FISH OPERATIONS PLAN IMPLEMENTATION REPORT

April 2016

Submitted by the U.S. Army Corps of Engineers
Northwestern Division
Portland, OR.

Introduction

The U.S. Army Corps of Engineers (Corps) is submitting this report in accordance with the 2016 Fish Operations Plan (2016 FOP) posted to the TMT website on February 29, 2016. The 2016 FOP describes the Corps' project operations for fish passage at its Federal Columbia River Power System (FCRPS) dams during the spring and summer fish migration season, generally April through August. To the extent Corps project operations are not specified in the 2016 FOP, the FCRPS operations will be consistent with the 2014 NOAA Fisheries Supplemental Biological Opinion (2014 Supplemental BiOp), the USFWS 2000 and 2006 BiOps, and/or other operative documents, including the 2016 Water Management Plan (WMP), WMP seasonal updates, and the 2016 Fish Passage Plan (FPP).

The Corps' April 2016 lower Snake and Columbia River project and fish passage operations are contained in this report. In particular, information in this report includes the following:

- Hourly flow through the powerhouse at each dam;
- Hourly flow over the spillway compared to the spill target for that hour; and
- Daily average Total Dissolved Gas (TDG) levels (percent of saturation) in the tailwater at each project, and in the subsequent downstream project's forebay.[1]

This report also provides information on presented issues and unanticipated or emergency situations that arose during implementation of the 2016 FOP in April 2016.

Data Reporting

I. For each project providing fish passage operations, this report contains one graph per operational month (April) displaying the performance of the fish passage spill program, with hourly spill, FOP spill, generation, and total flows. The monthly graphs begin on April 1 and end on April 30 for the following lower Snake River and lower Columbia River projects: Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville.

[1] Averages reported are consistent with the current and applicable Oregon TDG standard modification (120% tailwater) and Washington TDG criteria adjustments (120% tailwater/115% forebay). The Oregon TDG standard modification and the Washington TDG criteria adjustments have different methodologies for calculating TDG. When the standards vary or conflict, the Corps applies the more stringent standard.

Operations represented on the monthly graphs start at 0100 hours on April 1 for the lower Snake River and the lower Columbia River projects as follows:

- The dark tan line represents the average hourly total river flow through the project in thousand cubic feet per second (kcfs).
- The dotted blue line represents the average hourly flow through the powerhouse each hour in kcfs.
- The dotted pink line represents the actual average hourly spill level through the spillway in kcfs.
- The thin green line represents the hourly FOP spill level as defined in the 2016 FOP.
- The thick green line represents the adjusted FOP spill. This is the hourly maximum spill level that can be achieved taking into consideration that spill may vary as a function of total river flow, forebay elevation and generator capacity, and is subject to the following conditions:

    - spill percentage or flow rate specified in the 2016 FOP;
    - spill caps as set daily for TDG management;
    - test spill levels for fish passage research;
    - minimum generation for power system needs;
    - minimum spill at Bonneville (50 kcfs) dam; and
    - minimum spill at John Day is 25 percent of project outflow.

II. The average daily %TDG for the 12 highest hours for all projects is found at the end of the report (see Figure 9). The numbers in red indicate the project exceeded the %TDG cap - i.e. 115% (forebay of the next downstream dam) or 120% (tailwater) for each project. For the lower Columbia projects, tailwater TDG values are presented by displaying the highest value %TDG (controlling limit), and the lower value is displayed with a strikethrough.

General Implementation Remarks

For all projects that spill for fish passage, the actual spill may vary from the target spill due to various conditions as described below. When spill levels briefly deviate below or above the level specified in the 2016 FOP, the dotted pink line will be below or above the heavy green line in the figures. Actual deviations from the target operation during voluntary spill hours are described below in the April 2016 Spill Variance Table (Table 1).[2] The Spill Variance Table includes average hourly data; therefore, while spill may vary from target FOP spill for only a portion of an hour, the Spill Variance Table characterizes the variance as a full hour. There are instances when the hourly FOP spill levels are not achievable due to mechanical limitations in setting spill gates to implement the regionally coordinated spill pattern. The project operator sets the spill gate stops to most closely approximate the 2016 FOP level of spill while also avoiding exceeding the %TDG spill cap to the extent practicable.

[2] Involuntary spill conditions appearing in the graphs, but are not considered variances and are not reported in the Spill Variance Table. Involuntary spill conditions may result from lack of load, high river inflows that exceed available powerhouse capacity, scheduled or unscheduled turbine unit outages or transmission outages of various durations, and passing debris.

"Low flow" operations at the lower Columbia and Snake projects are triggered when inflow is insufficient to provide both minimum generation and the specified spill levels. In these situations, the projects operate at minimum generation and pass the remainder of project inflow as spill and through other routes, such as fish ladders, sluiceways, and navigation locks. As flows transition from higher flows to low flows, there may be situations when flows recede at a higher rate than forecasted. In addition, inflows provided by nonfederal projects upstream are variable and uncertain.

The combination of these factors may result in instances when unanticipated changes to inflow result in forebay elevations dropping to the low end of the Minimum Operating Pool (MOP). Since these projects have limited operating flexibility, maintaining minimum generation, MOP elevation, and the target spill may not be possible throughout every hour. During low flow periods at Little Goose Dam, the overall project spill percentage appears to be reduced because the calculations do not account for the volume of water released during navigational lockages; however, the actual spill volume remains constant. When this occurs, it is recorded in the monthly Pre-Coordinated Operations Table (Table 2)[3] denoted as "Navigation" type.

Actual spill levels at Corps projects with set flow targets may vary up to ±2 kcfs within the hour (except as otherwise noted in the 2016 FOP for Bonneville and The Dalles dams[4], which may range up to ±3 kcfs) as compared to those specified in the 2016 FOP and the RCC spill priority list (defining the project %TDG spill caps). A number of factors influence actual spill, including hydraulic efficiency, exact gate opening calibration, spillway gate hoist cable stretch due to temperature changes, and forebay elevation (e.g. a higher forebay results in a greater level of spill since more water can pass under the spill gate).

The 2016 FOP describes project "Operations during Rapid Load Changes" (p. 6). For reporting purposes, when hourly spill levels were not met as a result of load swing hours and other related within-hour load variability issues, the notation "Transmission Stability" will be used in the Spill Variance Table. "Transmission Stability" occurs because projects must be available to respond to within-hour load variability to satisfy North American Electric Reliability Corporation (NERC) reserve requirements ("on response") or other NERC mandatory reliability regulatory requirements. In addition to within-hour load variability, projects on response must be responsive to within hour changes resulting from intermittent generation (such as wind generation). During periods of rapidly changing loads and intermittent generation, projects on response may have significant changes in turbine discharge within the hour while spill quantity remains the same within the hour. Under normal conditions, within-hour load changes primarily occur immediately preceding and following the peak load hours; however, within-hour changes in intermittent generation can occur at any hour of the day. Occasionally, several hours after peak load hours, the project may be decreasing total outflow and generation faster than the corresponding spill decreases causing the percent spill to be slightly higher. Due to the high

[3] Other routine activities that change spill levels and have been coordinated with regional partners will be identified in Table 2.

[4] As specified in the 2016 FOP (p. 14), this applies when the spill level is below 40% of total flow at The Dalles Dam.

variability of within-hour load, reporting actual spill percentages that vary by more than the ±1 percent within hour requirement (or other ranges specified in the 2016 FOP) may occur with greater frequency with "Transmission Stability" hours than other hours.

Occurrences requiring an adjustment in operations and/or regional coordination are described in greater detail in the "Operational Adjustments" section below.

April Operations

The month of April was characterized by well above average flows for both the lower Snake and the lower Columbia rivers. The NOAA Northwest River Forecast Center's Runoff Processor indicated that the April 2016 adjusted volume runoff on the lower Snake River was above the 30 year average (1981-2010): 5.5 MAF (Million Acre Feet) or 120% of average as measured at Lower Granite Dam. For the lower Columbia, the Runoff Processor indicated the April 2016 adjusted volume runoff was above the 30 year average (1981-2010): 21.6 MAF or 157% of average as measured at The Dalles. The monthly precipitation summary for April was below average at 80% on the Snake River above Ice Harbor Dam and well below average on the Columbia River above The Dalles Dam at 63%.

During the April 2016 reporting period, the planned 2016 FOP spill operations were carried out as follows:

- Lower Granite Dam - The hourly target spill level was 20 kcfs, 24 hours/day.
- Little Goose Dam - The hourly target spill level was 30% of total project outflow, 24 hours/day.
- Lower Monumental Dam - The hourly target spill level was the %TDG cap, 24 hours/day.
- Ice Harbor Dam - April 3–April 28: The hourly target spill level was 45 kcfs during the daytime and the %TDG cap during the nighttime. Starting April 28: The hourly target spill level was alternated between two day treatments of 30% of total project outflow, 24 hours/day vs. 45 kcfs during the daytime and the %TDG cap during the nighttime. Nighttime spill hours are 1800–0500.
- McNary Dam - The hourly target spill level was 40% of total project outflow, 24 hours/day.
- John Day Dam - April 10–28: The hourly target spill level was 30% of total project outflow, 24 hours/day. Starting on April 27: at 2000 hours, the hourly target spill level was alternated between two day treatments of 30% and 40% of total project outflow, 24 hours/day. Spill level changes occur at 2000 hours.
- The Dalles Dam - The hourly target spill level was 40% of total project outflow, 24 hours/day.
- Bonneville Dam - The hourly target spill level was 100 kcfs, 24 hours/day.

Operational Adjustments

1. Ice Harbor Dam

On April 19 at 1818 hours, BPA declared a transmission system emergency due to unacceptably high line-loading issues in the Tri-Cities area. ("Line loading" refers to the magnitude of flow of electricity on a transmission line.) This was triggered by a convergence of events and circumstances, including unseasonably high ambient air temperatures and higher local power demand, alternating day/night fish passage spill treatments at Ice Harbor and the resultant drop in generation at the facility during the transition from daytime to nighttime spill levels, a pre-scheduled transmission line outage for maintenance, and geographic limitations on transmission line capacity to serve the metropolitan region. To relieve the line loading issues while continuing to supply power to the Tri Cities area, generation increased at Ice Harbor Dam, resulting in reduced spill below the FOP level for approximately six hours until the transmission emergency was lifted at 0010 on April 20.

Per the 2016 FOP, the spill operation at Ice Harbor is to spill to the current TDG cap (93 kcfs), except when there is insufficient flow to maintain one unit at minimum generation (approximately 10 kcfs) and the remaining flow for spill is less than the TDG cap. During the six hours of transmission emergency operations, Ice Harbor total outflow ranged from 81 to 111 kcfs and the FOP target spill would have ranged from 71 to 93 kcfs. Due to the increased generation during the transmission emergency, spill during those hours instead ranged from 27 to 83 kcfs. Average hourly spill during those 6 hours was below the FOP level by 7 to 47 kcfs.

The Corps notified the TMT of this operation via email on April 20 and convened an unscheduled conference call at 1400 hours to discuss a proposal to avoid another transmission emergency that evening. During the call, the Action Agencies proposed rearranging spill treatments in a manner that maintained the same number of treatments over the season, consistent with the FOP, but also accommodated the imminent transmission system condition concerns. Specifically, on April 20, the previously scheduled spill operation should have been 45 kcfs day/TDG cap night, but it was switched to 30% in coordination with the TMT and avoided another emergency. Additionally, to make the number of spill treatments over the season equivalent the previously scheduled 30% spill operation on April 28 was switched to 45 kcfs day/TDG cap night. TMT members either supported or did not object to this operation.

Table 1: April 2016 (4/1 – 4/30) – Spill Variance Table

Parameter	Project	Date	Time [5]	Hours	Type	Reason
Additional Spill	Ice Harbor	4/18/16	0600	1	Human Error	Hourly spill remained at 95 kcfs (TDG spill cap). Delay in changing to FOP spill operation of 45 kcfs.
Reduced Spill	Ice Harbor	4/19/16 – 4/20/16	1900 – 0000	6	Transmission Stability	Hourly spill decreased to 27-83 kcfs (below 93 kcfs TDG spill cap) due to transmission system emergency. Project increased generation to assure system reliability.

Table 2: April 2016 (4/1 – 4/30) – Pre-Coordinated Operations Table

Project	Date	Type	Description of Event	Regional Coordination
There are no reportable pre-coordinated operations to report in April				

[5] Note: Data collected for reporting spill variances is reported using hourly-averaged data. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented in the Spill Variance Table as an hour.

Figure 1

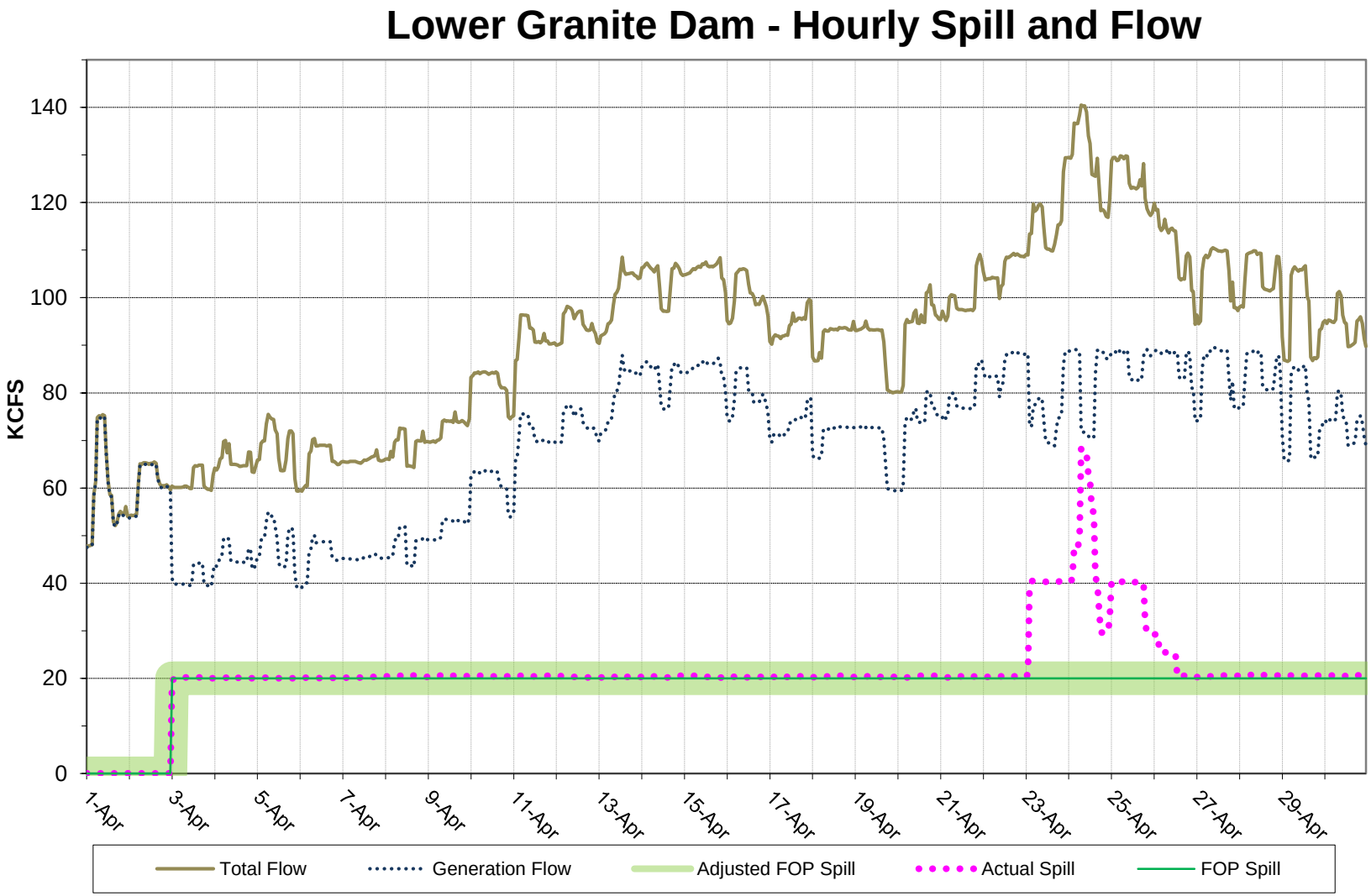
Lower Granite Dam - Hourly Spill and Flow
KCFS
140
120
100
80
60
40
20
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 2

Little Goose Dam - Hourly Spill and Flow

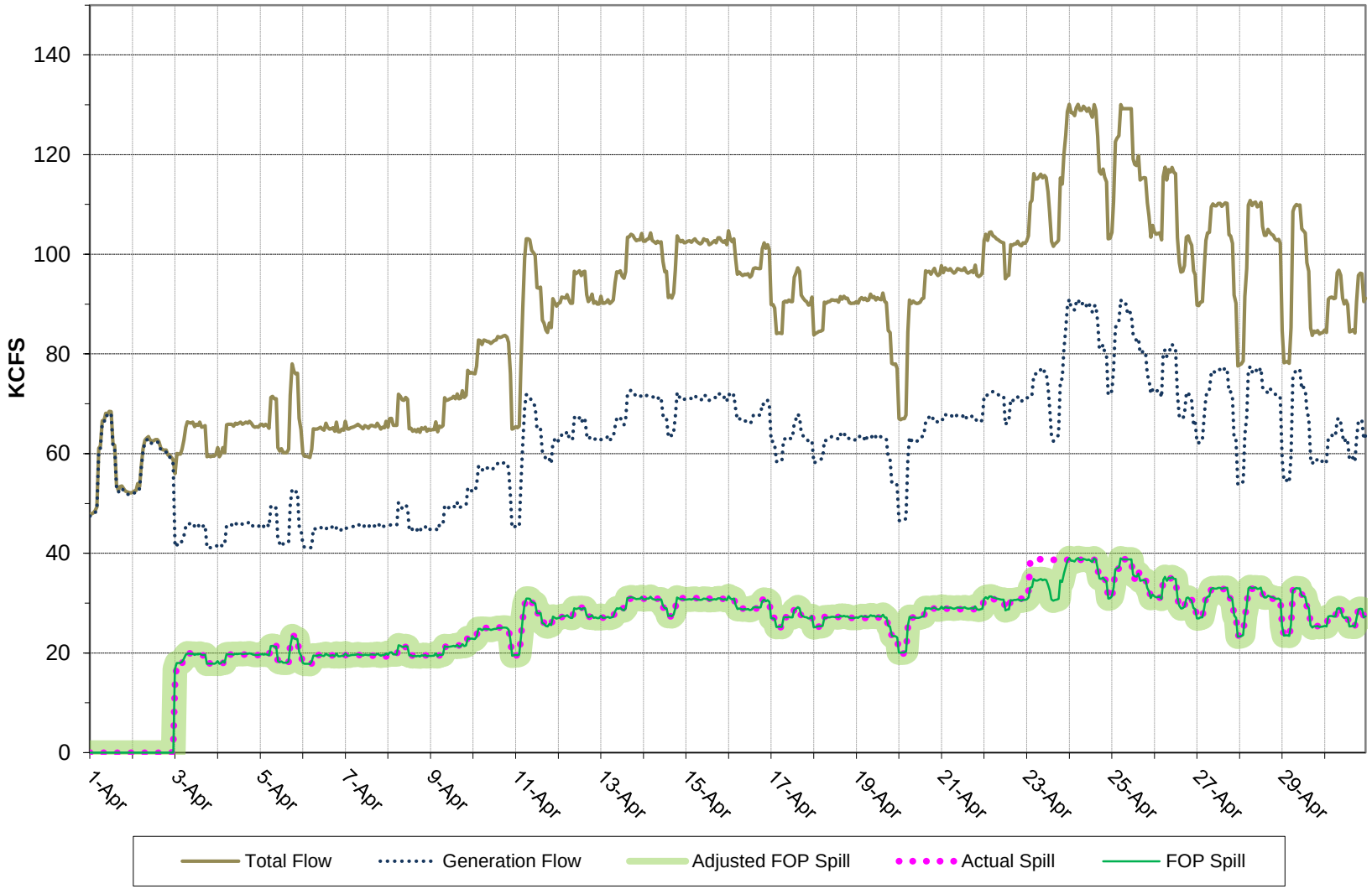

Figure 3

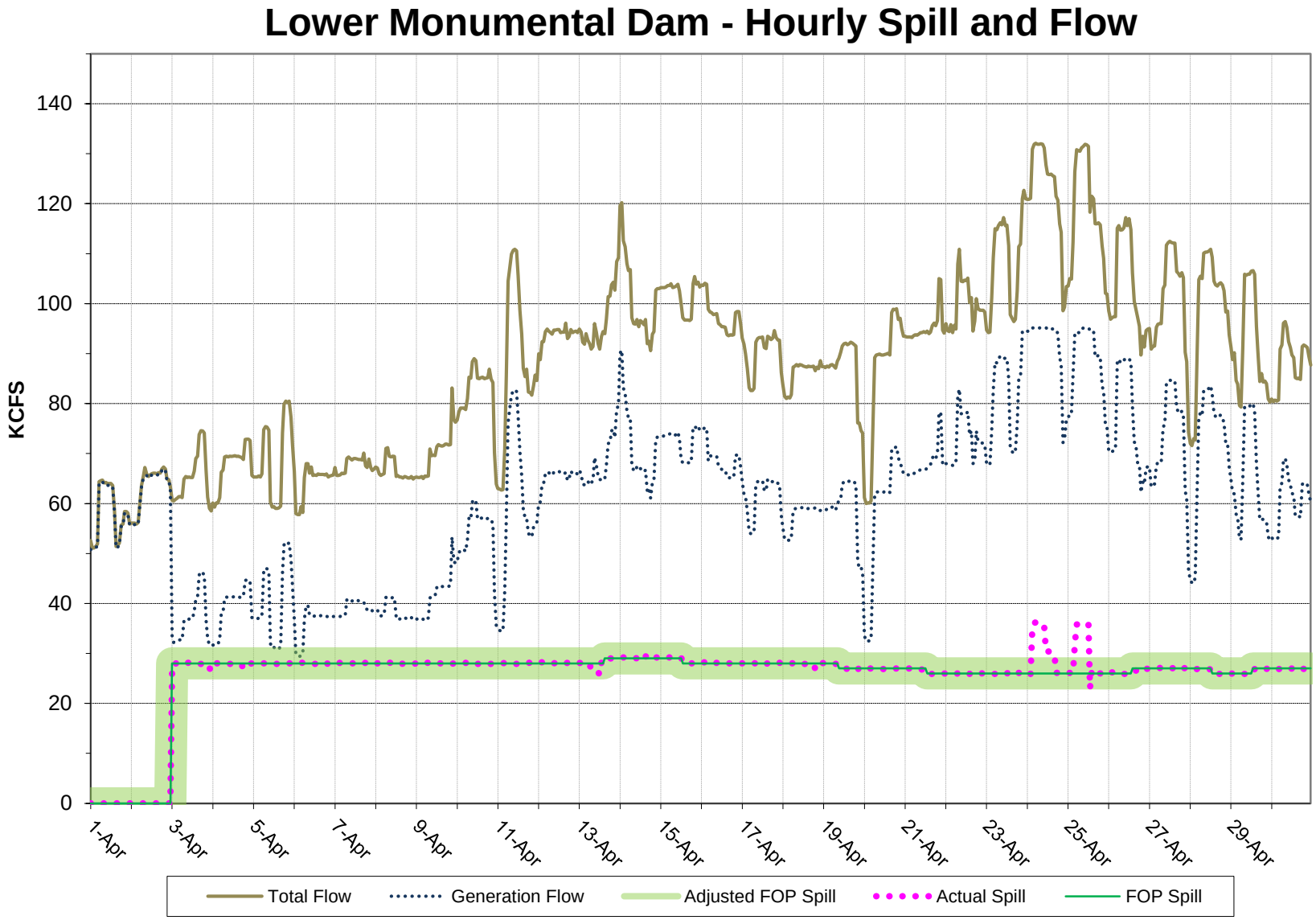
Lower Monumental Dam - Hourly Spill and Flow
KCFS
140
120
100
80
60
40
20
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 4

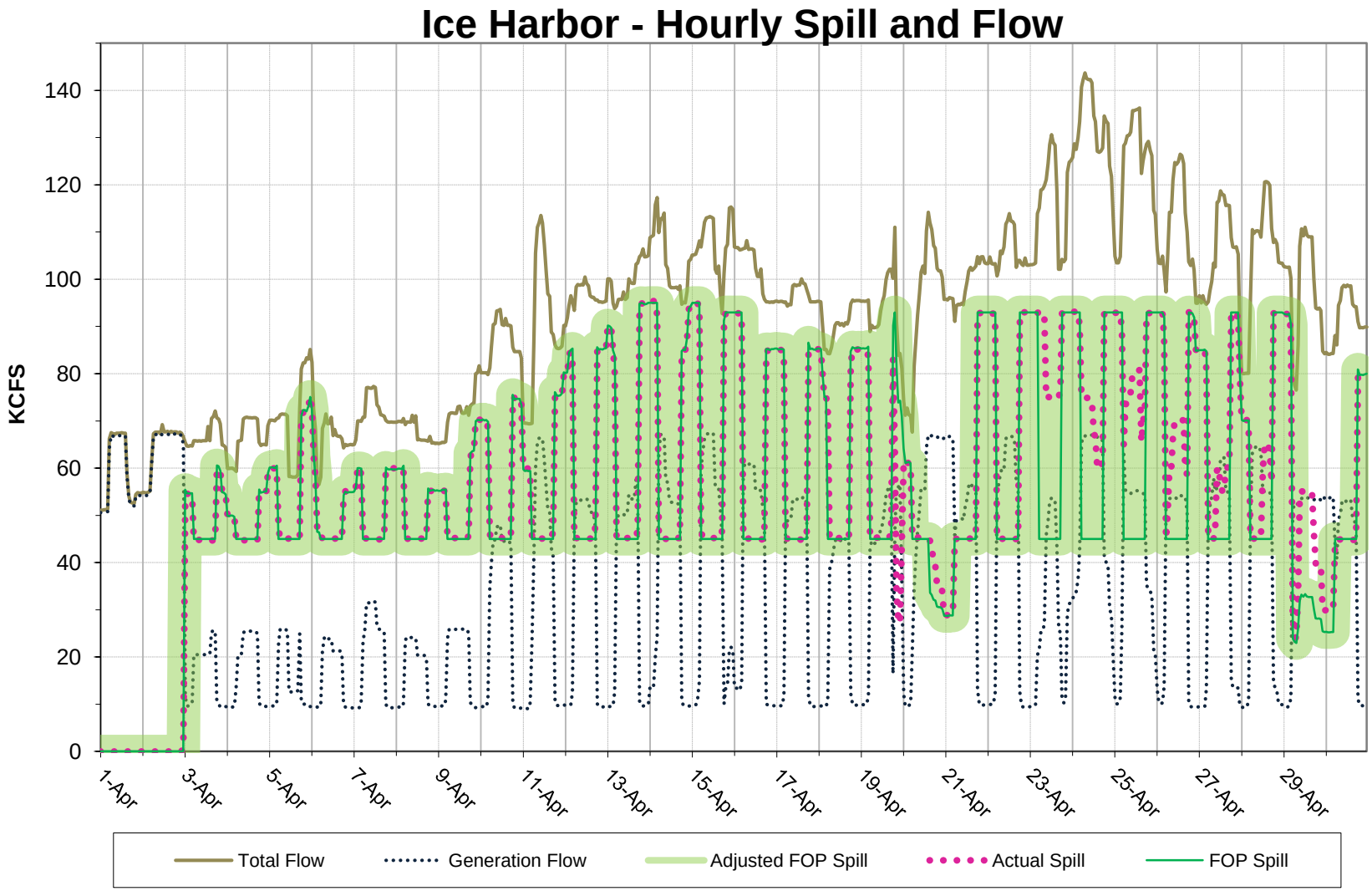
Ice Harbor - Hourly Spill and Flow
KCFS
140
120
100
80
60
40
20
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 5

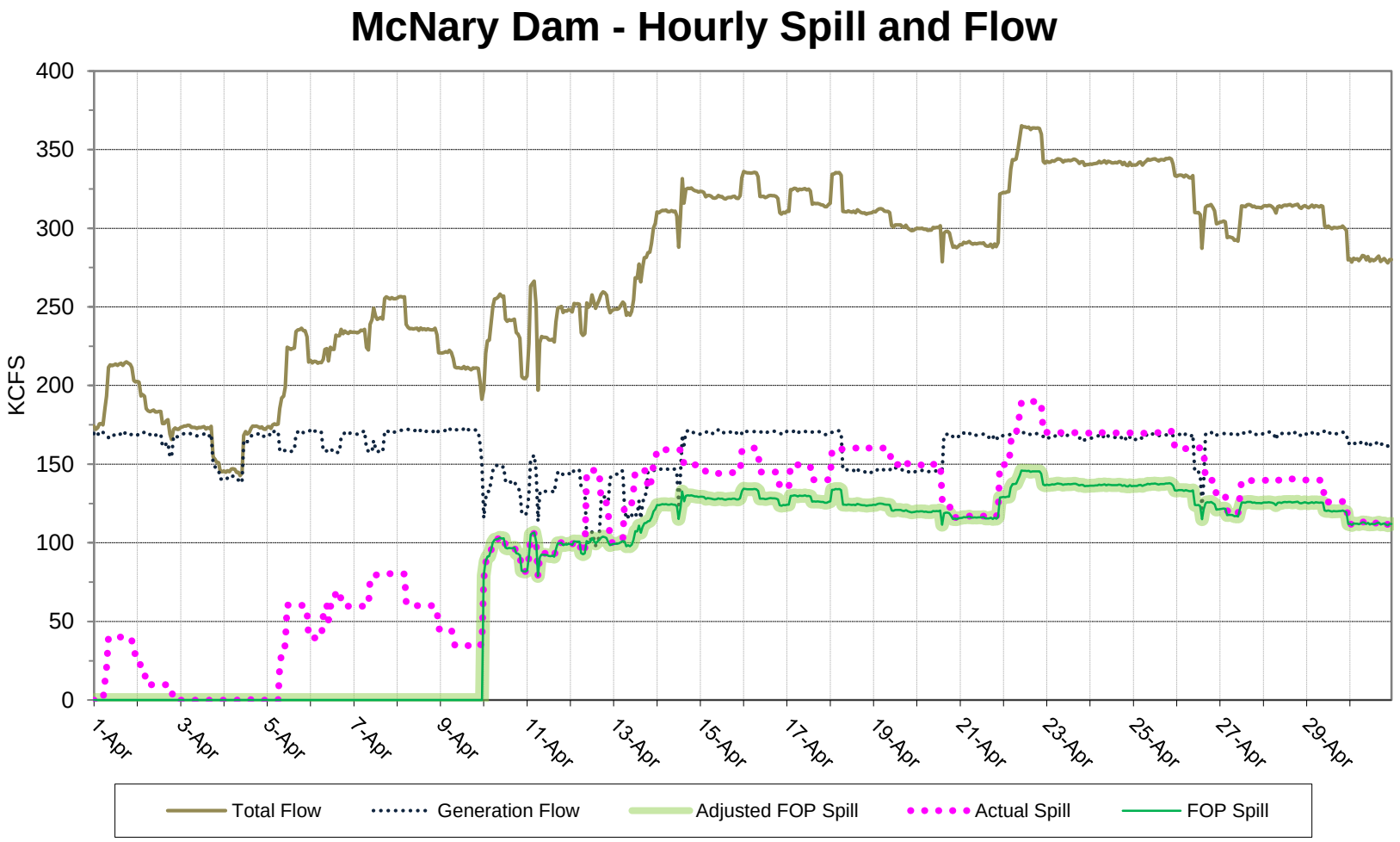
McNary Dam - Hourly Spill and Flow
KCFS
400
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 6

John Day Dam - Hourly Spill and Flow

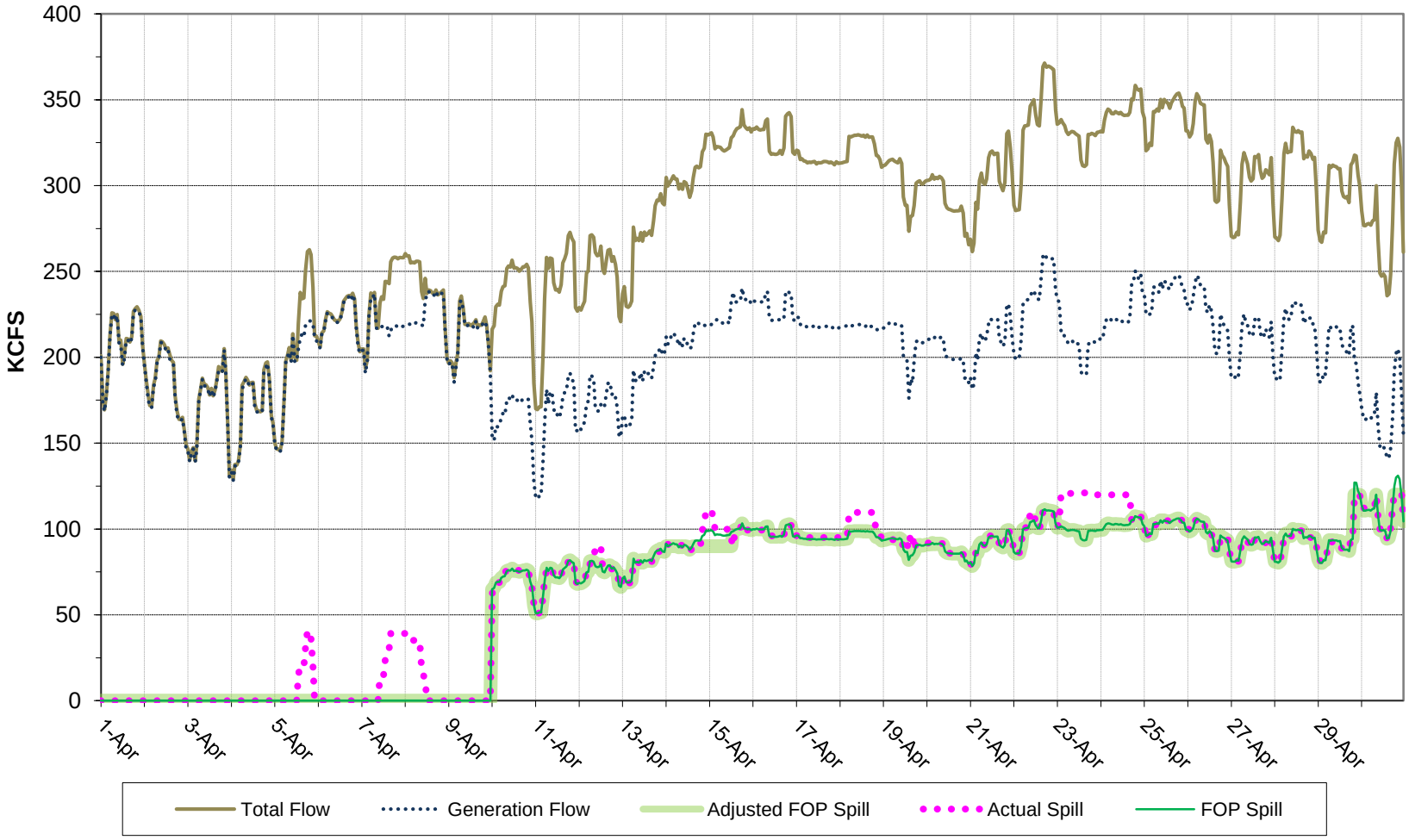

Figure 7

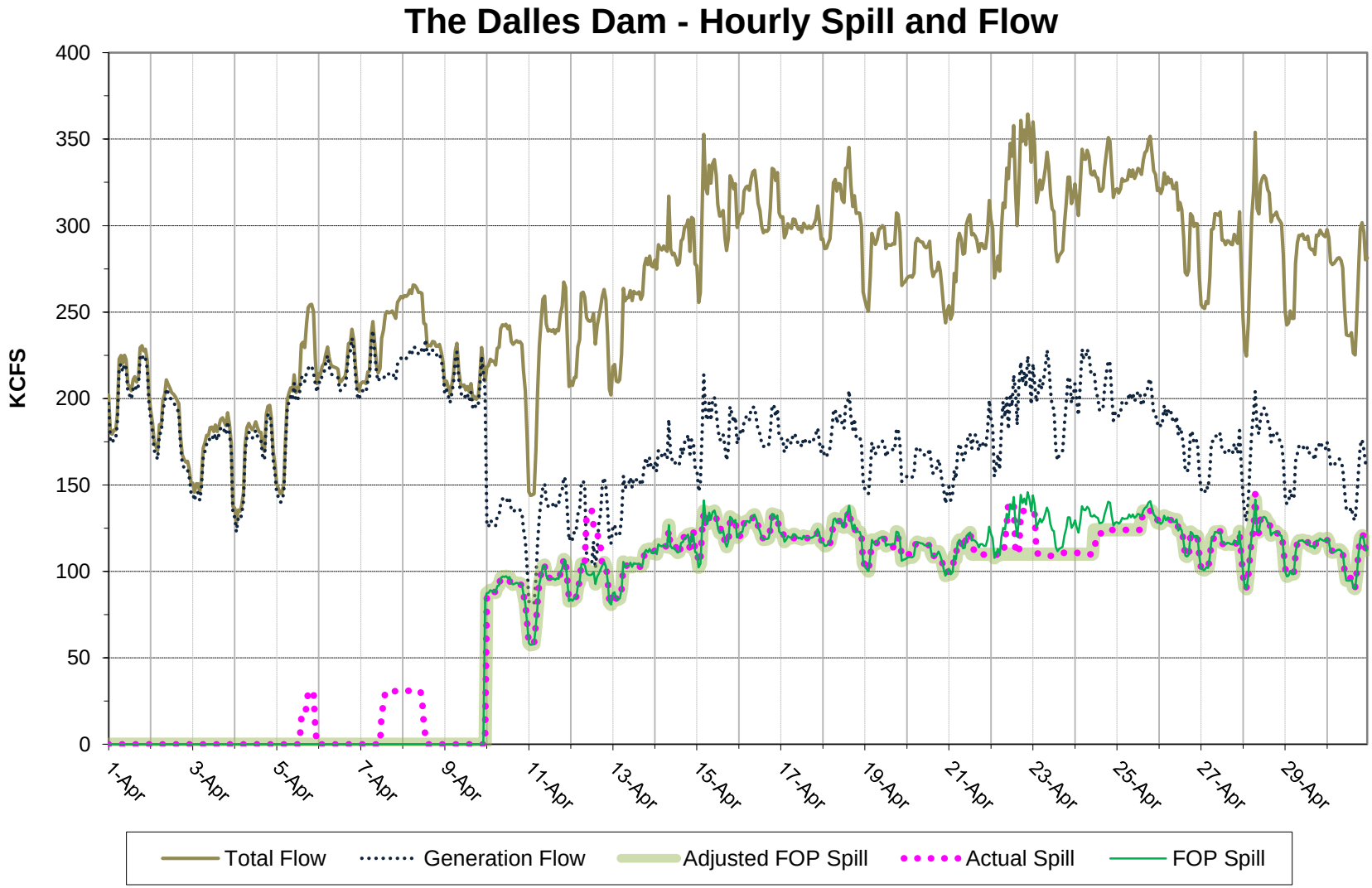
The Dalles Dam - Hourly Spill and Flow
KCFS
400
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 8

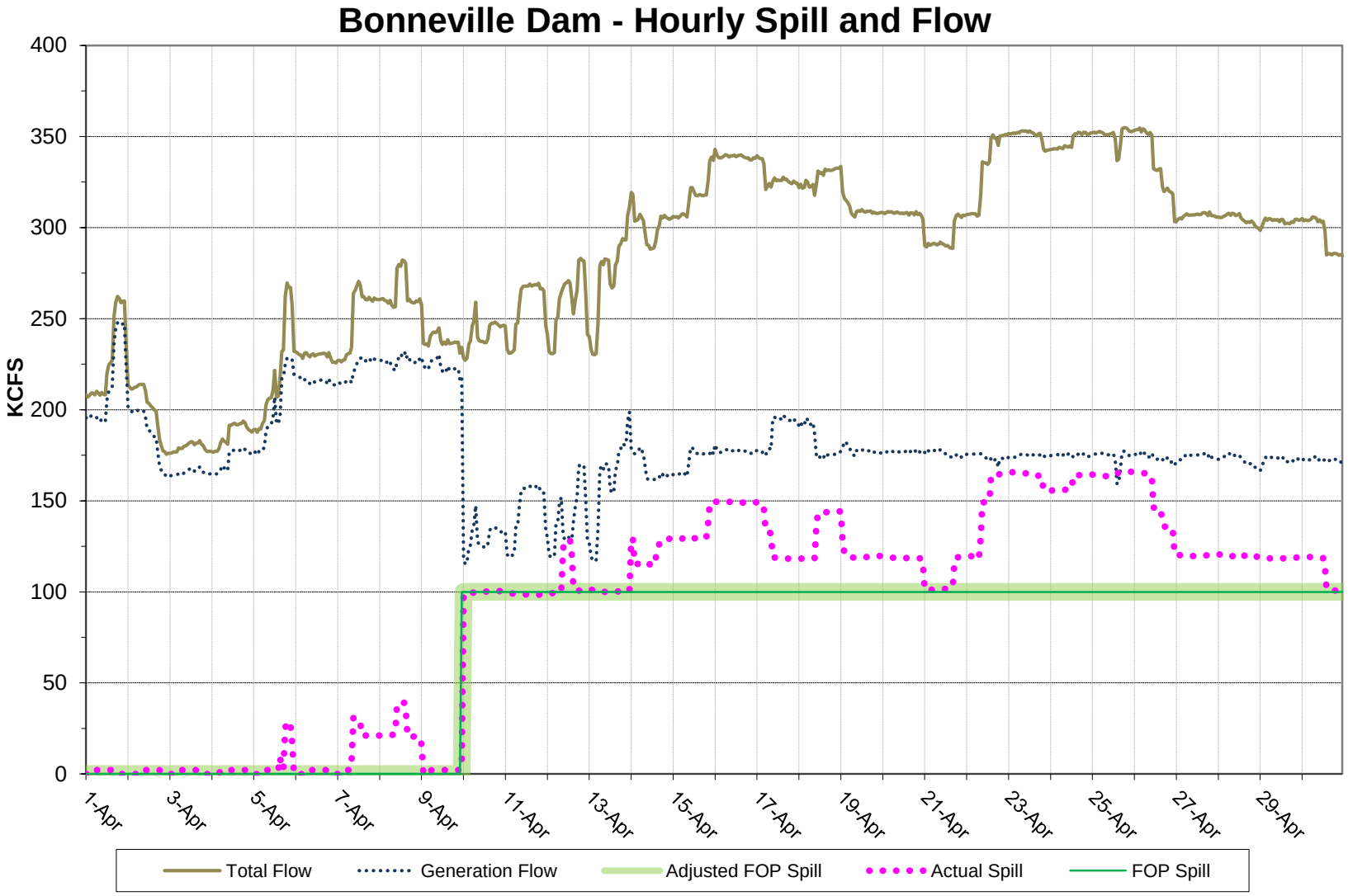
Bonneville Dam - Hourly Spill and Flow
KCFS
400
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 9

Average Percent TDG Values for April 1 – April 30

Date	FIXED MONITORING STATIONS																			
	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW		JDY	JHAW		TDA	TDDO		BON	CCIW	
Gas Cap %:	115	120	115	120	115	120	115	120	115	120		115	120		115	120		115	120	
Method:	WA	WA	WA	WA	WA	WA	WA	WA	WA	OR	WA	WA	OR	WA	WA	OR	WA	WA	OR	WA
4/1/2016	102	102	101	101	101	101	102	102	105	~~112~~	112	104	103	~~103~~	103	102	~~102~~	104	108	~~108~~
4/2/2016	103	102	103	101	102	102	103	103	105	~~108~~	112	104	103	~~103~~	103	103	~~103~~	104	~~108~~	108
4/3/2016	103	110	104	109	102	116	103	115	106	~~106~~	106	104	104	~~104~~	104	103	~~103~~	105	~~107~~	108
4/4/2016	103	110	103	109	102	116	103	115	106	~~105~~	106	104	~~103~~	104	104	~~102~~	103	105	~~106~~	106
4/5/2016	102	110	102	108	103	117	106	115	104	114	~~114~~	103	110	~~110~~	102	~~103~~	103	102	~~108~~	108
4/6/2016	102	110	103	109	106	118	109	115	105	~~113~~	113	104	~~104~~	110	105	105	~~105~~	104	108	~~108~~
4/7/2016	103	110	107	110	109	119	114	116	108	115	~~115~~	106	116	~~116~~	105	106	~~106~~	106	110	~~110~~
4/8/2016	105	111	110	111	112	119	**117**	116	111	115	~~115~~	107	~~115~~	117	109	109	~~109~~	107	111	~~111~~
4/9/2016	106	111	113	112	112	120	**118**	116	112	116	~~116~~	107	107	~~107~~	109	~~107~~	109	108	~~110~~	111
4/10/2016	106	111	113	114	112	120	**118**	116	112	~~115~~	116	108	117	~~117~~	107	112	~~112~~	108	117	~~117~~
4/11/2016	105	110	112	115	112	119	**117**	117	110	~~114~~	114	109	115	~~115~~	108	114	~~114~~	108	~~118~~	118
4/12/2016	103	110	112	114	112	119	**116**	117	108	116	~~116~~	109	115	~~115~~	109	118	~~118~~	110	119	~~119~~
4/13/2016	103	110	109	115	114	120	114	118	108	~~117~~	117	110	116	~~116~~	111	~~116~~	117	**116**	119	~~119~~
4/14/2016	104	110	109	115	114	120	114	120	109	118	~~118~~	110	117	~~117~~	111	~~116~~	116	**117**	**121**	~~120~~
4/15/2016	103	110	108	114	114	**121**	114	119	108	~~117~~	118	109	~~118~~	118	110	~~115~~	116	115	**121**	~~121~~
4/16/2016	102	109	106	114	113	120	114	119	111	117	~~117~~	108	118	~~118~~	110	115	~~115~~	115	**123**	~~123~~
4/17/2016	103	109	107	114	114	120	115	117	114	118	~~118~~	110	~~117~~	117	111	116	~~116~~	115	~~122~~	**123**
4/18/2016	105	110	107	113	114	**121**	**117**	117	**116**	118	~~118~~	112	119	~~119~~	113	117	~~117~~	**116**	**123**	~~123~~
4/19/2016	105	110	109	114	115	**121**	**118**	117	**117**	118	~~118~~	115	~~117~~	118	114	118	~~118~~	**118**	~~121~~	**123**
4/20/2016	106	110	110	115	115	**121**	**119**	116	**119**	118	~~118~~	**117**	117	~~117~~	115	118	~~118~~	**119**	120	~~120~~
4/21/2016	106	110	111	115	115	120	**119**	118	**119**	~~117~~	117	**118**	118	~~118~~	**116**	118	~~118~~	**118**	~~120~~	120
4/22/2016	105	110	111	115	**116**	120	**119**	120	**118**	120	~~120~~	**118**	119	~~119~~	**116**	118	~~118~~	**118**	**123**	~~123~~
4/23/2016	105	117	110	117	**116**	119	**117**	120	**116**	~~119~~	120	**117**	~~119~~	119	114	~~115~~	117	**116**	**123**	~~123~~
4/24/2016	103	**121**	108	116	115	119	115	120	112	119	~~119~~	112	119	~~119~~	112	~~115~~	115	114	**123**	~~123~~
4/25/2016	103	116	110	116	115	119	113	120	111	119	~~119~~	110	~~118~~	119	111	~~114~~	115	113	~~123~~	**123**
4/26/2016	104	115	112	116	114	120	114	119	114	119	~~119~~	108	~~118~~	118	110	116	~~115~~	113	~~123~~	**123**
4/27/2016	104	110	112	115	**116**	120	115	119	114	~~118~~	118	108	117	~~117~~	110	~~115~~	115	114	~~120~~	**122**
4/28/2016	104	110	112	115	**116**	**121**	**116**	119	114	118	~~118~~	110	118	~~118~~	110	115	~~115~~	113	~~120~~	120
4/29/2016	104	110	110	115	115	120	**116**	119	113	~~117~~	118	110	~~118~~	118	110	~~115~~	115	112	~~120~~	120
4/30/2016	103	109	108	113	114	120	**116**	117	112	~~116~~	117	110	120	~~120~~	113	117	~~117~~	112	~~119~~	119