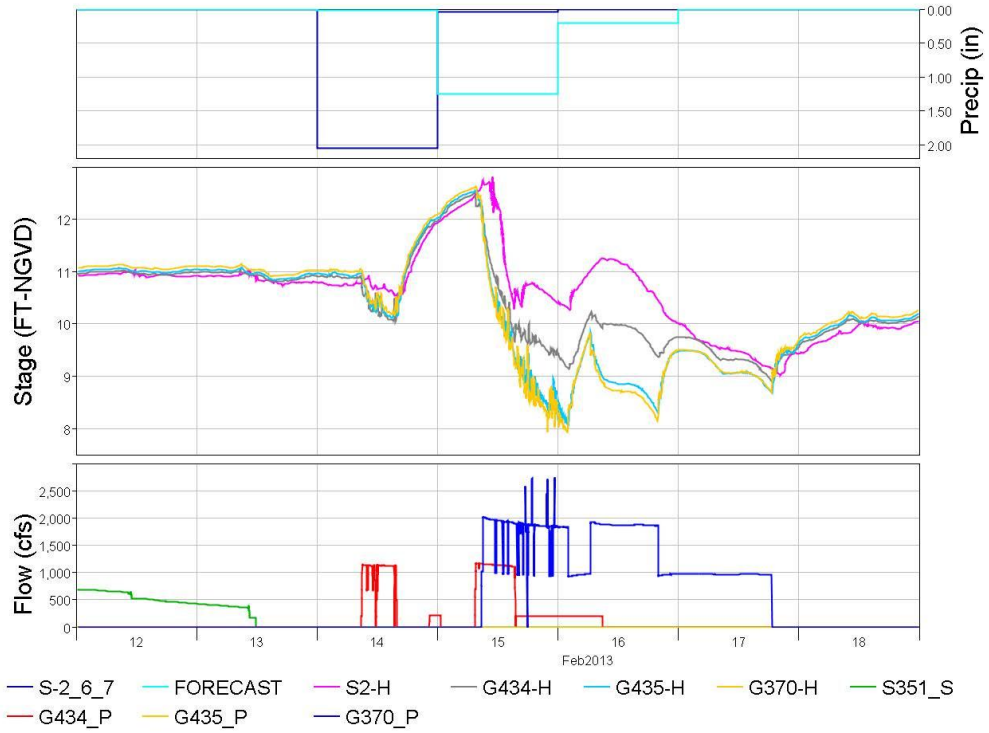
Weekly Flow and Stage — North New River Canal



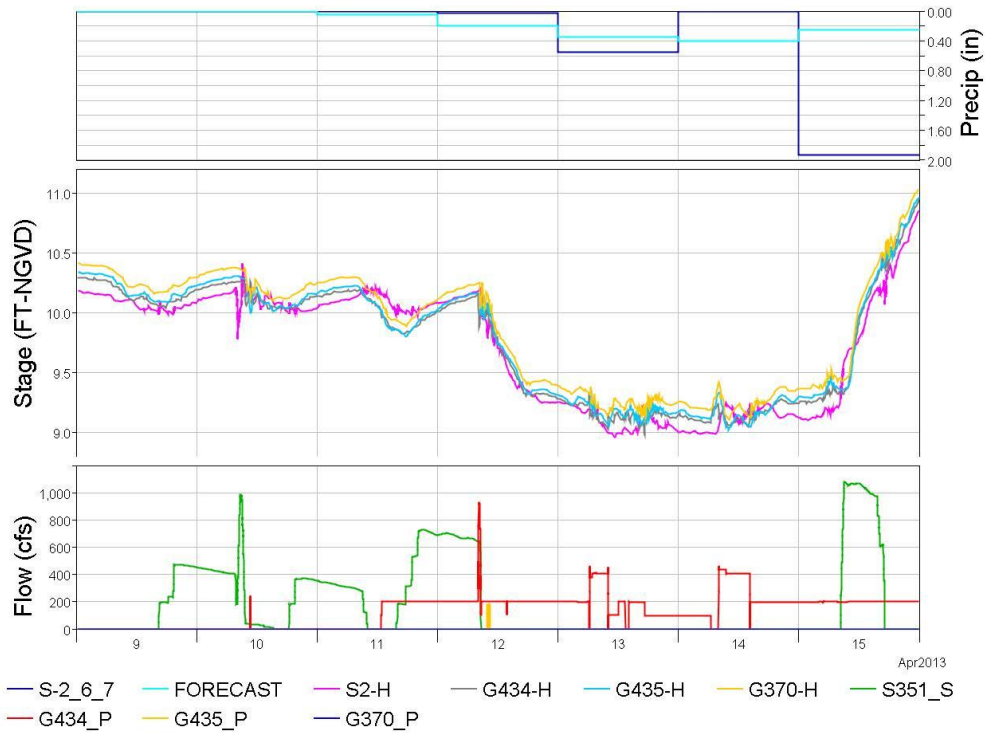
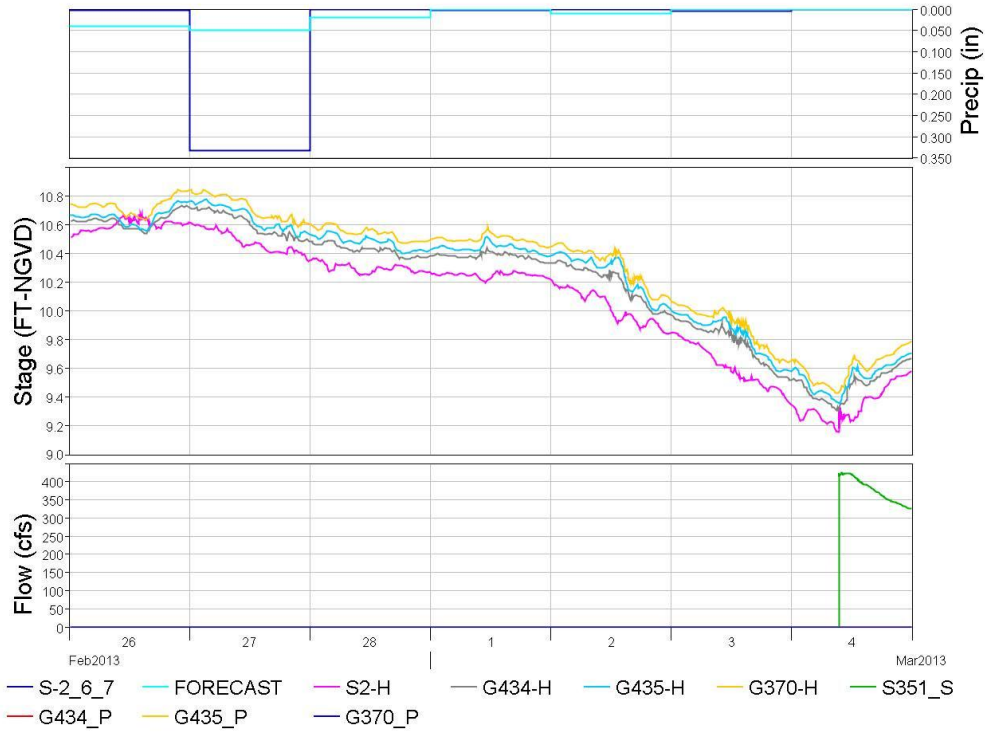
Weekly Flow and Stage — North New River Canal



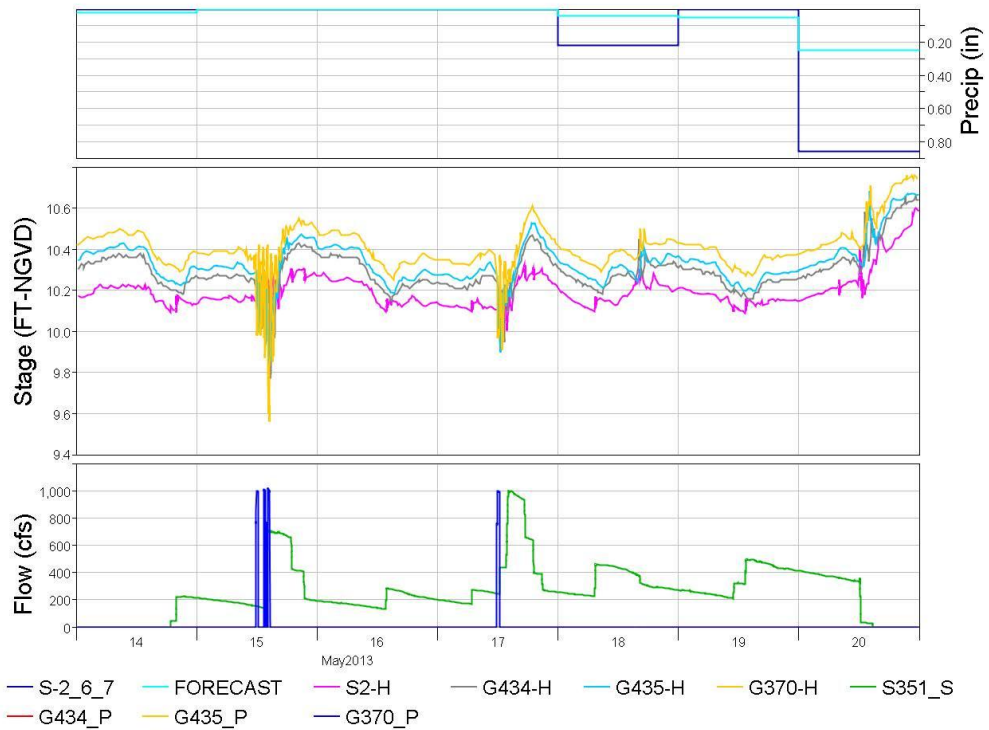
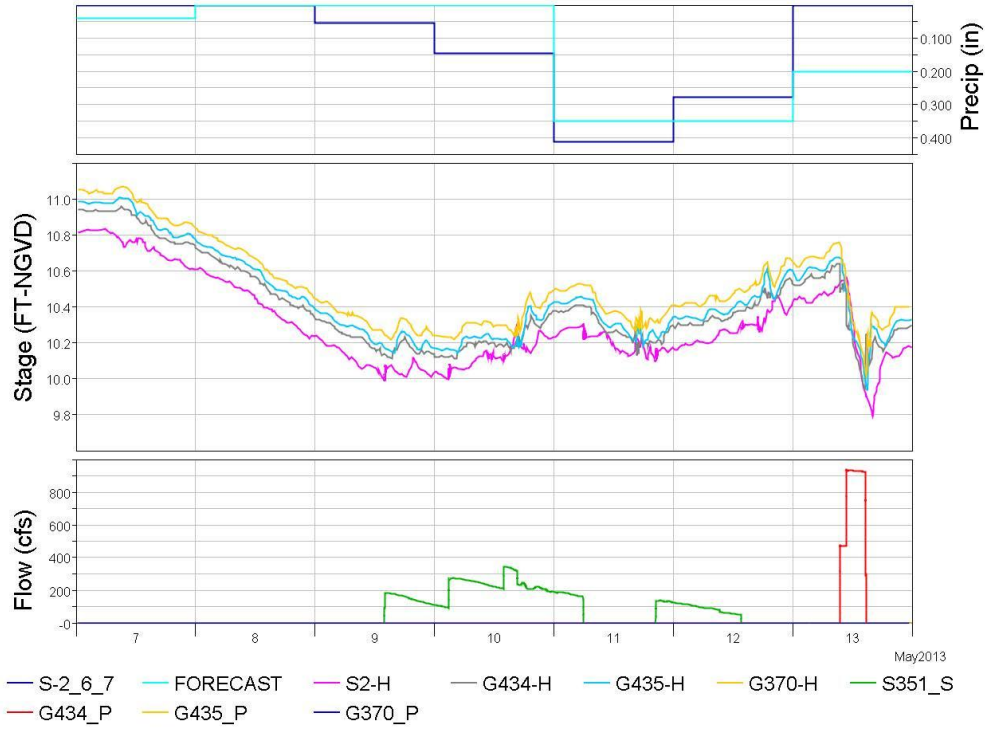
Weekly Flow and Stage — North New River Canal



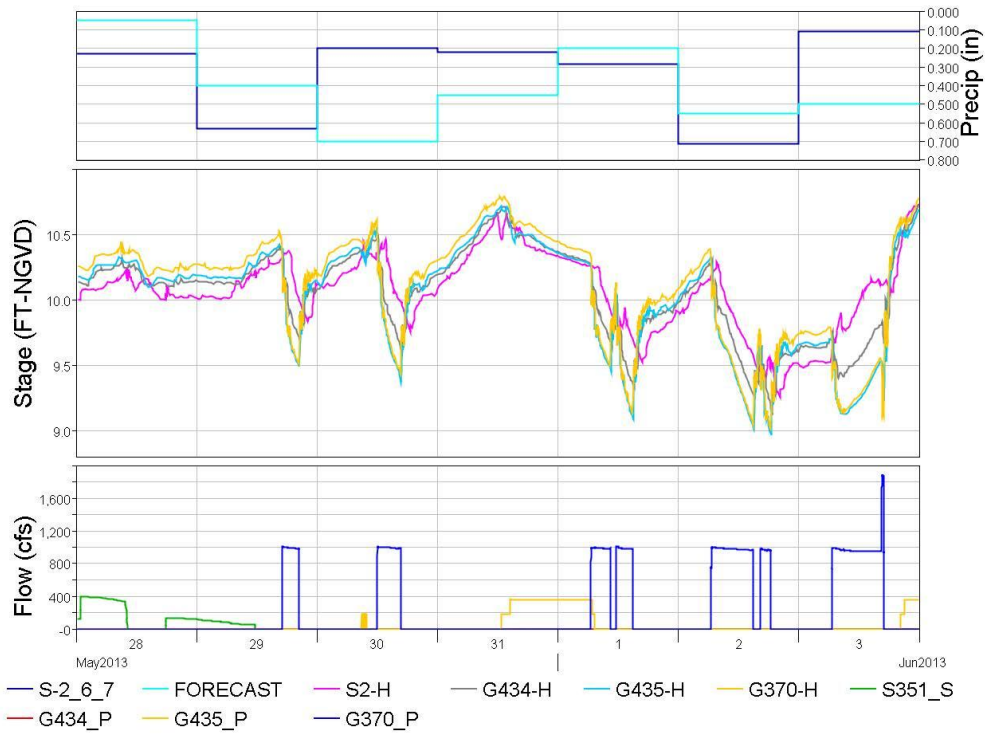
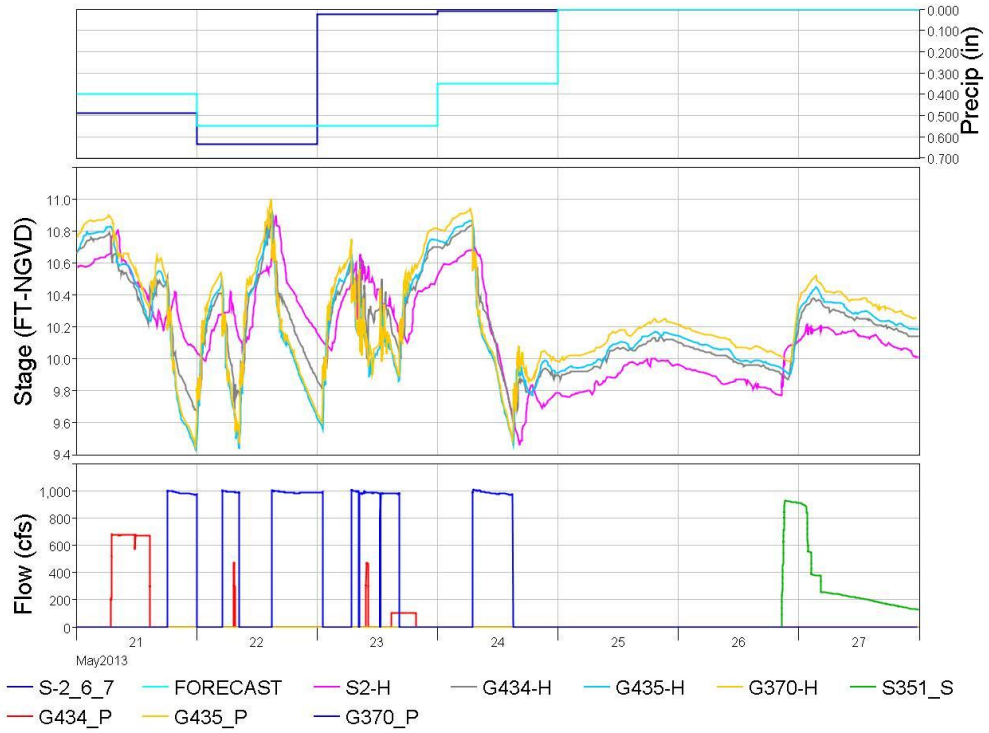
Weekly Flow and Stage — North New River Canal



Weekly Flow and Stage — North New River Canal



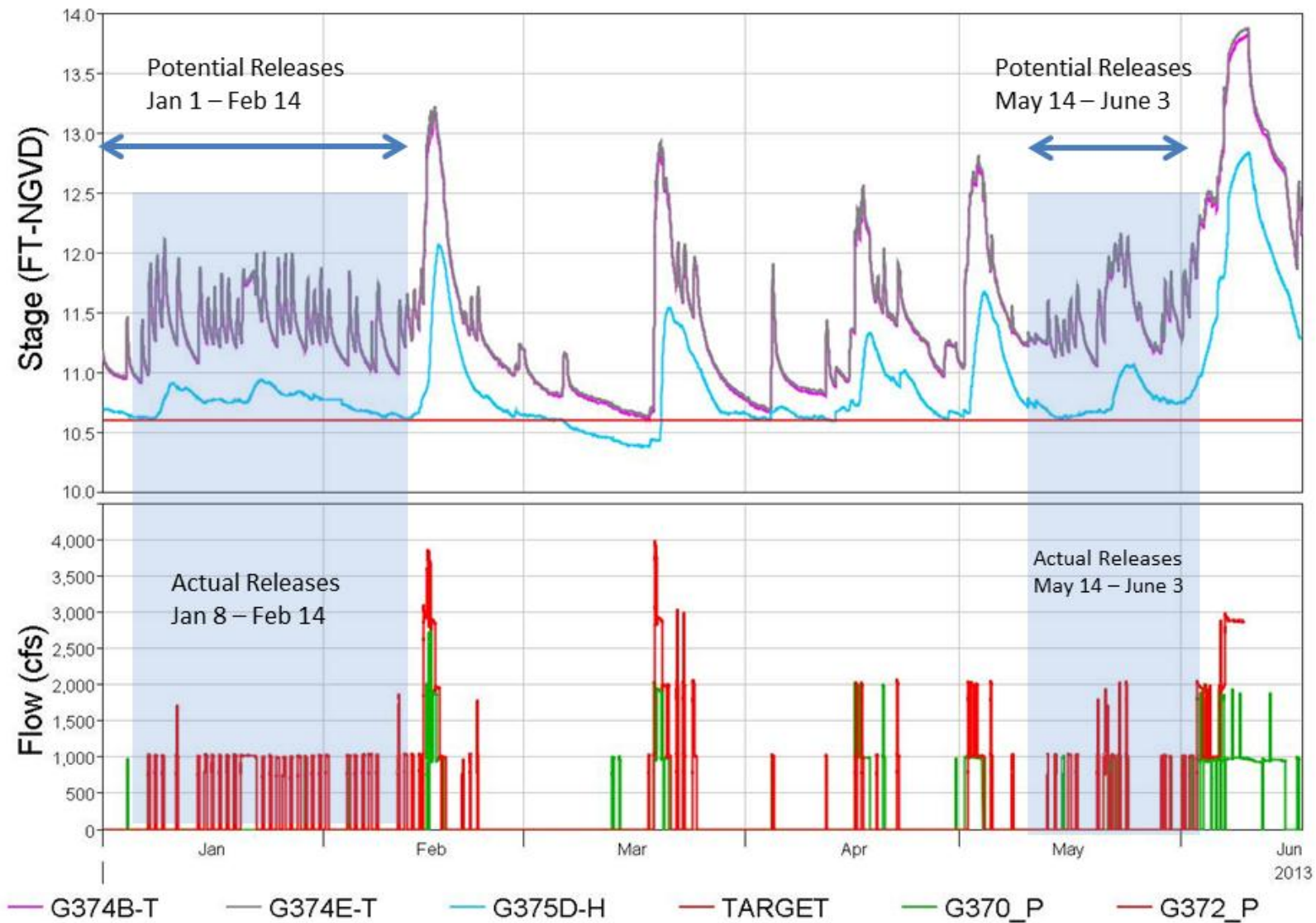
Weekly Flow and Stage — North New River Canal



Appendix C: STA-2 and STA-3/4 Inflows and Stages

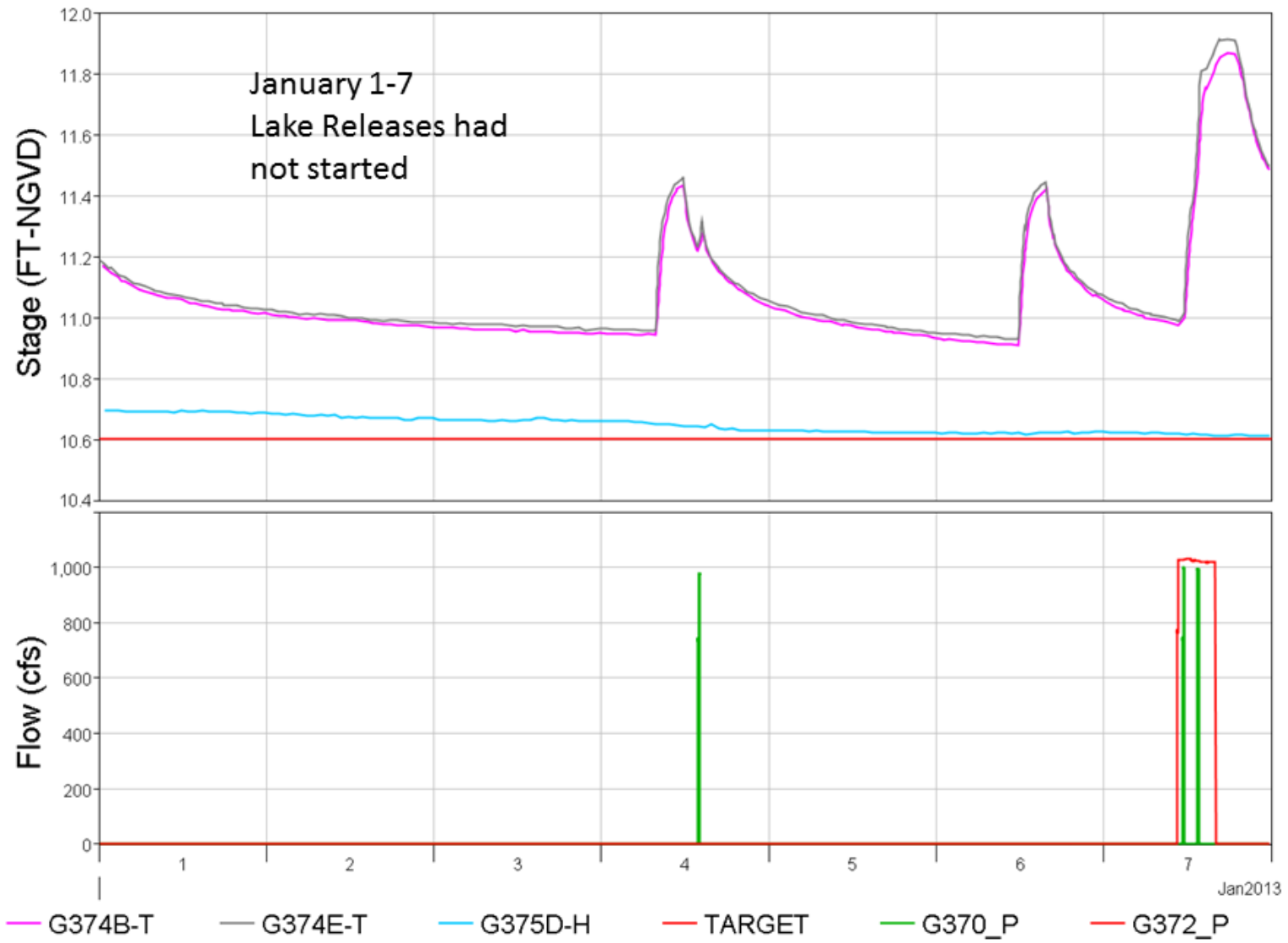
STA-3/4 Inflows and Stages

STA 3/4 Cell 1A



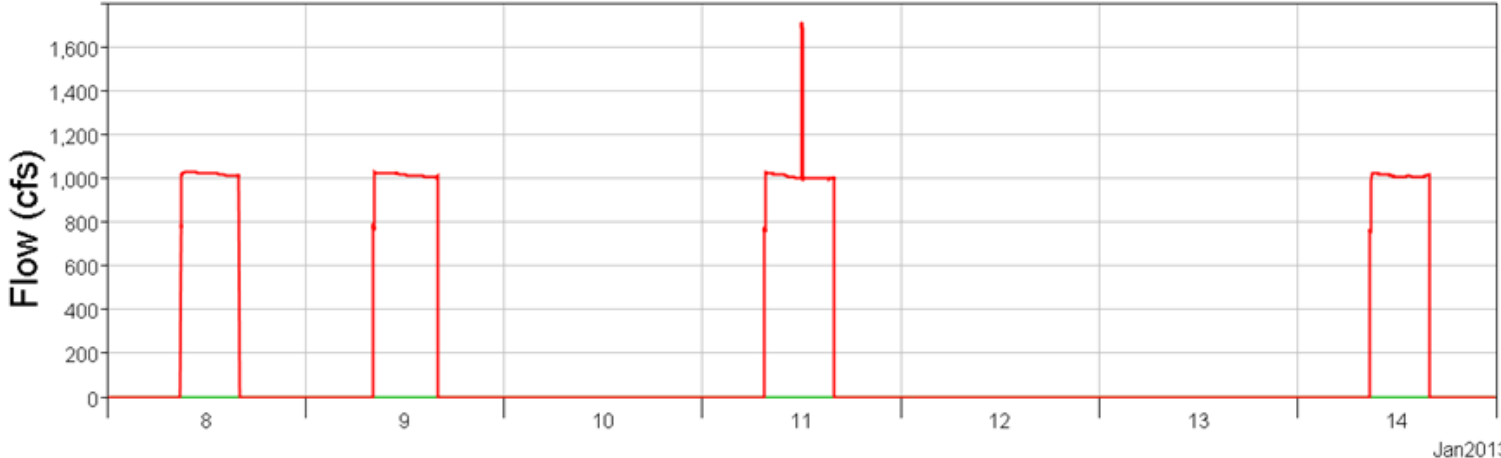
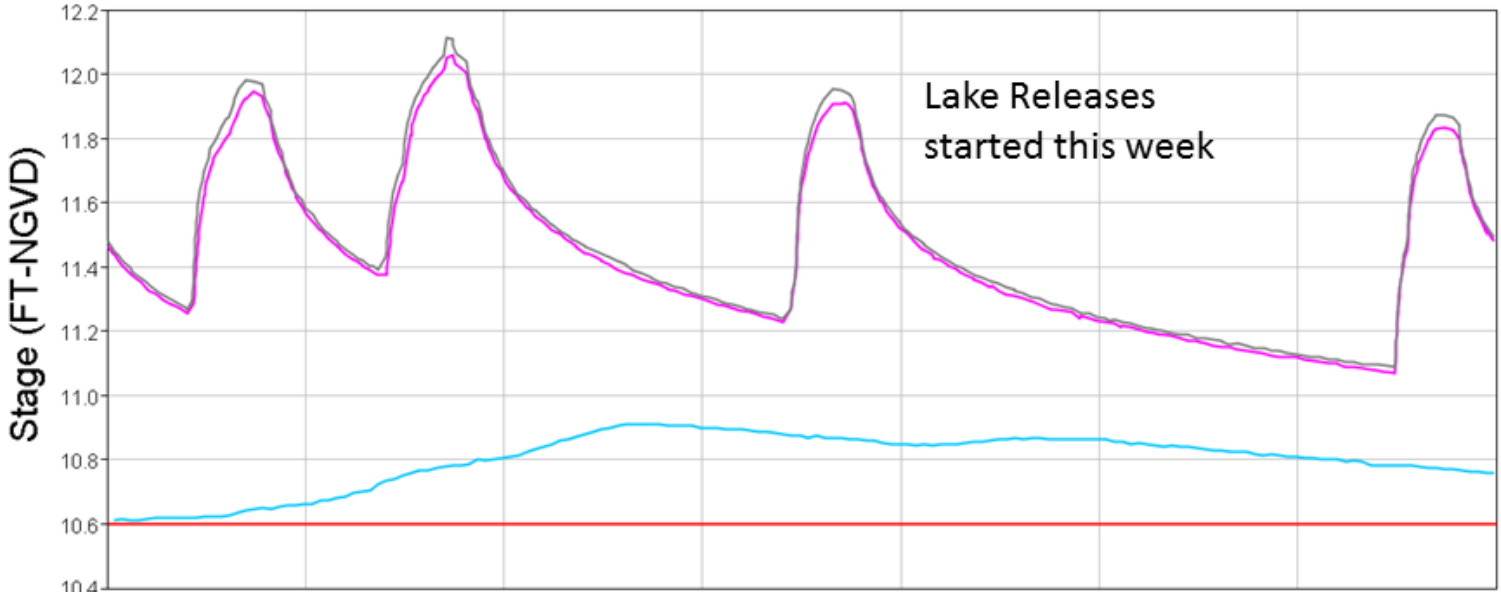
STA-3/4 Inflows and Stages

STA 3/4 Cell 1A Week 1



STA-3/4 Inflows and Stages

STA 3/4 Cell 1A Week 2

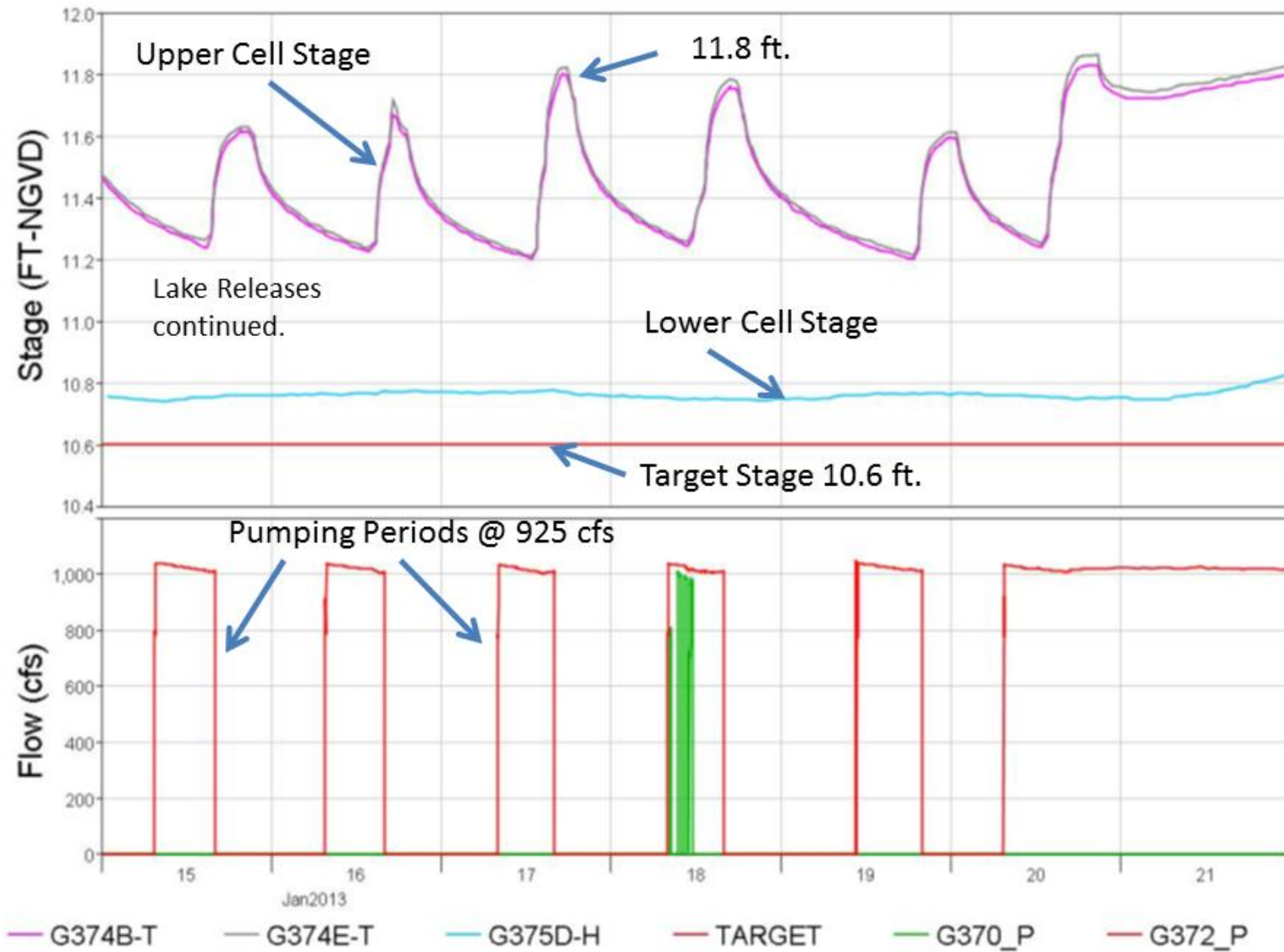


— G374B-T — G374E-T — G375D-H — TARGET — G370_P — G372_P

Jan2013

STA-3/4 Inflows and Stages

STA 3/4 Cell 1A



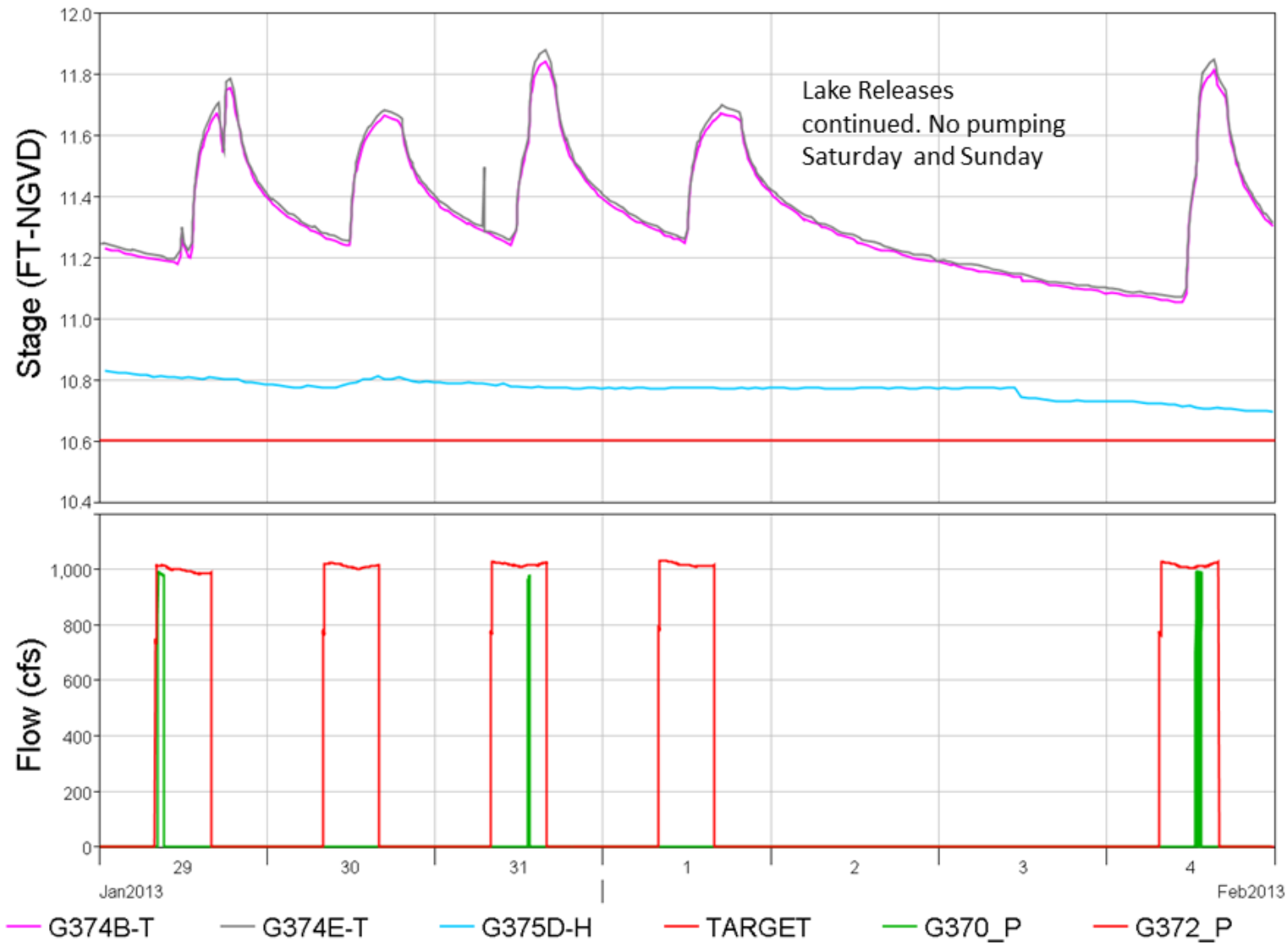
STA-3/4 Inflows and Stages

STA 3/4 Cell 1A Week 4



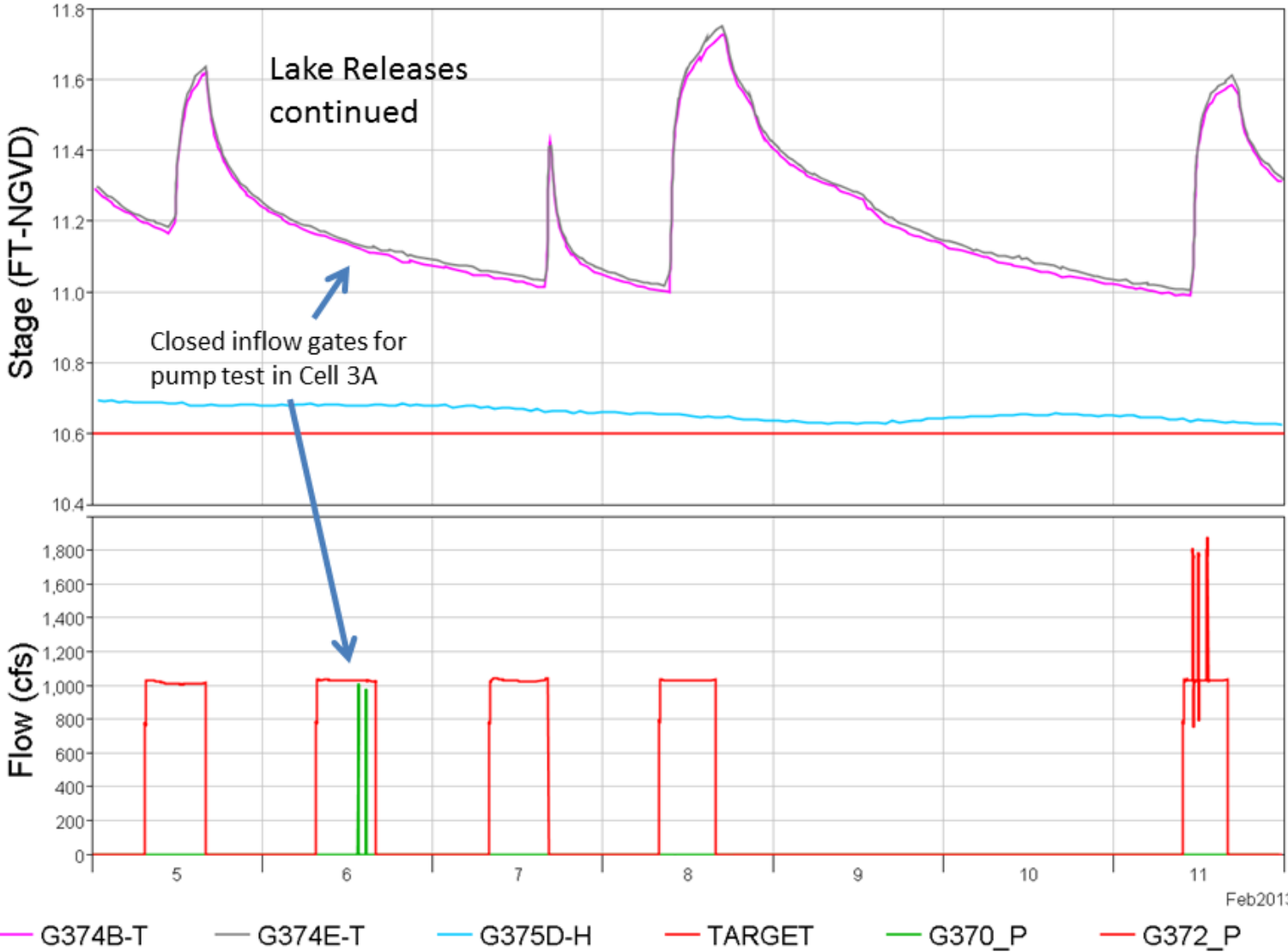
STA-3/4 Inflows and Stages

STA 3/4 Cell 1A Week 5

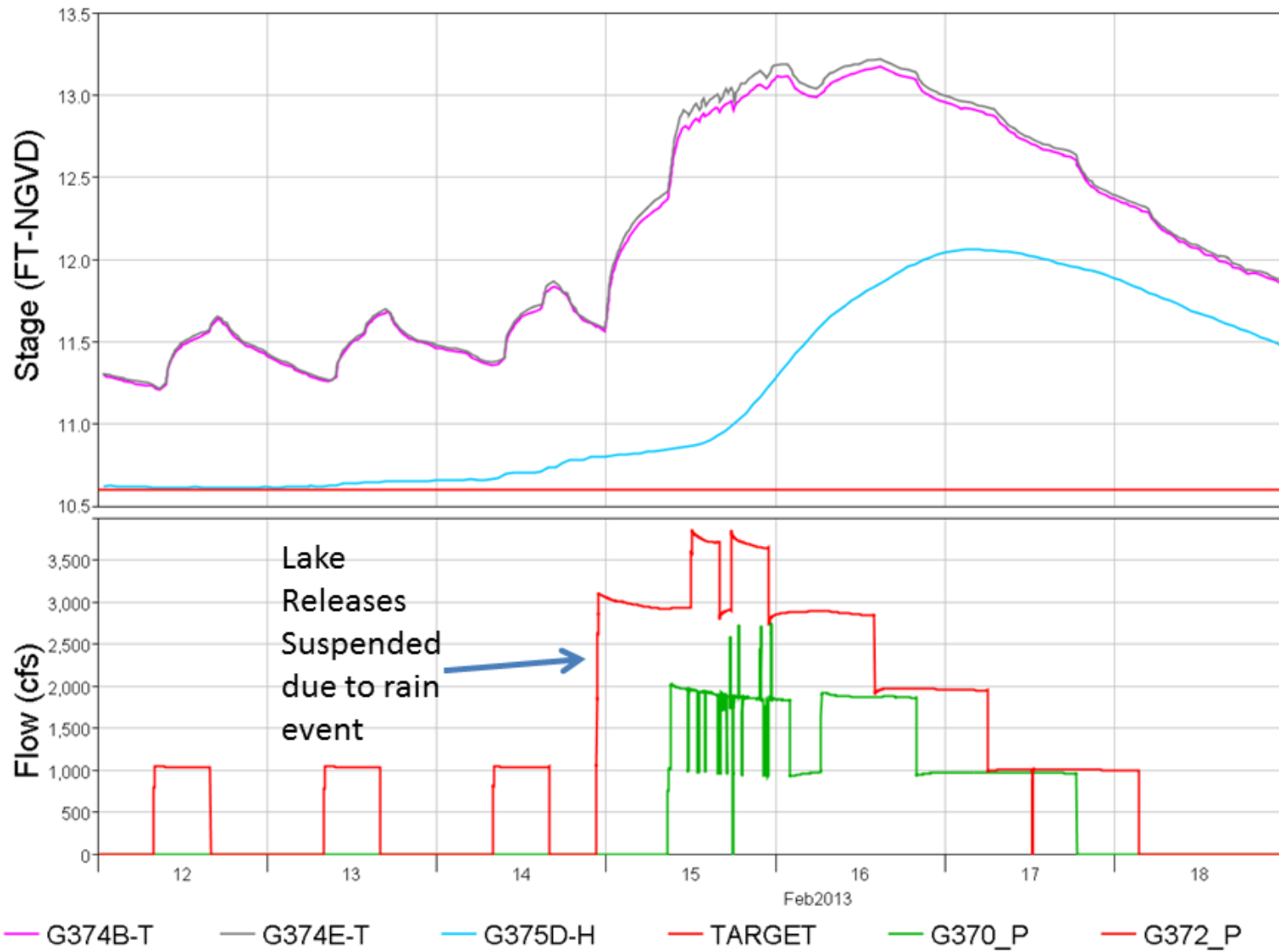


STA-3/4 Inflows and Stages

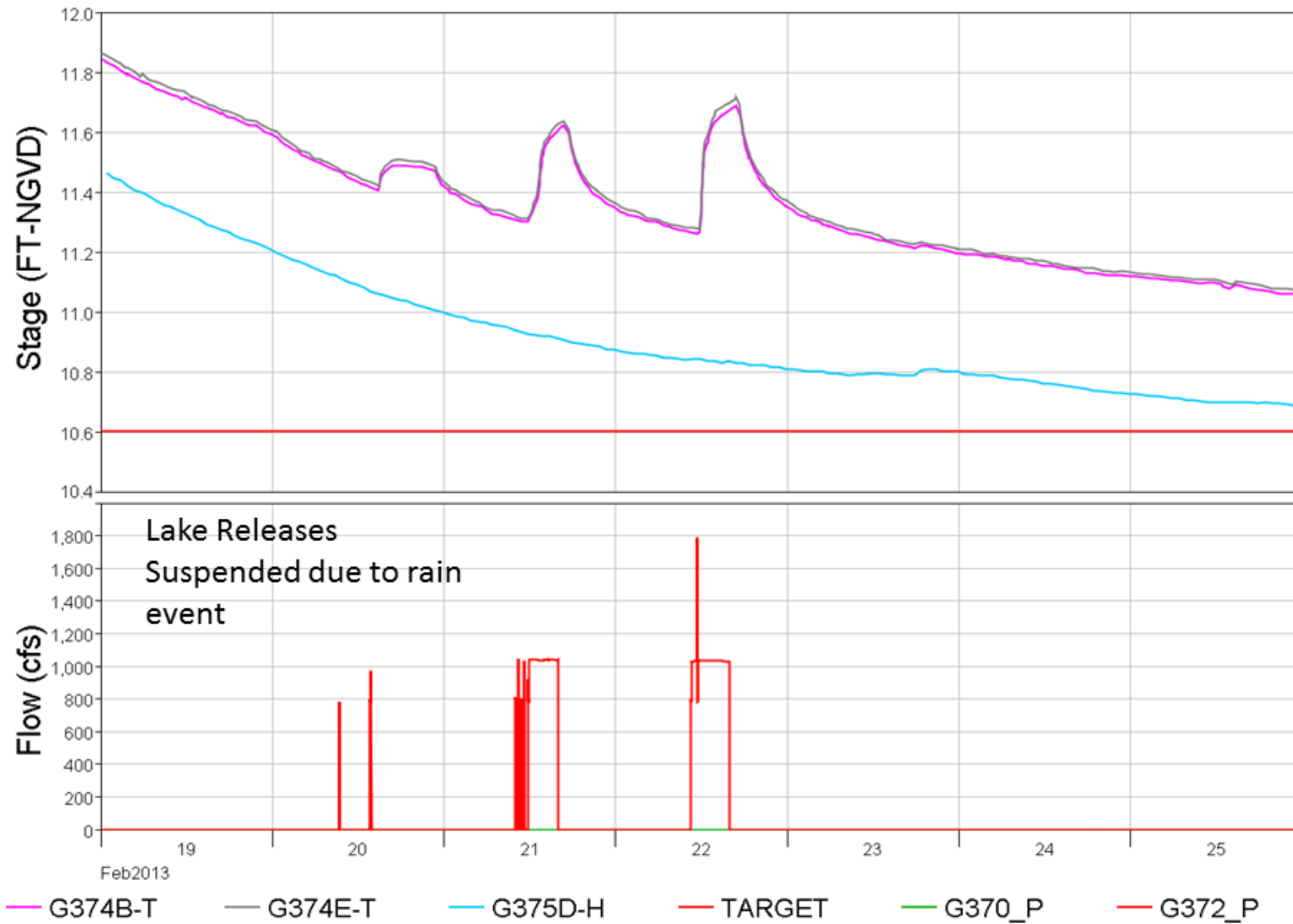
STA 3/4 Cell 1A Week 6



STA-3/4 Inflows and Stages STA 3/4 Cell 1A Week 7

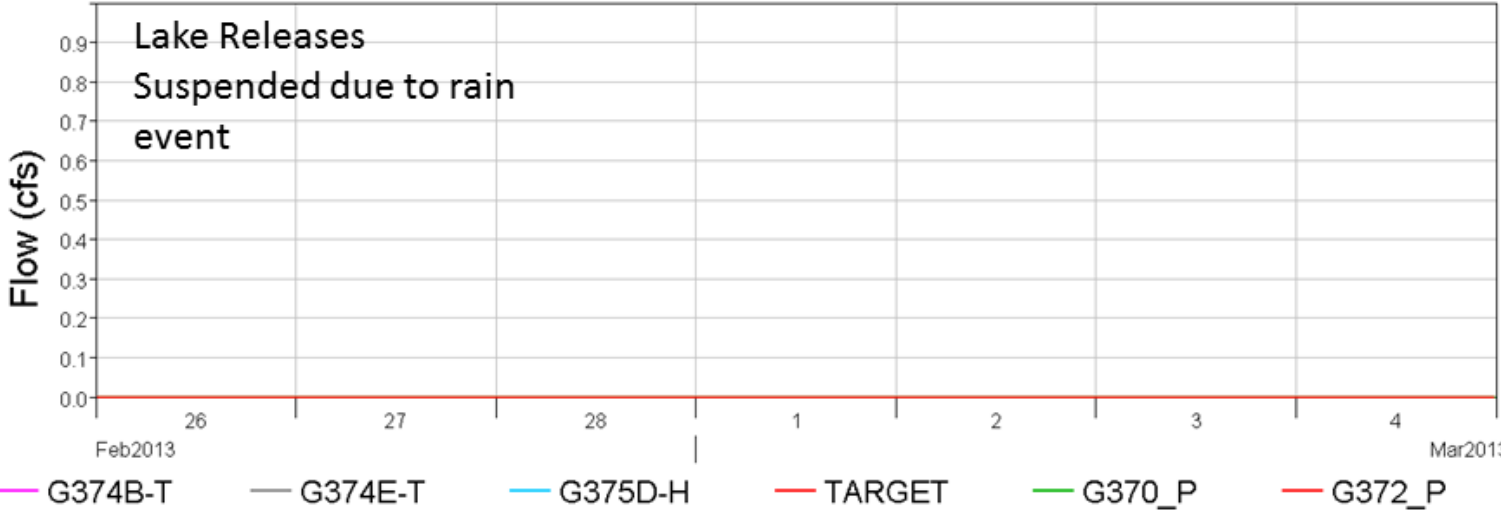
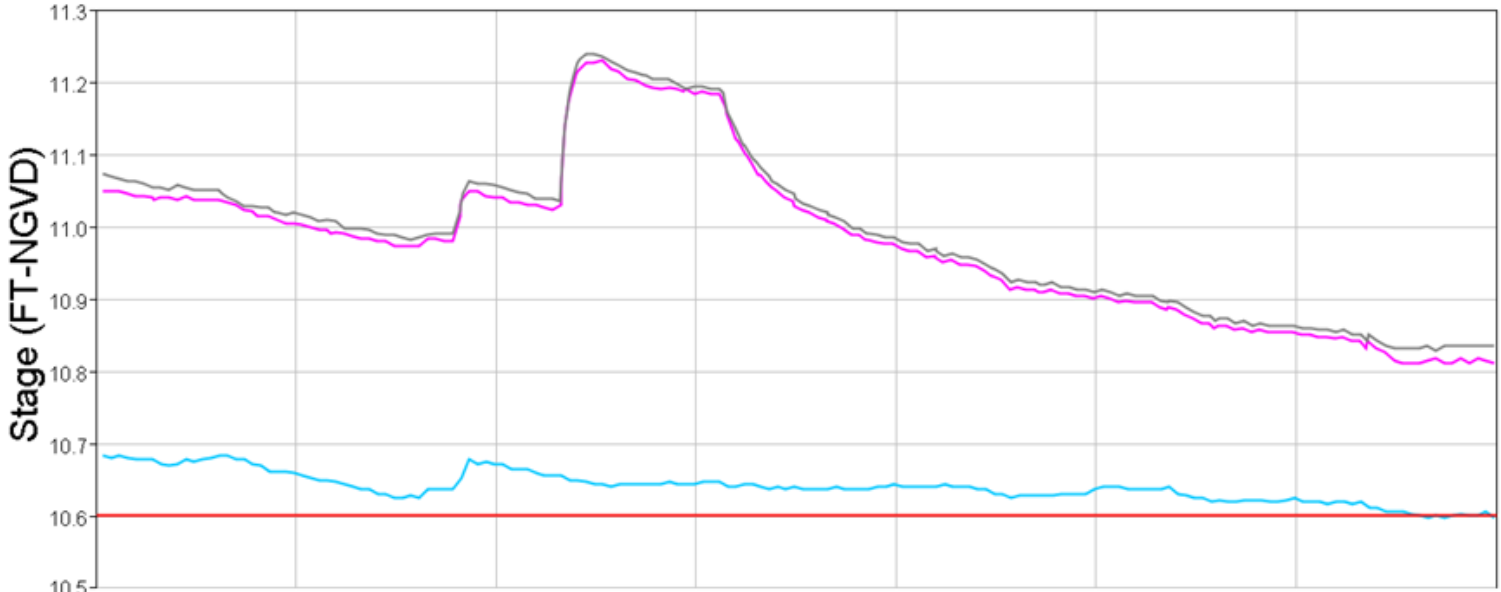


STA-3/4 Inflows and Stages
STA 3/4 Cell 1A Week 8

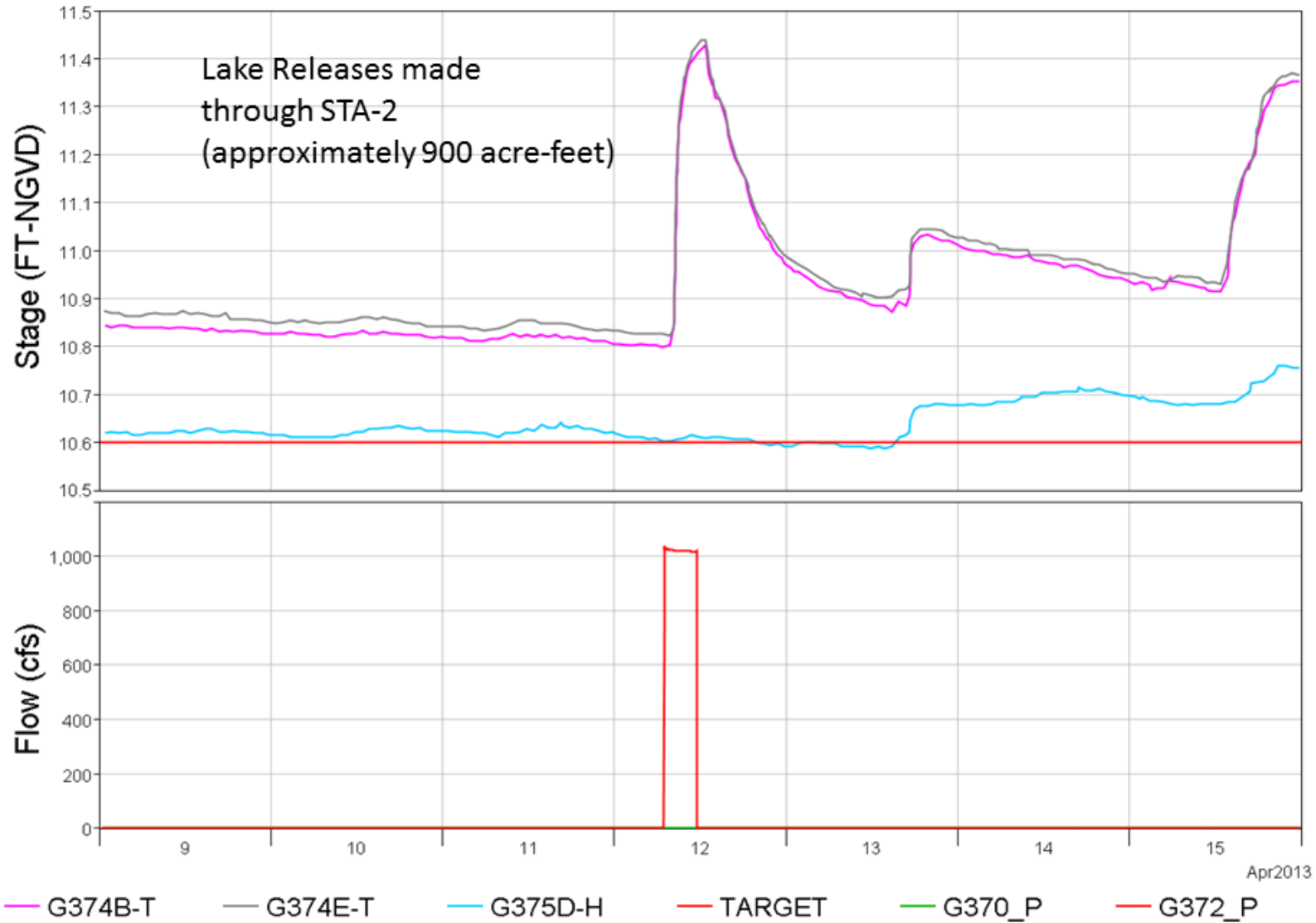


STA-3/4 Inflows and Stages

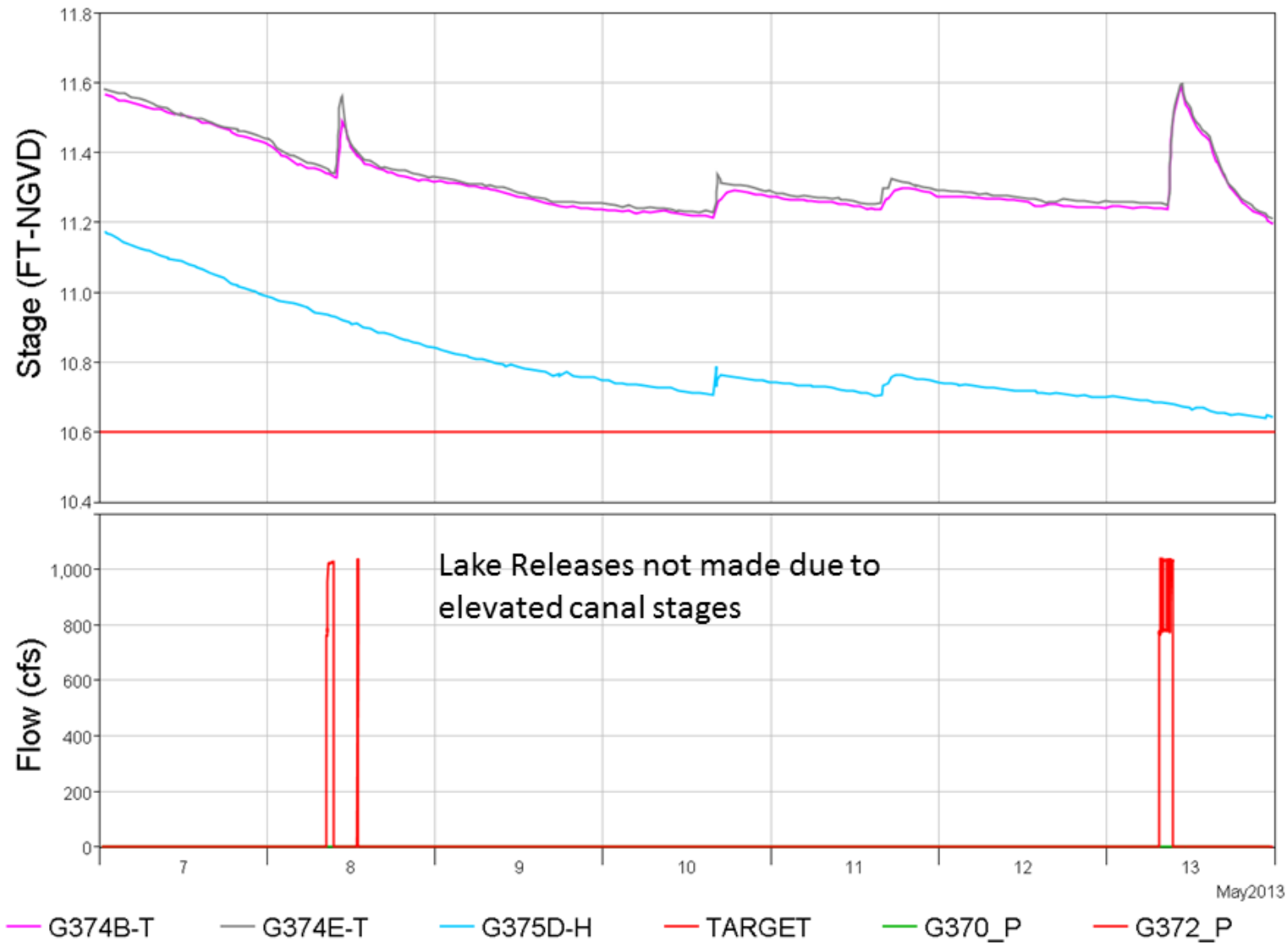
STA 3/4 Cell 1A Week 9



STA-3/4 Inflows and Stages
STA 3/4 Cell 1A Week 15

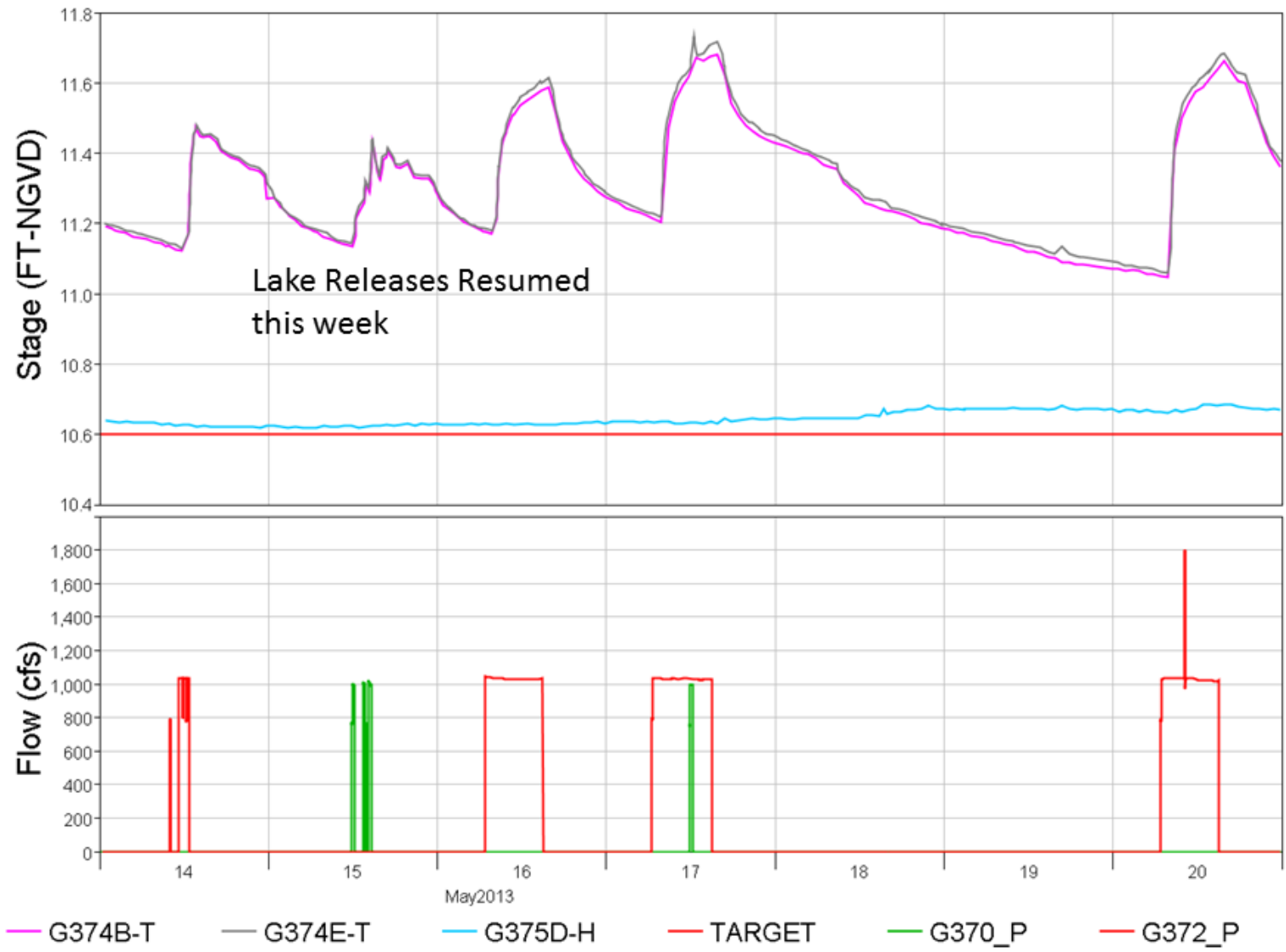


STA-3/4 Inflows and Stages
STA 3/4 Cell 1A Week 19

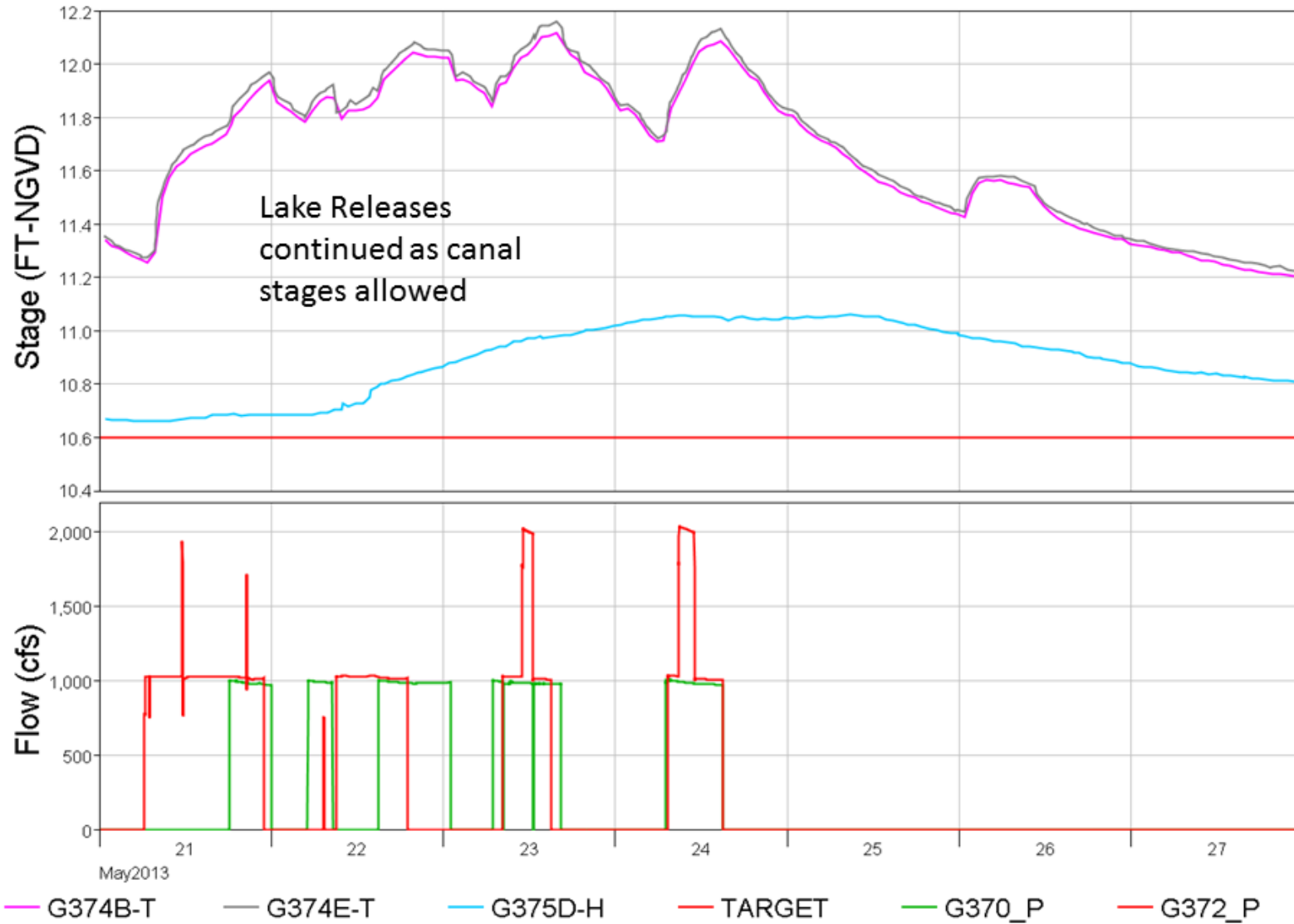


STA-3/4 Inflows and Stages

STA 3/4 Cell 1A Week 20

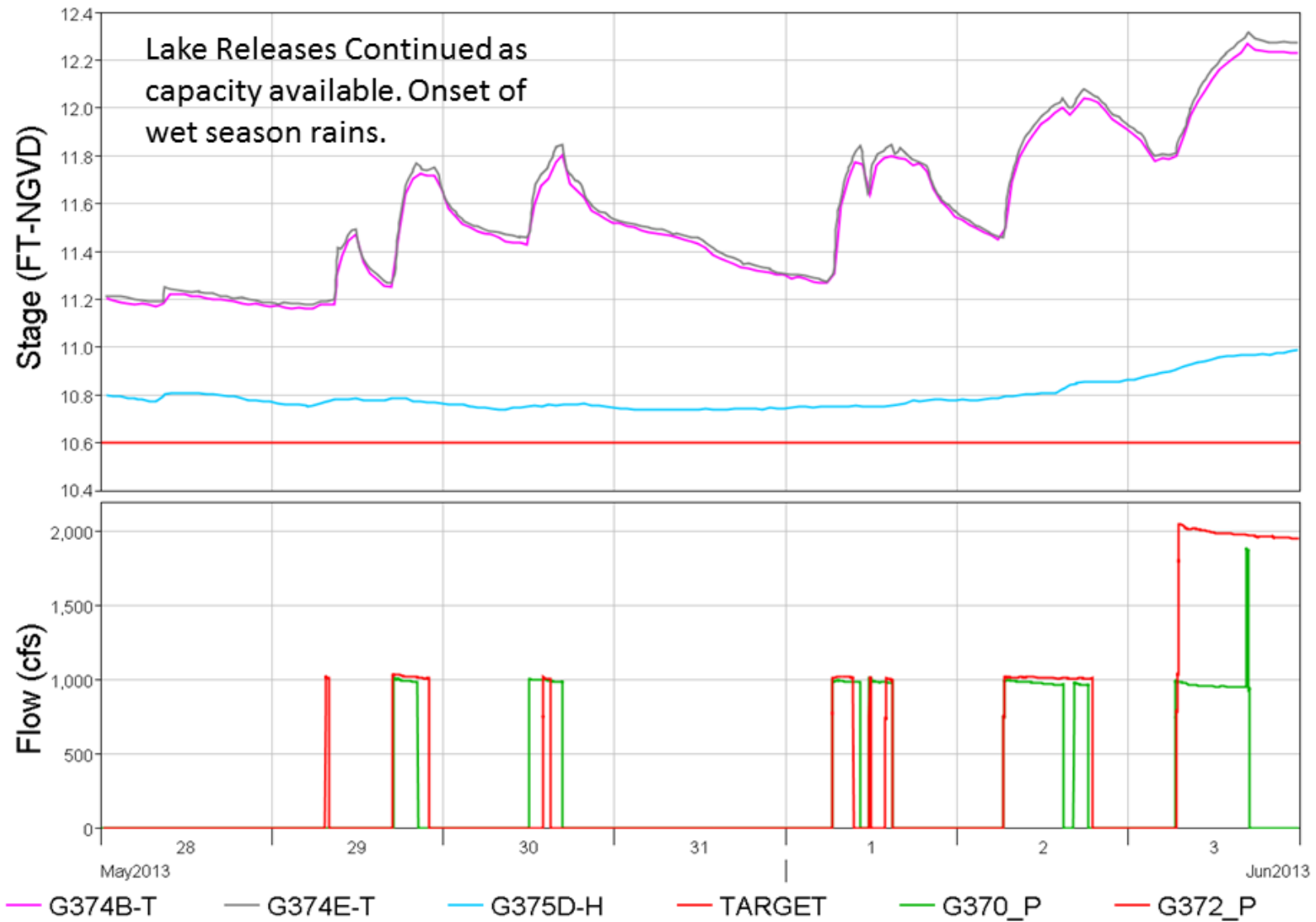


STA-3/4 Inflows and Stages
STA 3/4 Cell 1A Week 21



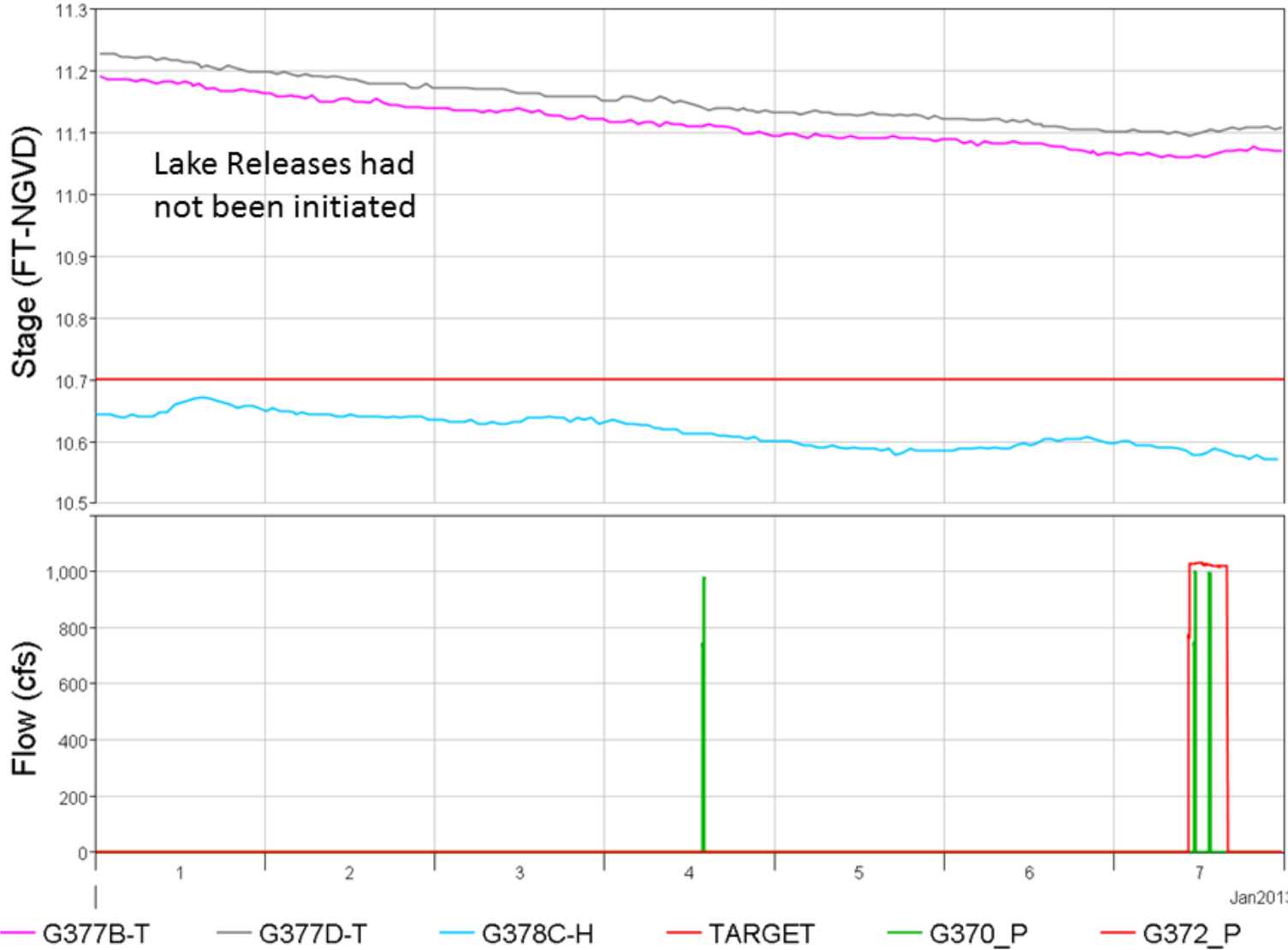
STA-3/4 Inflows and Stages

STA 3/4 Cell 1A Week 22



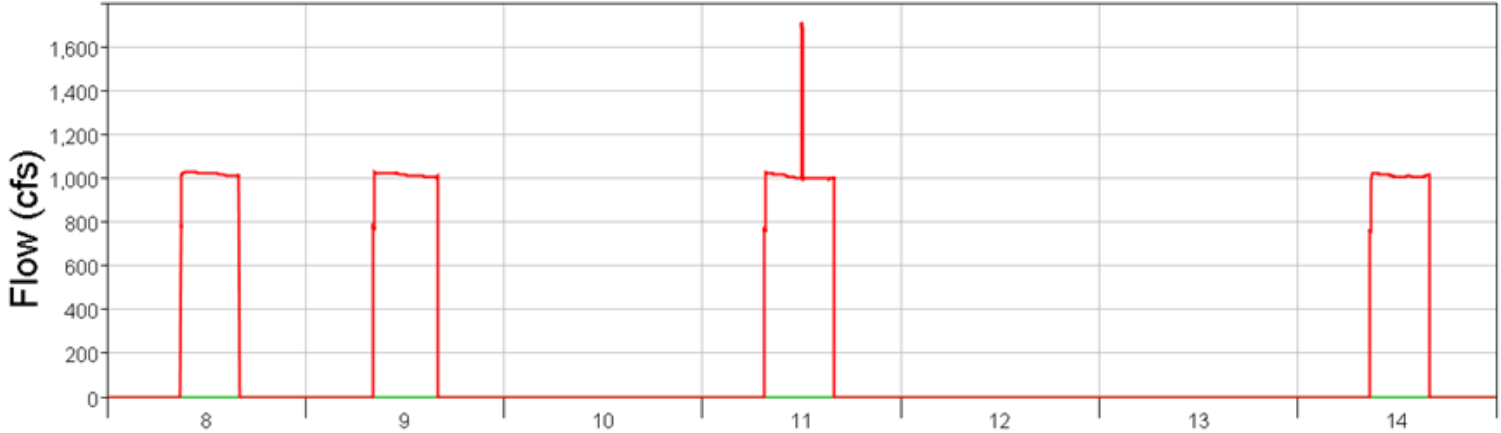
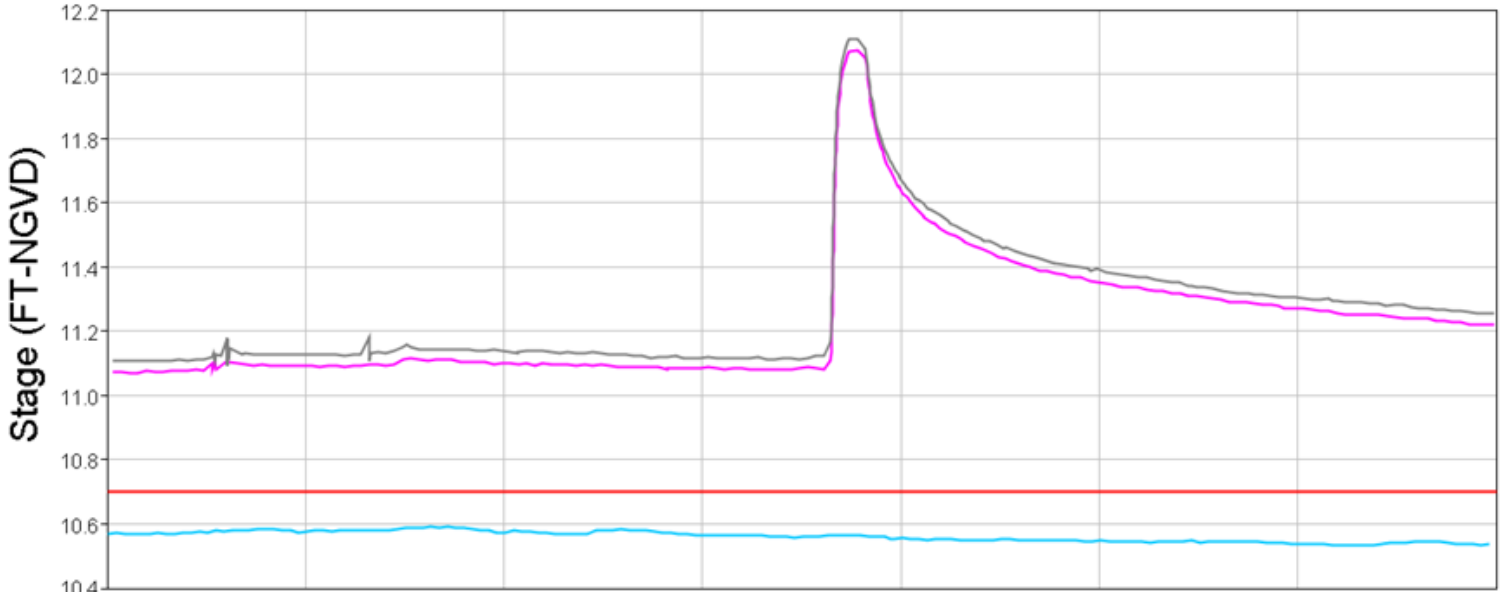
STA-3/4 Inflows and Stages

STA 3/4 Cell 2A Week 1



STA-3/4 Inflows and Stages

STA 3/4 Cell 2A Week 2

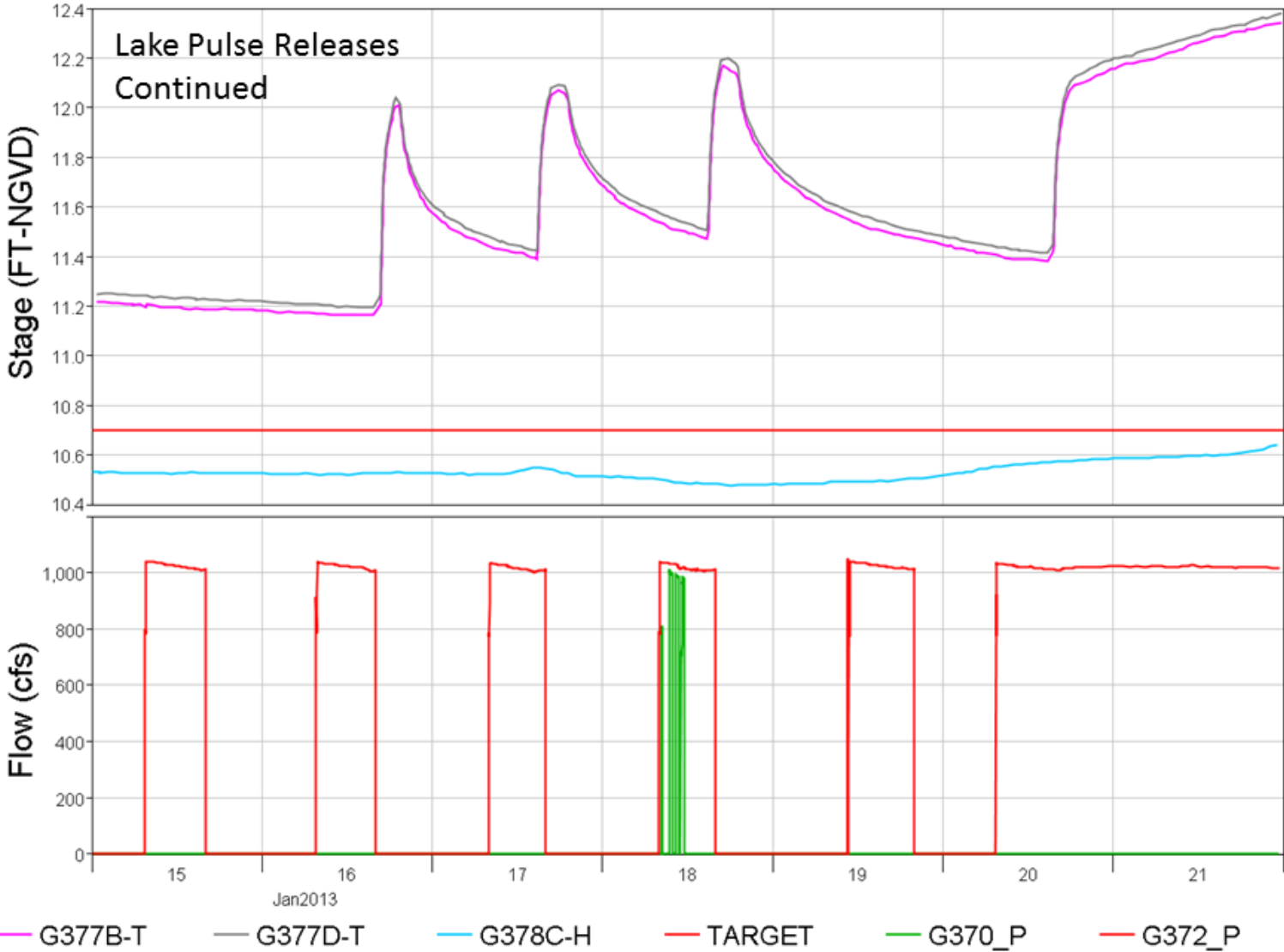


— G377B-T — G377D-T — G378C-H — TARGET — G370_P — G372_P

Jan2013

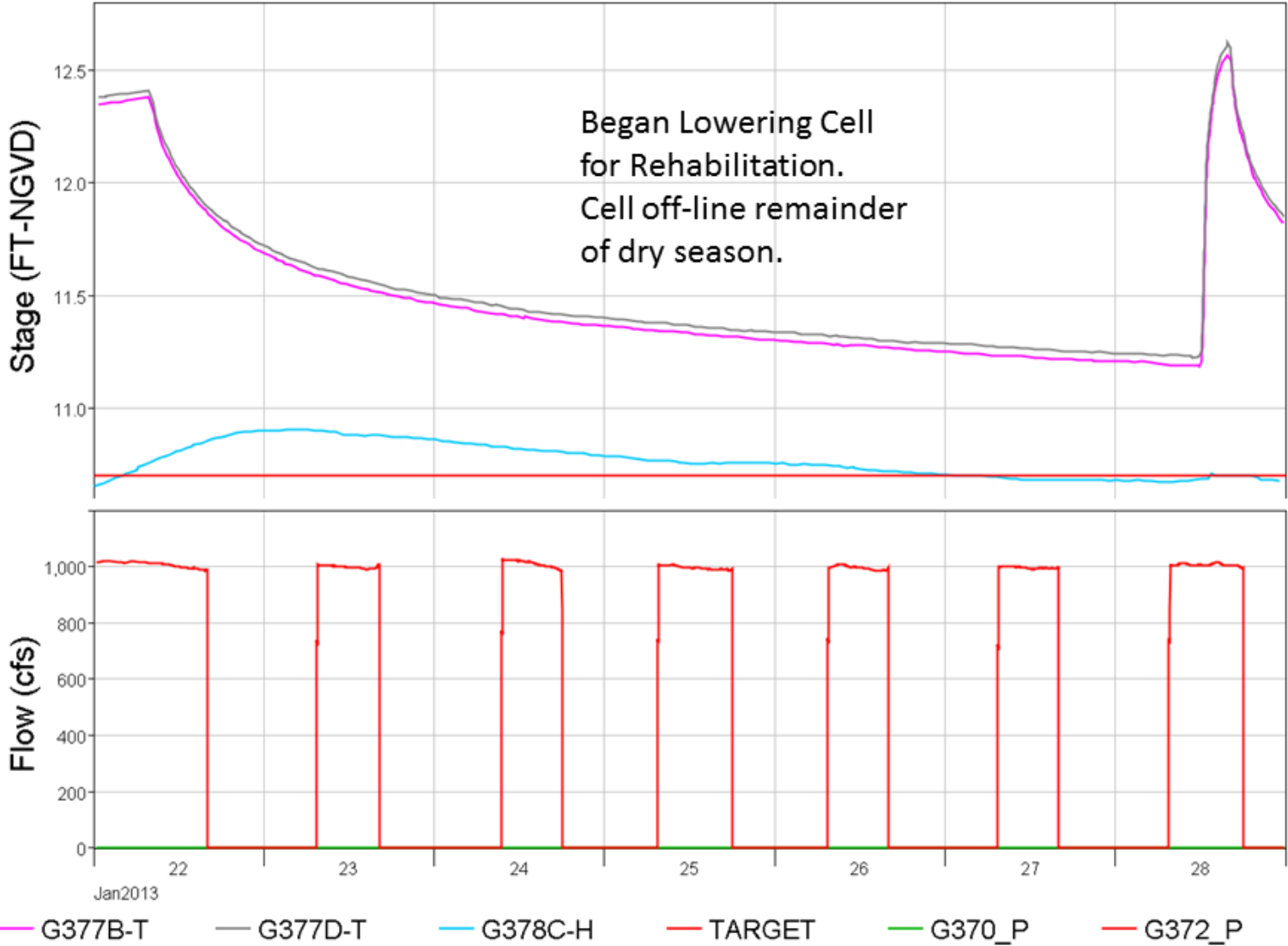
STA-3/4 Inflows and Stages

STA 3/4 Cell 2A Week 3



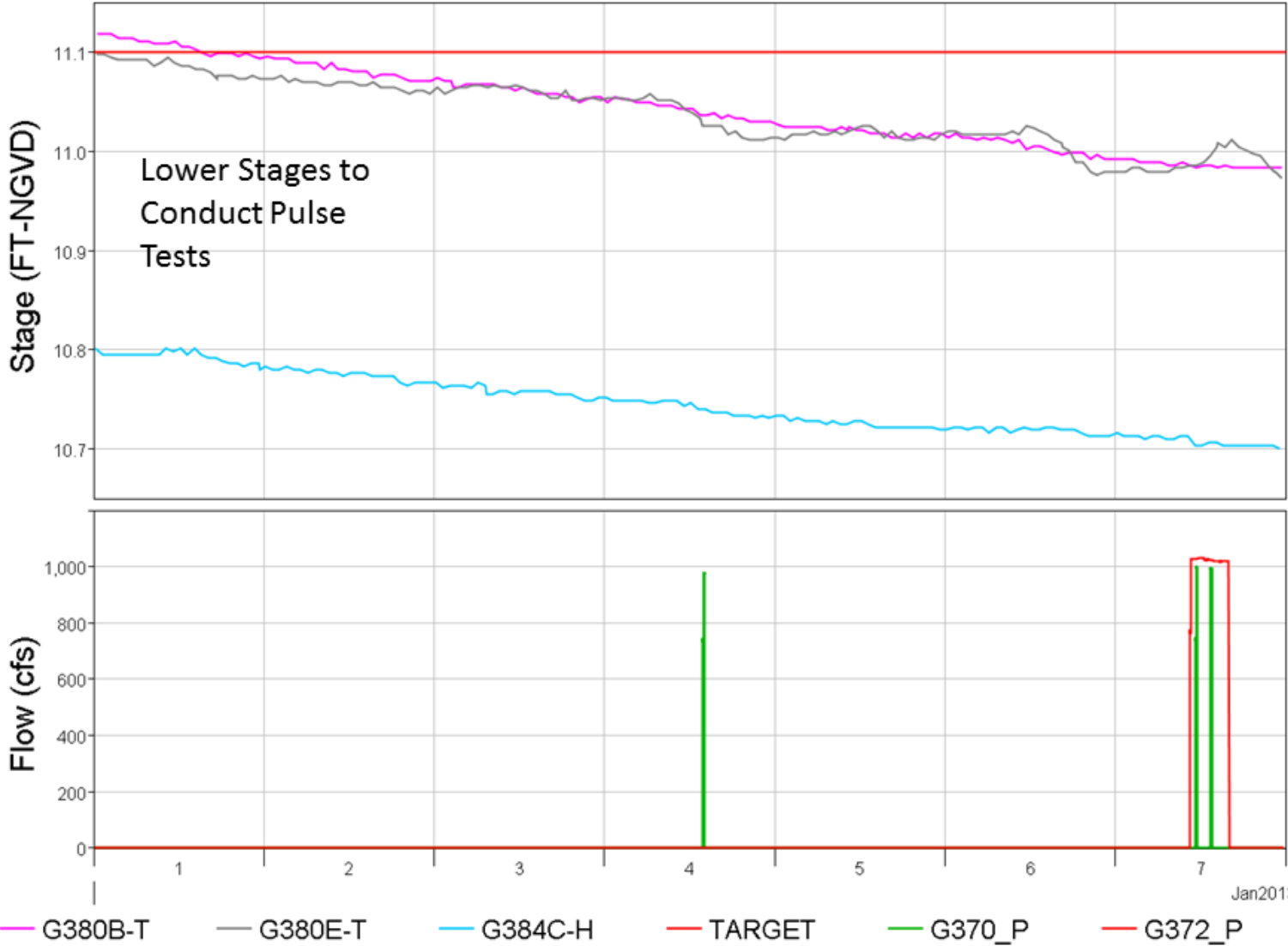
STA-3/4 Inflows and Stages

STA 3/4 Cell 2A Week 4



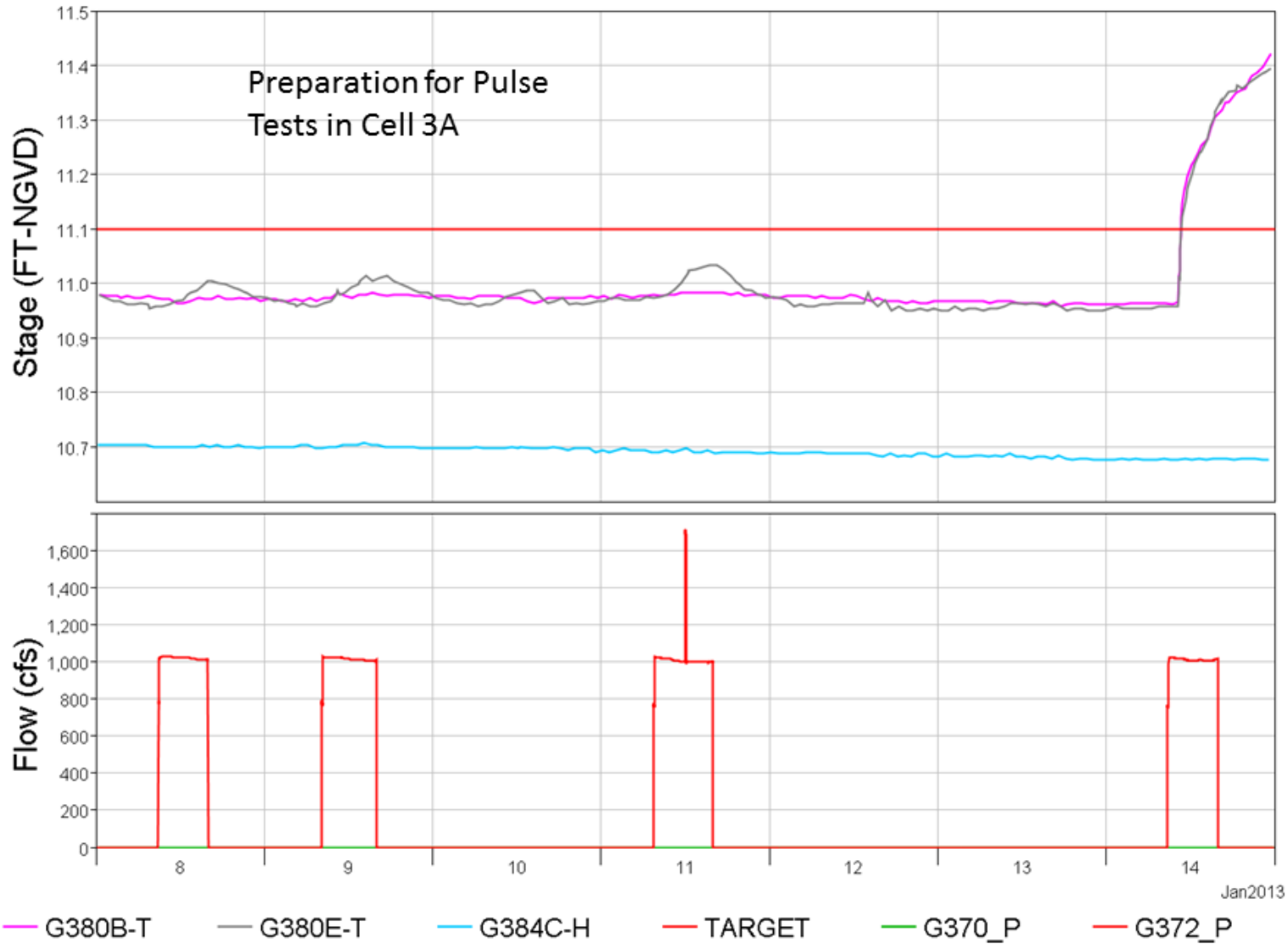
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 1



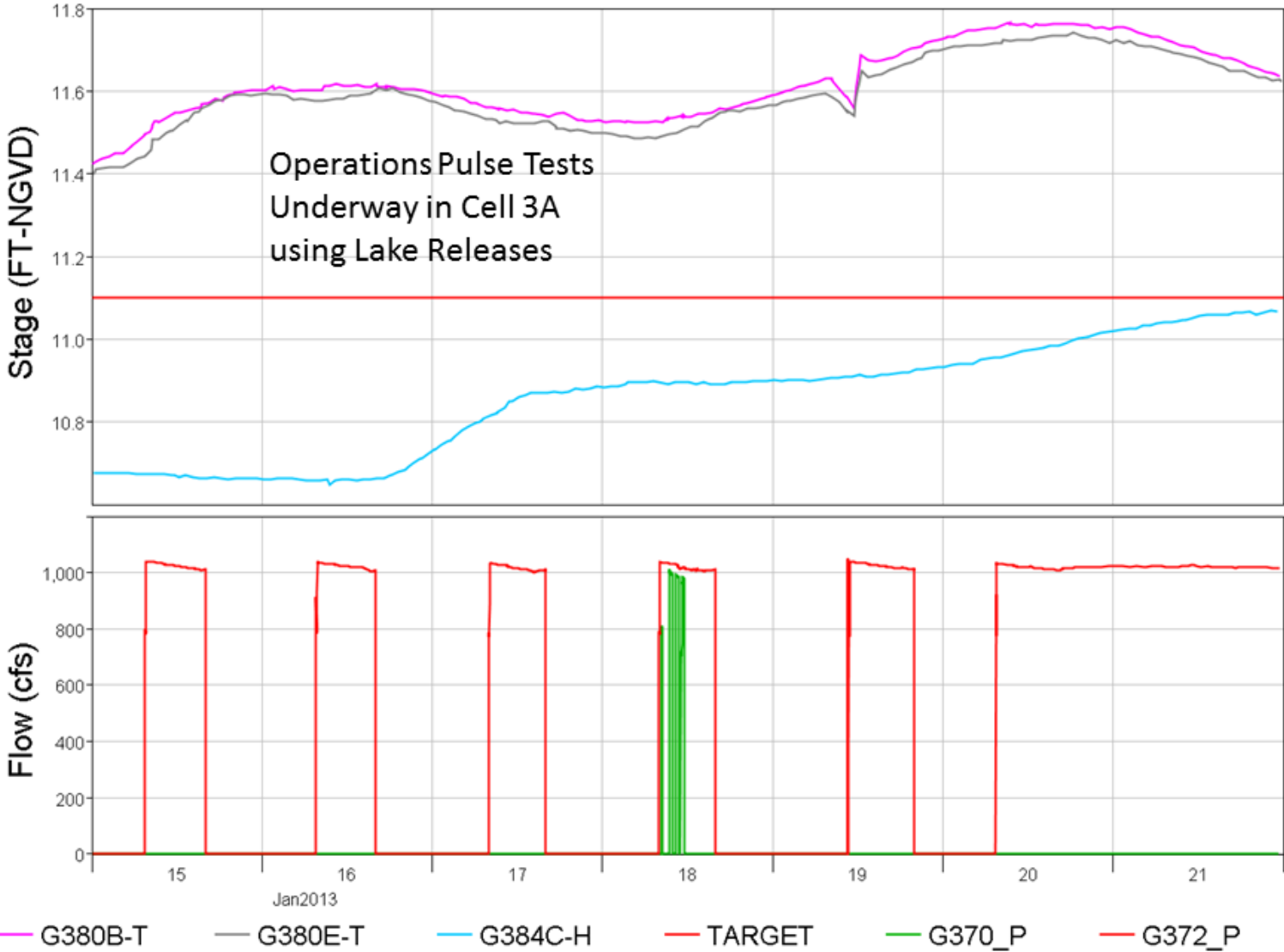
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 2



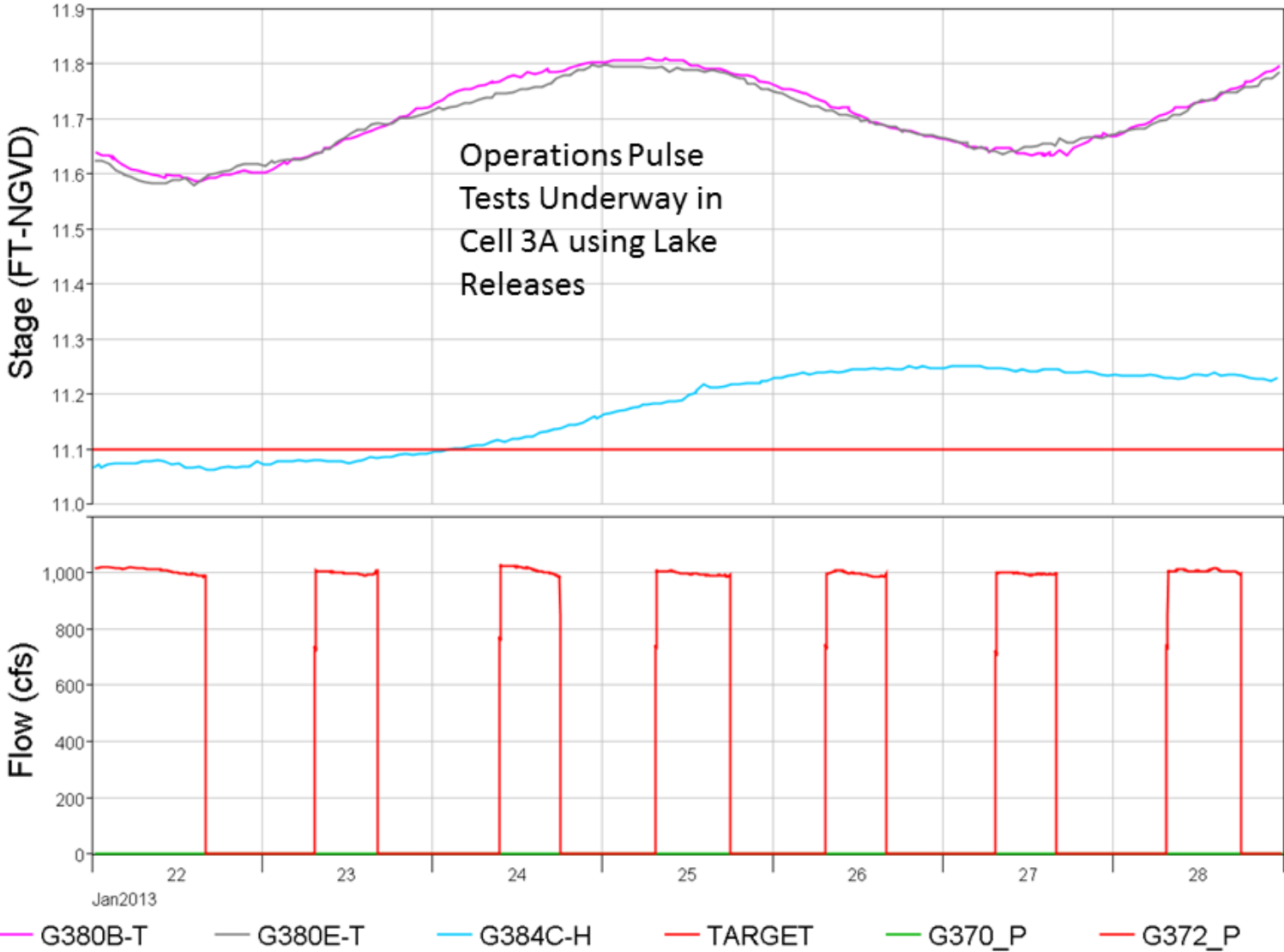
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 3



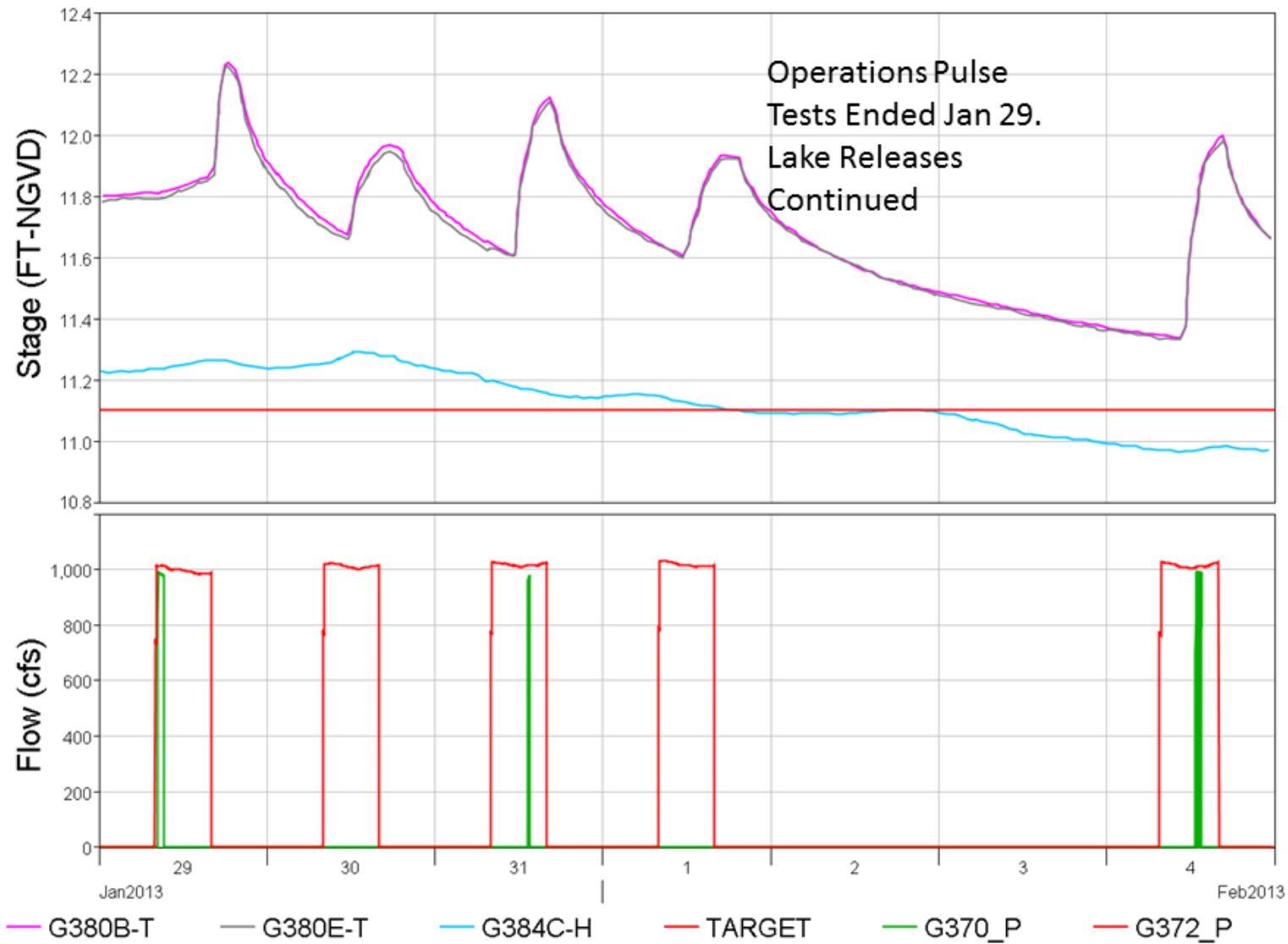
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 4



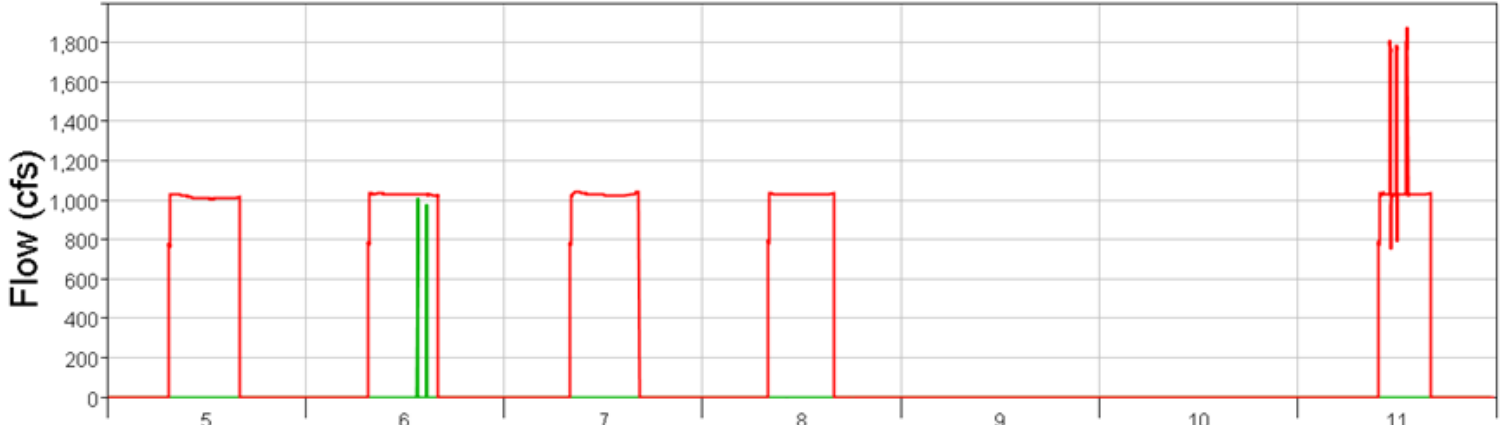
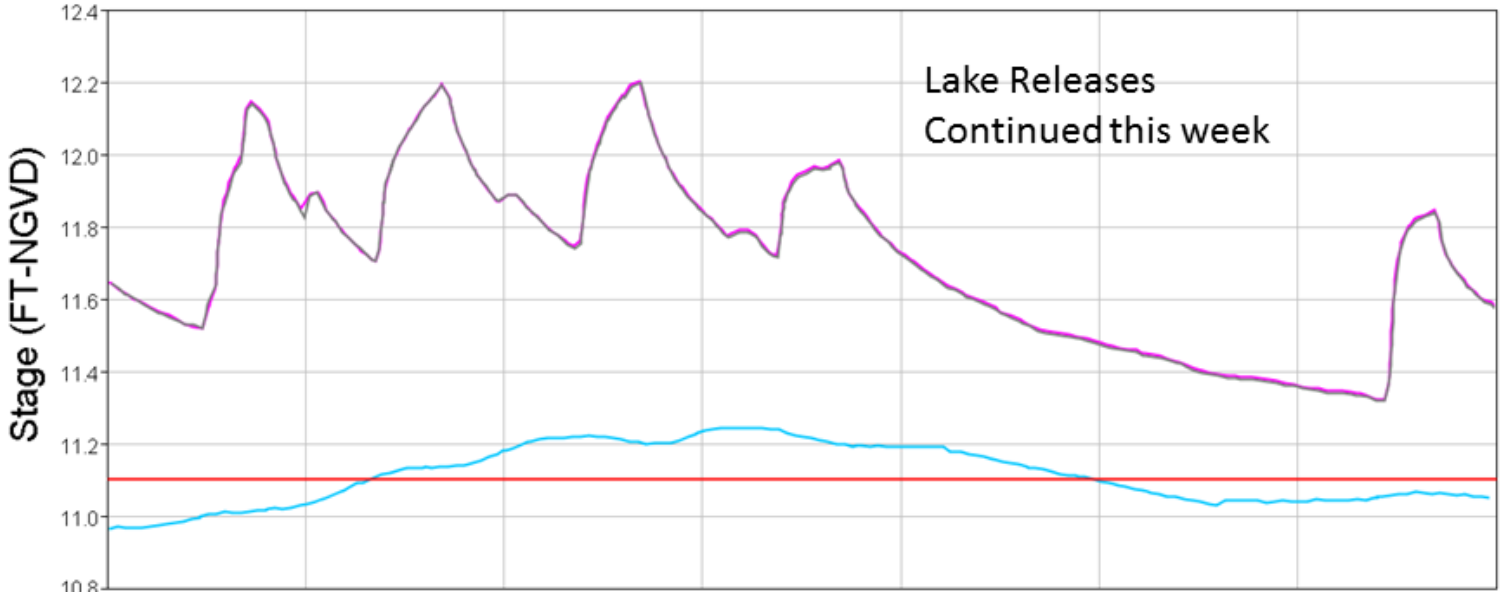
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 5



STA-3/4 Inflows and Stages

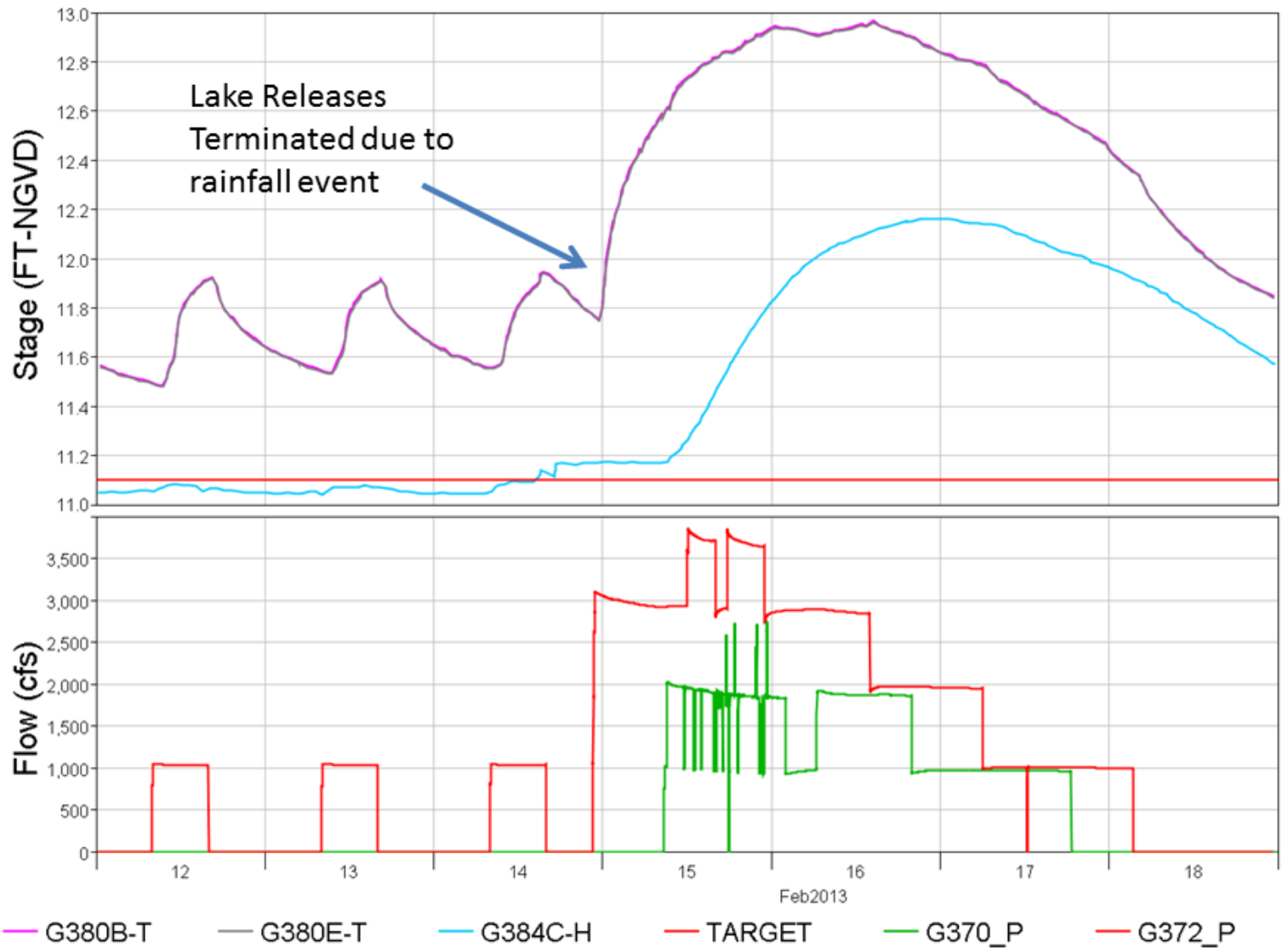
STA 3/4 Cell 3A Week 6



— G380B-T — G380E-T — G384C-H — TARGET — G370_P — G372_P

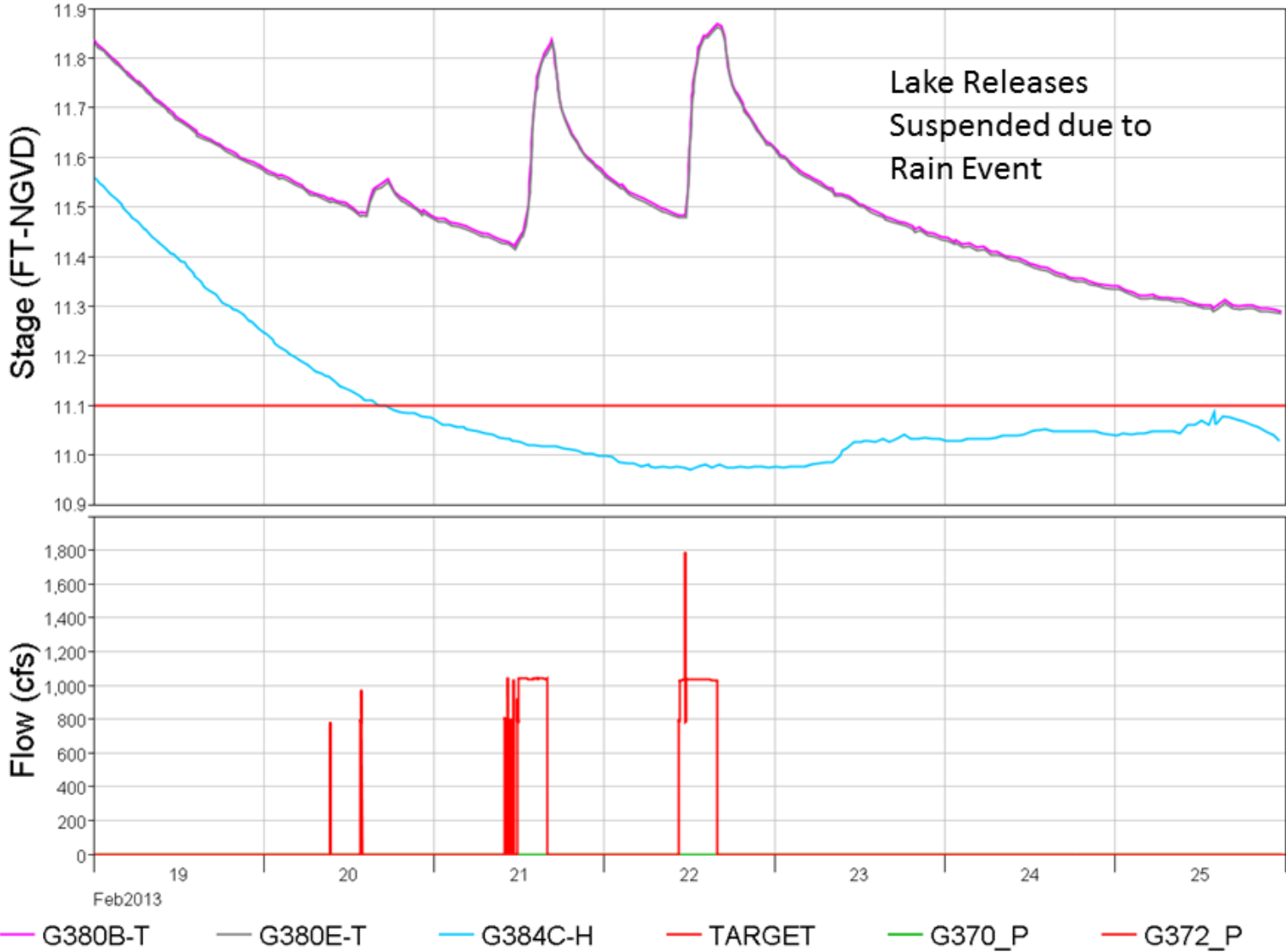
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 7



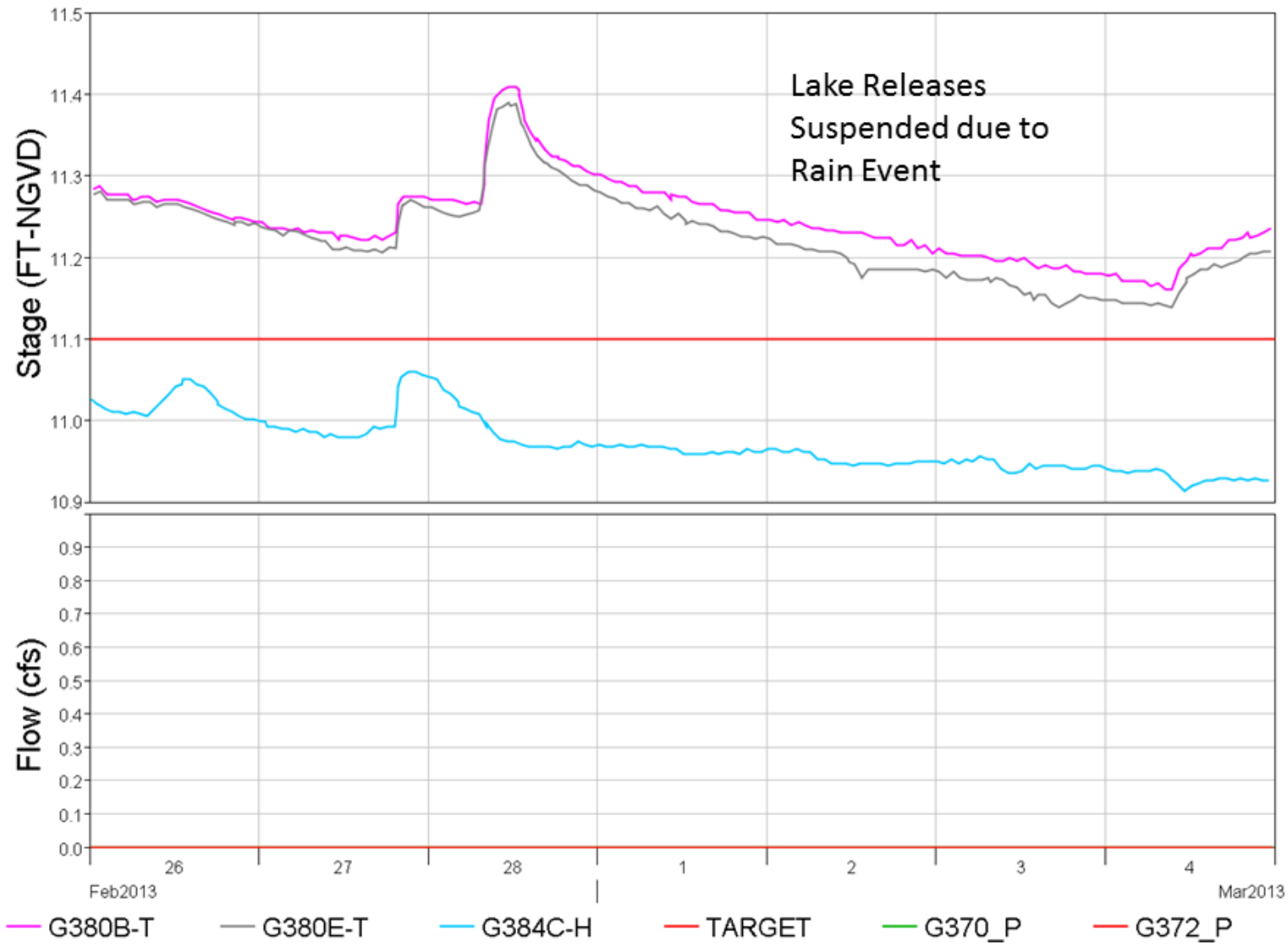
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 8



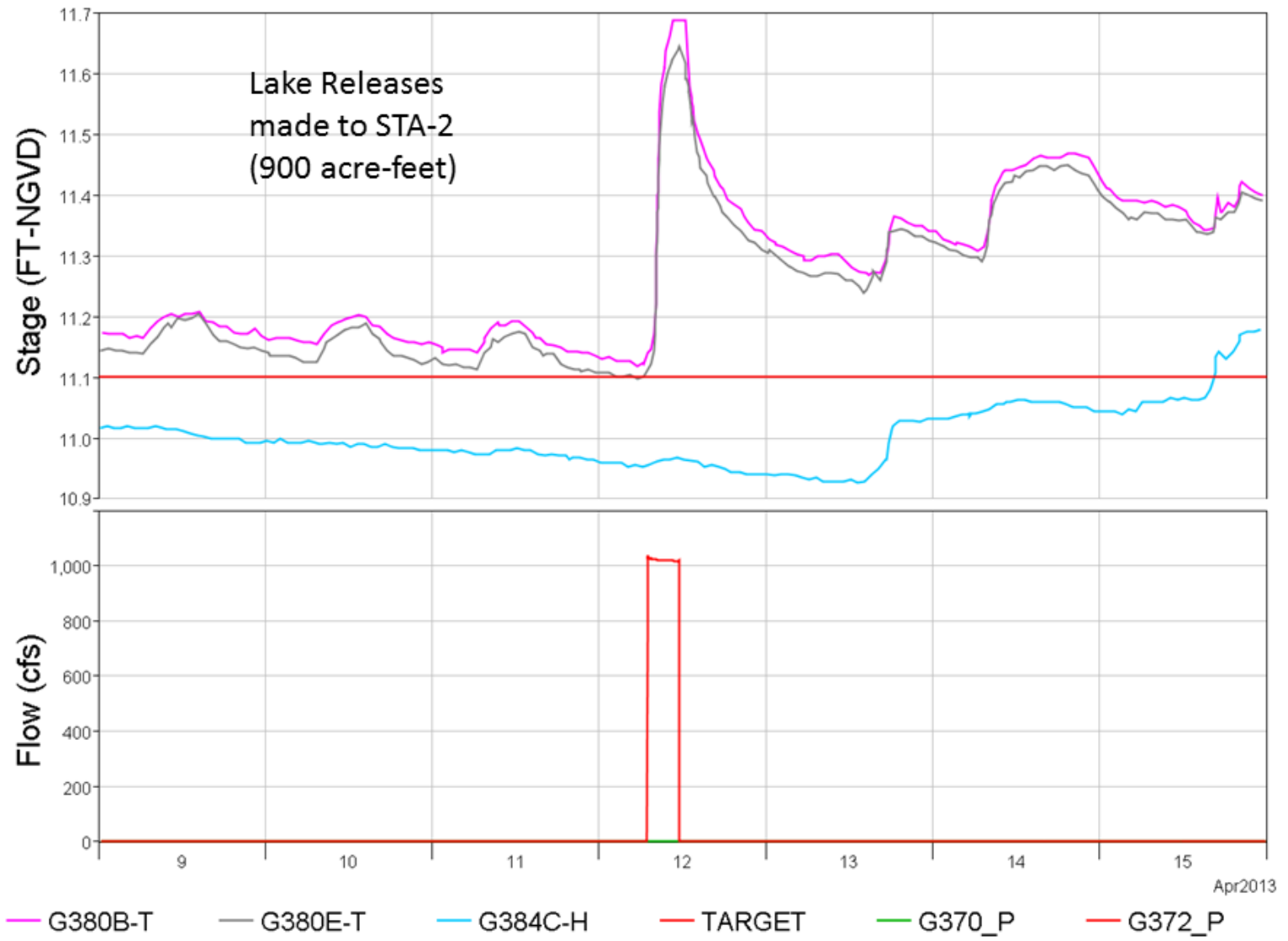
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 9



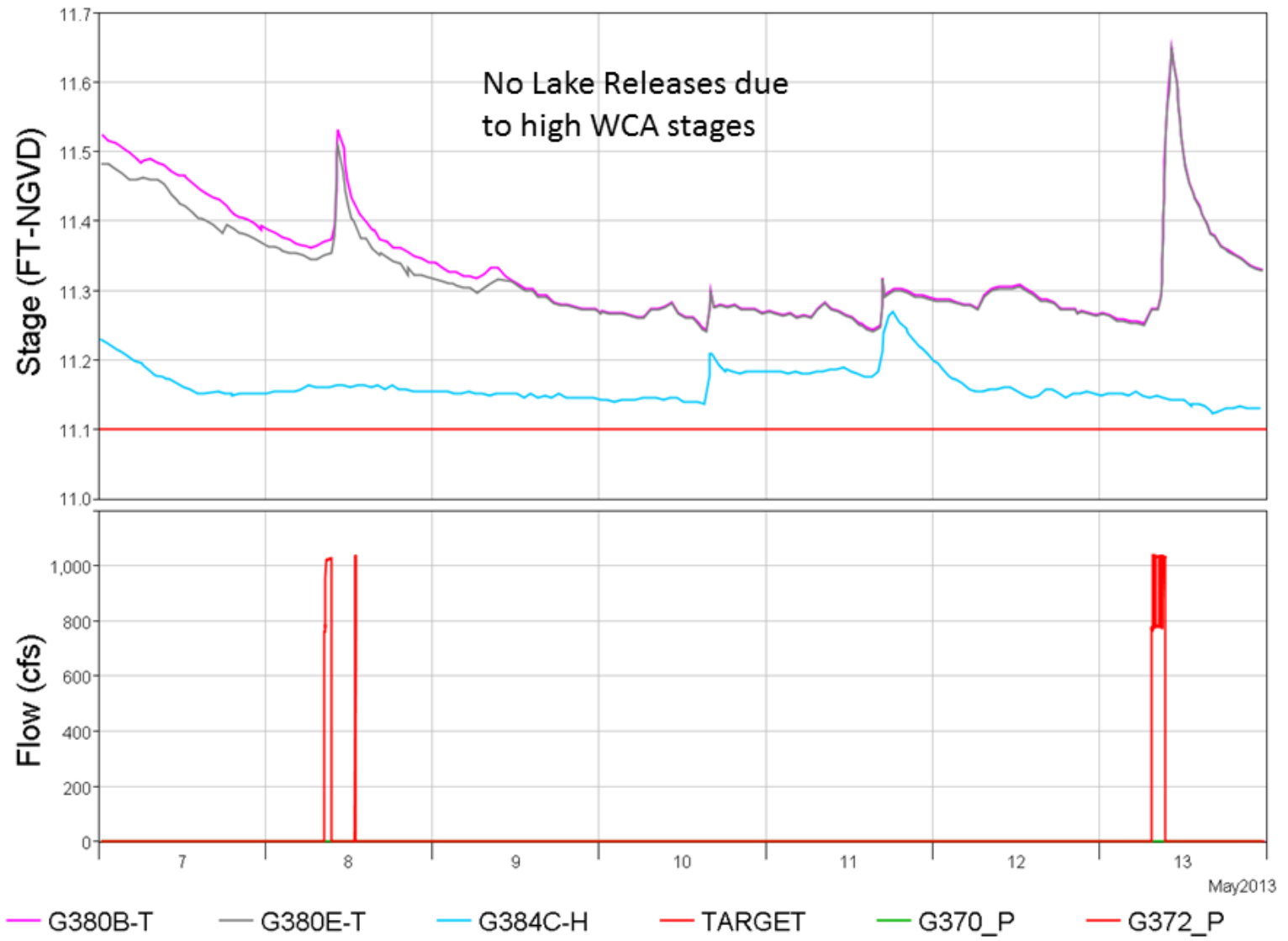
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 15



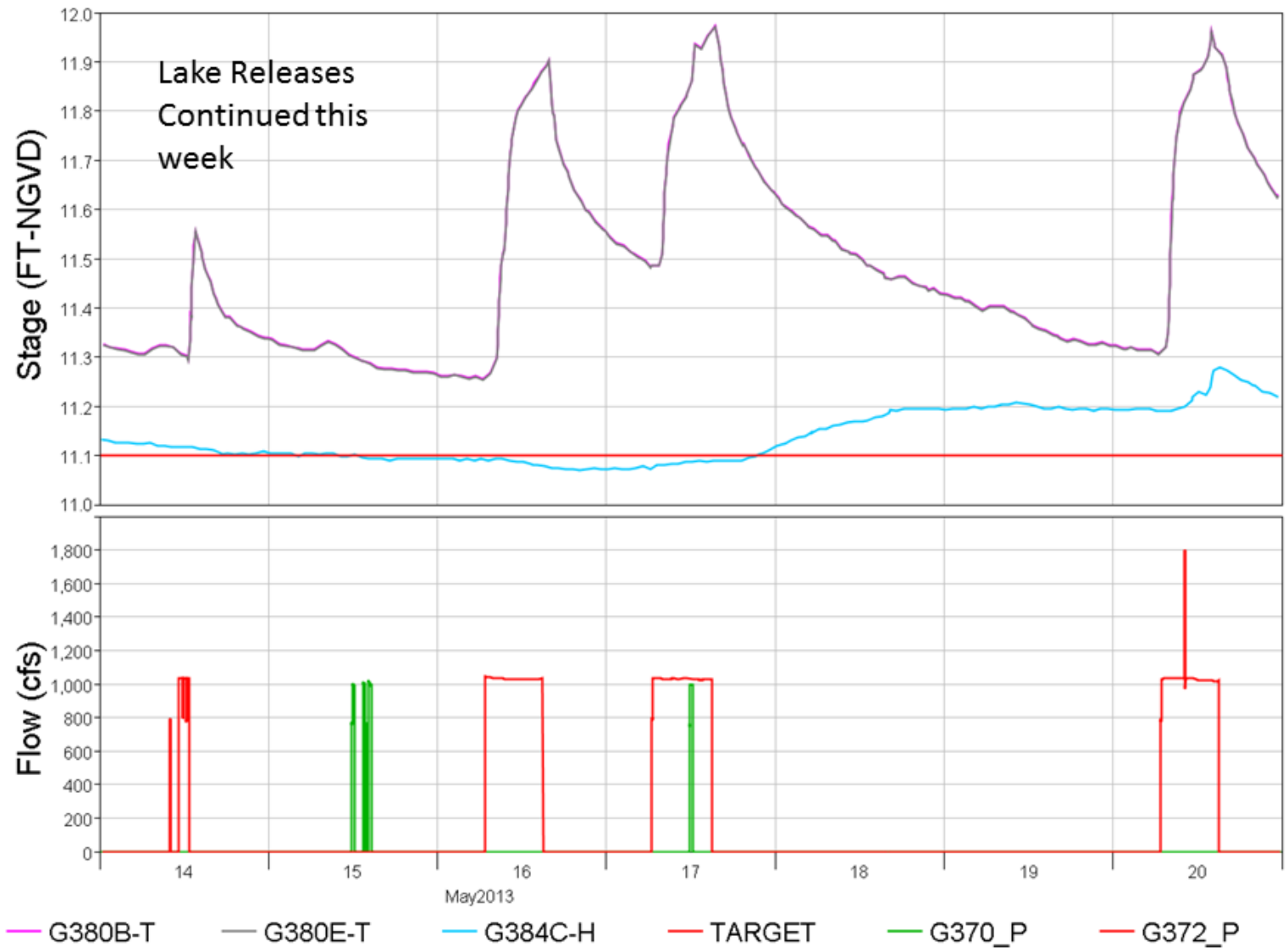
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 19

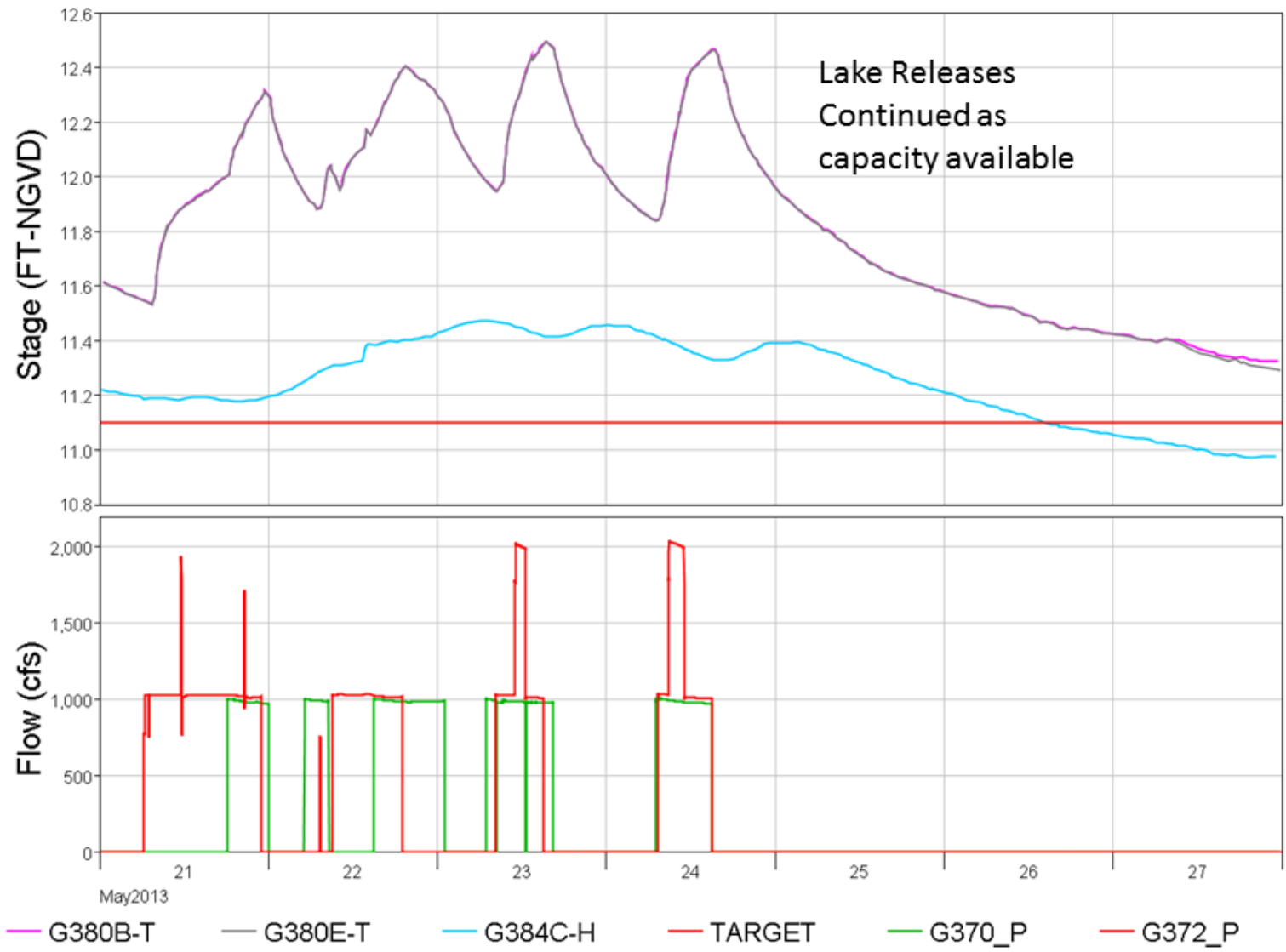


STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 20

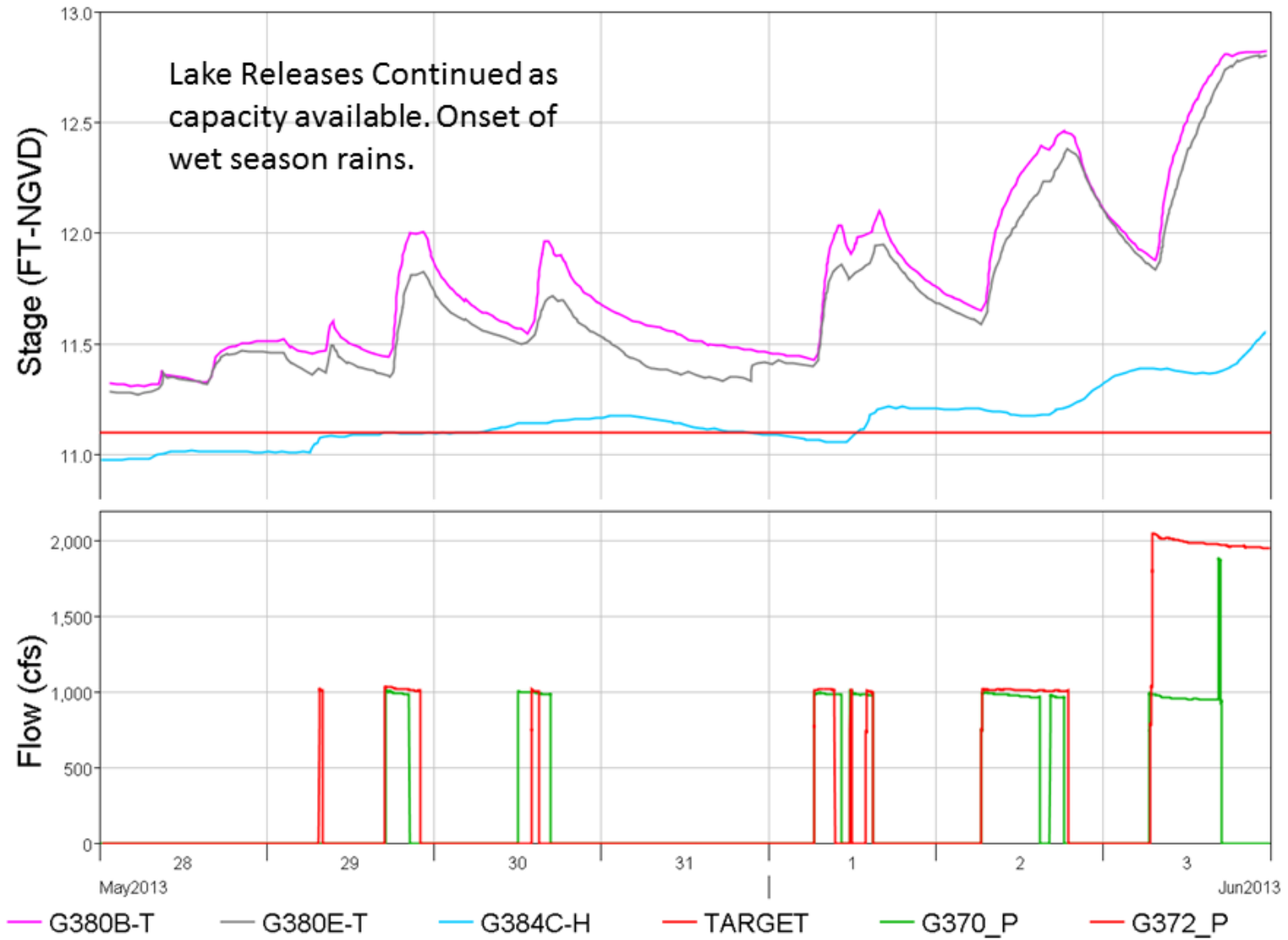


STA-3/4 Inflows and Stages
STA 3/4 Cell 3A Week 21



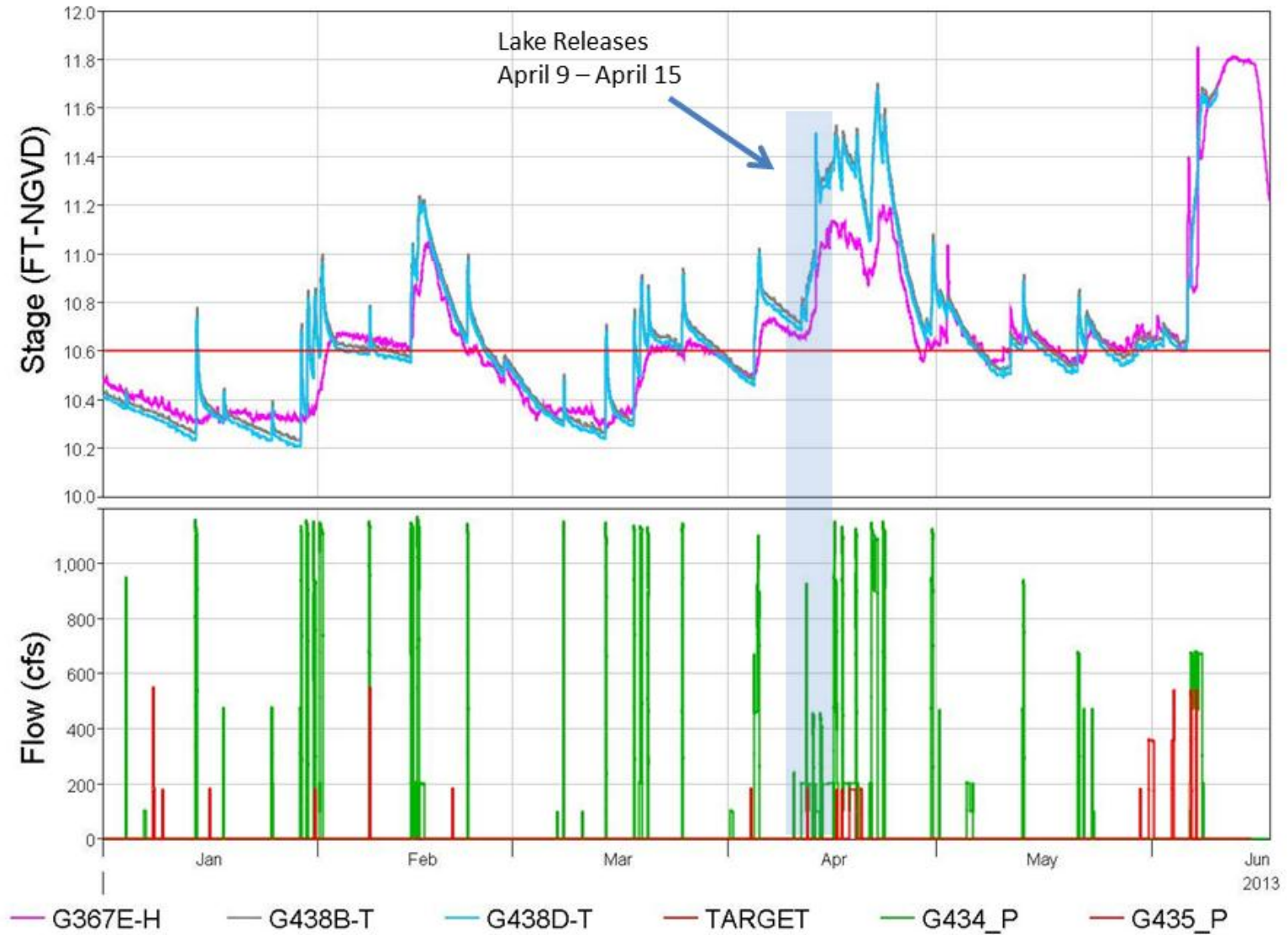
STA-3/4 Inflows and Stages

STA 3/4 Cell 3A Week 22



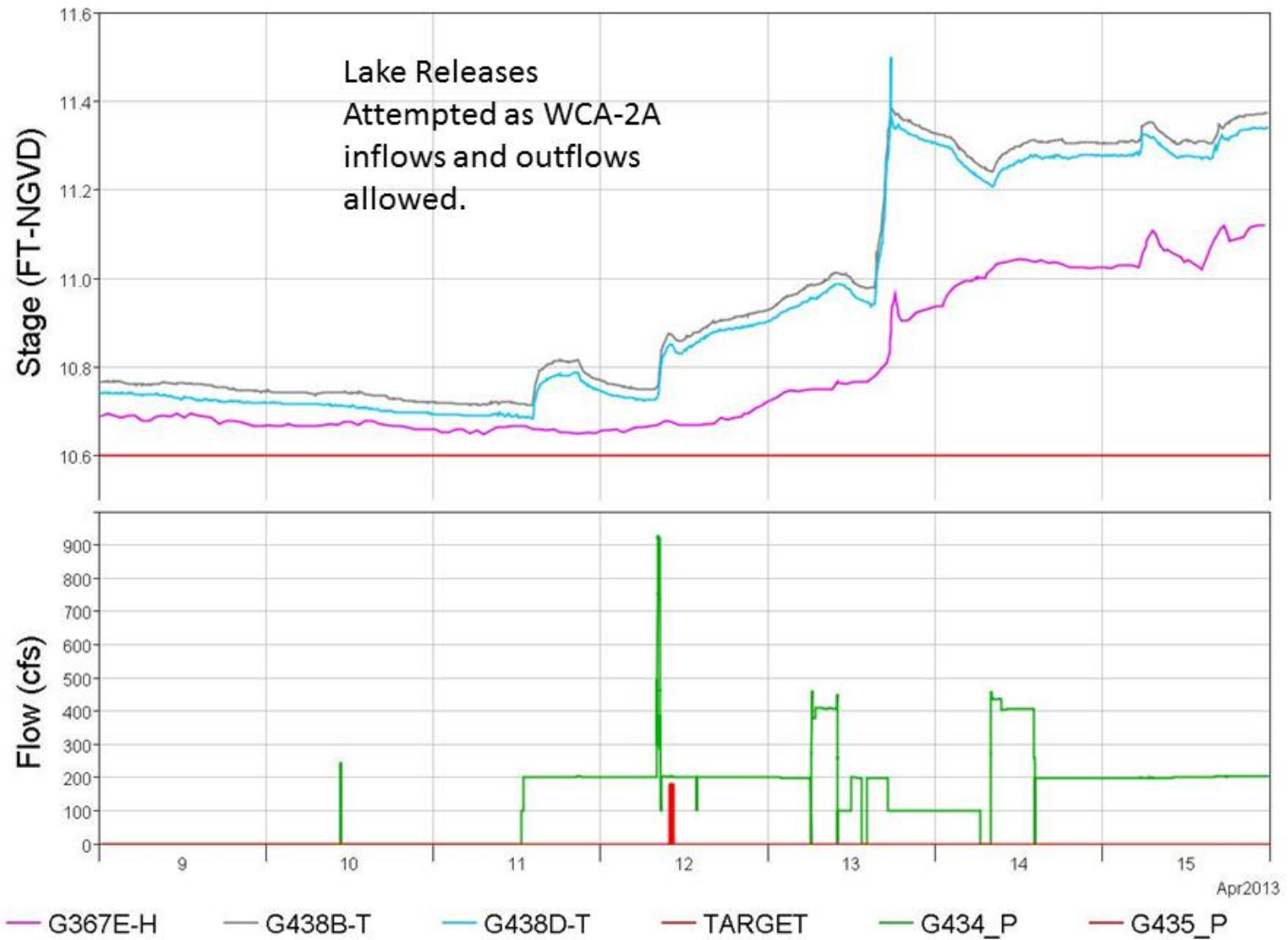
STA-2 Inflows and Stages

STA 2 Cell 5



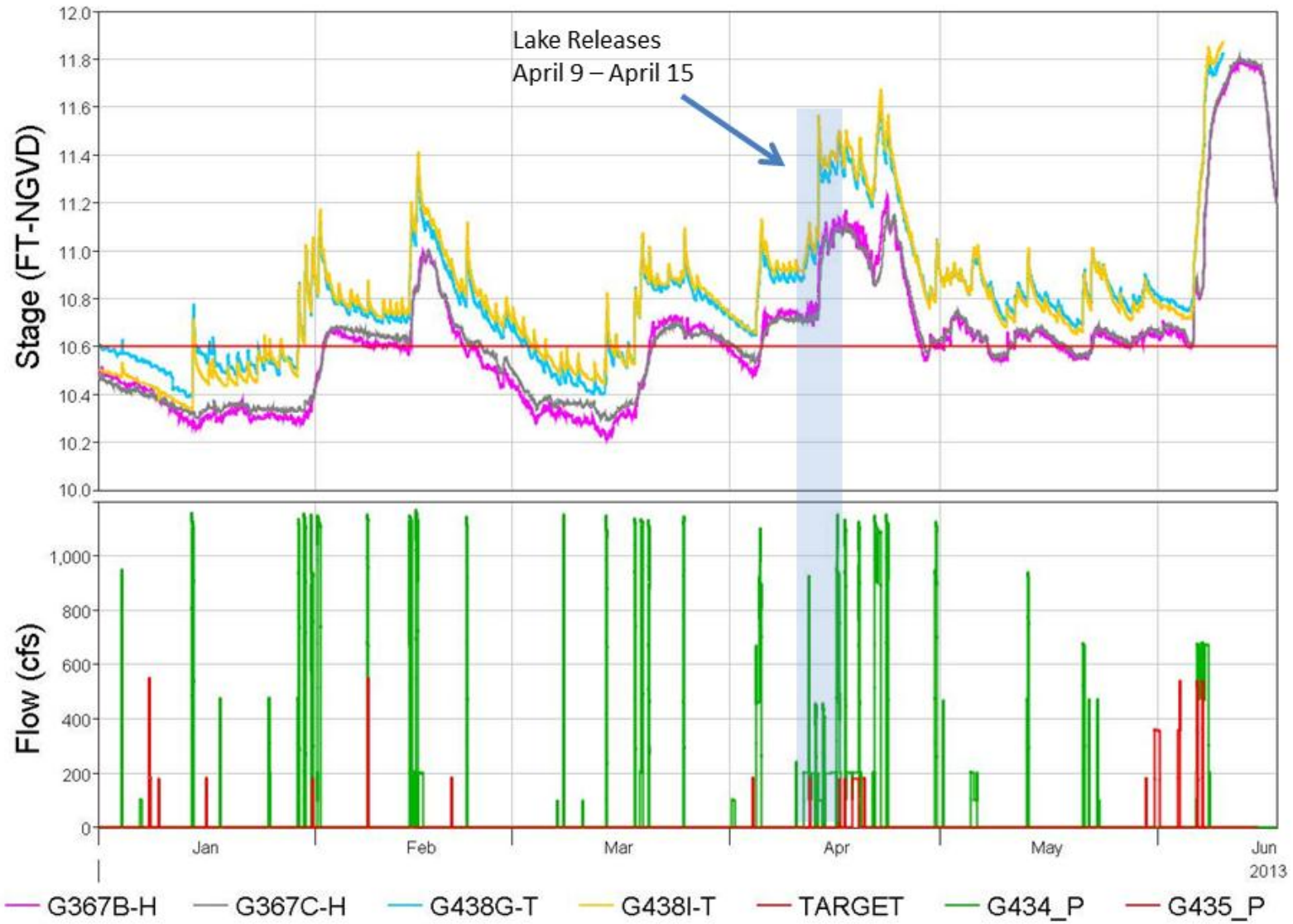
STA-2 Inflows and Stages

STA 2 Cell 5



STA-2 Inflows and Stages

STA 2 Cell 6



STA-2 Inflows and Stages

STA 2 Cell 6

