FISH OPERATIONS PLAN IMPLEMENTATION REPORT

June 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 Technical Management Team (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' June 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 June 2016.

Data Reporting

I. For each project providing fish passage operations, this report contains one graph per operational month (June) displaying the performance of the fish passage spill program, with hourly spill, FOP spill, generation, and total flows. The monthly graphs begin on June 1 and end on June 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 June 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 shown in the June 2016 Average Percent TDG Values Table (Table 3). 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.[2] Actual deviations from the target operation during voluntary spill hours are described below in the June 2016 Spill Variance Table (Table 1).[3] 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

[2] The actual thickness of the heavy green line (Adjusted FOP Spill) is not intended to represent the full allowable tolerance; and if the dotted pink line is slightly outside it should not be construed to indicate a spill variance or involuntary spill.

[3] Involuntary spill conditions shown in the graphs 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.

stops to most closely approximate the 2016 FOP level of spill while also avoiding exceeding the %TDG spill cap to the extent practicable.

"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)[4] 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[5], 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

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

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

corresponding spill decreases causing the percent spill to be slightly higher. Due to the high 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.

June Operations

The month of June was characterized by well below average flows for the lower Snake River and well below average flows for the lower Columbia River. The NOAA Northwest River Forecast Center's Runoff Processor indicated that the June 2016 adjusted volume runoff on the lower Snake River was below the 30 year average (1981-2010): 3.4 MAF (Million Acre Feet) or 55% of average as measured at Lower Granite Dam. For the lower Columbia, the Runoff Processor indicated the June 2016 adjusted volume runoff was below the 30 year average (1981-2010): 16.6 MAF or 63% of average as measured at The Dalles. The monthly precipitation summary for June was below average at 30% on the Snake River above Ice Harbor Dam and below average on the Columbia River above The Dalles Dam at 53%.

During the June 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 through June 20. The operation transitioned to the summer hourly target spill level of 18 kcfs, 24 hours/day on June 21.
- 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 through June 20. The operation transitioned to the summer hourly target spill level of 17 kcfs, 24 hours/day on June 21.
- Ice Harbor Dam - 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 through June 15. The operation transitioned to the summer hourly target spill level of 50%, 24 hours/day on June 16.
- John Day Dam - The hourly target spill level alternated between two day treatments of 30% and 40% of total project outflow, 24 hours/day. Spill level changes occurred 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 through June 15. The operation transitioned to the summer hourly target spill level alternating between 2-day blocks of 95 kcfs, 24 hours/day vs. 85 kcfs during the day and 121 kcfs during the nighttime on June 16 at 0430. Nighttime hours are 2130-0430 through June 30. *See* Operational Adjustments section for additional discussion of operations.

Operational Adjustments

1. Lower Granite Dam

On June 29 at 1500 hours, the Corps implemented the TMT-recommended operation to close the spillway weir (SW) to improve tailrace hydraulics and temperature conditions for the benefit of adult fish passage. Spill was maintained at the planned 2016 FOP summer spill level and distributed in accordance with patterns defined in the 2016 FPP. The operation was coordinated to continue through 2400 hours on August 31.

2. Bonneville Dam

On Friday, June 17, 2016, from 0600-1145, Bonneville Dam spillway bays 2-18 were closed to facilitate an emergency remotely operated vehicle (ROV) survey of developing erosion holes in the shoreline beneath the Bradford Island B-Branch fish ladder on the south shore of the spillway tailrace. The holes were not observed during the May spillway inspection, and hydraulics in the eroded area indicated significant undercutting that could extend beneath the fish ladder and compromise the structural integrity of the fish ladder. Spill through bay 1 was maintained at 1 kcfs to provide attraction flow to the Cascades Island fish ladder on the north spillway tailrace.

During the six hour emergency operation, hourly average spill ranged from 1 to 24 kcfs (average 6 kcfs), and was below the planned 2016 FOP summer spill operation for this period of 95 kcfs, 24 hours per day. All other fish passage routes were operated in accordance with criteria in the 2016 Fish Passage Plan (FPP).

The Corps notified regional sovereigns of this emergency operation on Thursday, June 16, via a Memorandum for the Record (MFR) emailed to the Fish Passage Operations and Maintenance (FPOM) team and the TMT. The Corps also notified NOAA representatives via telephone and coordinated with CRITFC to address potential impacts to Treaty fishing operations in the Bonneville pool. Immediately following the emergency ROV survey, the Corps notified FPOM via email that spill and ladder operations had returned to normal. On Monday, June 20, the Corps provided the ROV inspection survey results to FPOM in an updated MFR and outlined the regional coordination process moving forward. The Corps also briefed the TMT on Wednesday, June 22. Regional sovereigns either supported or did not object to emergency measures to conduct the ROV survey.

Following the initial ROV inspection survey, the Corps implemented a revised spill treatment schedule to maintain constant spill to minimize further exacerbating the erosion that was occurring near the Bradford Island B-Branch ladder. From Saturday, June 18, at 0430, through Monday, June 20, at 0430, and again from Wednesday, June 22, at 0600, through Friday, June 24, at 0430, the Corps altered the planned 2016 FOP summer spill treatment schedule from 85 kcfs day/121 kcfs night to implement a constant 95 kcfs spill, 24 hours/day. These operational adjustments are shown in Figure 8. The Corps resumed the planned 2016 FOP summer spill treatment schedule on June 24 at 0430 for the remainder of June.

Table 1: Spill Variance Table – June 2016 (6/1 to 6/30)

Project	Parameter	Date	Time[6]	Hours	Type	Reason
Little Goose	Reduced Spill	6/7/16	0600	1	Human Error	Hourly spill decreased to 27% (below 30% ±1% range). Delay in changing to 23 kcfs.
Little Goose	Reduced Spill	6/14/16	1000	1	Operational Limitation	Hourly spill decreased to 28% (below 30% ±1% range). Turbines' physical limitation on generation occurred at the same time as a navigation lockage, preventing 30% spill. 24-hr avg. spill was 30%.
Little Goose	Reduced Spill	6/14/16	1300	1	Operational Limitation	Hourly spill decreased to 28% (below 30% ±1% range). Turbines' physical limitation on generation occurred at the same time as a navigation lockage, preventing 30% spill. 24-hr avg. spill was 30%.
Bonneville	Reduced Spill	6/17/16	0700-1200	6	Emergency	Hourly spill decreased to 1-24 kcfs (below 95 kcfs ±3 kcfs range). See Operational Adjustments section for additional information. Regional sovereigns were notified of the operation.
Bonneville	Reduced Spill	6/28/16	0600-1100	6	Human Error	Hourly spill decreased to 85 kcfs (below 95 kcfs ±3 kcfs range) due to a miscommunication of the planned spill operation. TMT was notified.

[6] 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.

Table 2: Pre-Coordinated Operations – June 2016 (6/1 to 6/30)

Project	Date[6]	Type	Description of Event	Regional Coordination
Little Goose	June 14 and June 26	Navigation	The volume of water needed to empty the navigation lock reduces the spill percentage.	2016 FOP, p. 2
Little Goose	June 24	Research Related	The FGE fish study required switching units, which during low flows, caused spill to drop below the FOP range.	2016 FPP Appendix A, section 8.2.2 and updated in FPOM coordination memo, MOC16LGS12 on June 14, 2016.
Lower Monumental	Every other day from June 2 through June 30	Navigation	Spill was reduced for safe passage of fish barges crossing project tailwater.	2016 FOP, p. 2, 4 and 7
Ice Harbor	June 3 and June 9	Operational Limitation	Spill treatment blocks were rearranged in order for BPA to meet energy demands during the heat wave from June 3-7.	2016 FOP, p. 12
Ice Harbor	June 18	Navigation	Hourly spill decreased to 28% (below 30% ±1% range). Two navigation lockages occurred in one hour, resulting in the need to empty the navigation lock twice, thereby reducing the spill percentage for that hour. 24-hr avg. spill was 30%.	2016 FOP, p. 7
John Day	June 4 and June 10	Operational Limitation	Spill treatment blocks were rearranged in order for BPA to meet energy demands during the heat wave from June 3-7.	2016 FOP, p. 14

Table 3: June 2016 Average Percent TDG Values Table (6/1 to 6/30)

Date	FIXED MONITORING STATIONS																			
	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW		JDY	JHAW		TDA	TDDO		BON	CCIW	
	Lower Granite FB	Lower Granite TW	Little Goose FB	Little Goose TW	Lower Monumental FB	Lower Monumental TW	Ice Harbor FB	Ice Harbor TW	McNary FB	McNary TW		John Day FB	John Day TW		The Dalles FB	The Dalles TW		Bonneville FB	Bonneville TW	
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
6/1/2016	104	111	111	112	112	118	119	117	111	115	~~115~~	107	~~114~~	114	110	115	~~115~~	115	~~117~~	117
6/2/2016	104	111	111	111	112	118	119	116	111	116	~~116~~	107	116	~~116~~	110	~~114~~	115	114	117	~~117~~
6/3/2016	104	111	110	111	111	117	117	116	110	116	~~116~~	108	~~114~~	115	111	116	~~116~~	113	117	~~117~~
6/4/2016	103	110	110	112	111	118	116	116	111	116	~~116~~	111	115	~~114~~	112	~~116~~	116	115	117	~~117~~
6/5/2016	104	110	111	112	113	119	119	117	113	~~115~~	116	112	117	~~117~~	113	117	~~117~~	116	118	~~118~~
6/6/2016	106	111	114	113	114	119	120	117	114	~~116~~	116	113	~~116~~	116	113	~~117~~	117	116	118	~~118~~
6/7/2016	106	111	115	113	114	119	119	117	115	116	~~116~~	113	115	~~115~~	112	~~116~~	116	115	~~118~~	118
6/8/2016	105	111	115	113	114	117	119	116	115	118	~~118~~	114	116	~~115~~	112	~~116~~	116	113	~~118~~	118
6/9/2016	104	110	114	112	114	118	118	116	113	117	~~117~~	114	116	~~116~~	112	116	~~116~~	110	~~117~~	117
6/10/2016	103	110	112	112	113	118	116	116	111	~~116~~	117	112	~~116~~	116	112	~~115~~	116	110	~~117~~	117
6/11/2016	102	110	111	111	111	116	114	116	108	~~115~~	116	109	~~115~~	115	110	~~114~~	114	110	117	~~117~~
6/12/2016	100	111	108	112	110	117	113	115	108	~~115~~	115	107	~~114~~	115	110	~~114~~	114	111	~~117~~	117
6/13/2016	101	111	109	112	111	118	114	115	109	~~115~~	115	107	114	~~114~~	111	~~114~~	114	111	~~117~~	117
6/14/2016	102	111	108	111	111	118	114	114	109	115	~~115~~	106	115	~~115~~	108	~~114~~	114	110	117	~~117~~
6/15/2016	102	111	107	111	110	118	114	116	107	116	~~116~~	105	114	~~114~~	109	114	~~114~~	111	~~117~~	117
6/16/2016	102	111	107	111	109	118	112	115	106	117	~~117~~	105	114	~~114~~	108	~~113~~	113	111	117	~~117~~
6/17/2016	101	110	106	111	108	117	113	115	107	116	~~116~~	105	115	~~115~~	108	114	~~114~~	110	~~117~~	117
6/18/2016	100	111	106	111	109	117	113	112	107	~~116~~	116	105	~~113~~	115	110	114	~~114~~	111	~~117~~	117
6/19/2016	100	111	107	111	108	117	111	114	106	~~115~~	116	104	114	~~114~~	108	113	~~113~~	111	117	~~117~~
6/20/2016	101	111	108	112	108	118	113	114	107	117	~~117~~	105	114	~~113~~	109	115	~~115~~	112	117	~~117~~
6/21/2016	102	114	108	112	109	117	113	113	107	~~116~~	116	105	116	~~116~~	108	~~114~~	114	112	117	~~117~~
6/22/2016	104	115	108	112	111	115	113	113	110	118	~~118~~	107	115	~~115~~	110	115	~~115~~	111	~~117~~	117
6/23/2016	105	115	109	112	112	115	115	113	110	~~118~~	118	107	~~113~~	114	110	~~114~~	115	110	~~117~~	117
6/24/2016	104	115	109	112	111	115	115	113	109	~~116~~	117	106	114	~~114~~	108	~~112~~	114	109	~~116~~	117
6/25/2016	103	115	108	111	109	116	112	113	106	117	~~117~~	106	115	~~115~~	108	113	~~113~~	110	117	~~116~~
6/26/2016	102	115	108	111	109	115	110	112	107	118	~~118~~	107	~~115~~	115	111	115	~~115~~	112	~~116~~	117
6/27/2016	102	115	109	111	109	116	110	114	109	~~118~~	118	108	~~114~~	114	111	116	~~116~~	114	~~117~~	117
6/28/2016	101	115	111	112	110	116	113	114	111	~~117~~	118	107	114	~~114~~	110	~~114~~	115	114	117	~~117~~
6/29/2016	103	114	115	112	112	116	113	114	111	~~117~~	117	107	114	~~114~~	108	~~113~~	114	110	~~116~~	117
6/30/2016	103	111	115	111	113	116	114	113	111	117	~~117~~	108	~~115~~	115	107	113	~~113~~	107	~~116~~	116

Figure 1

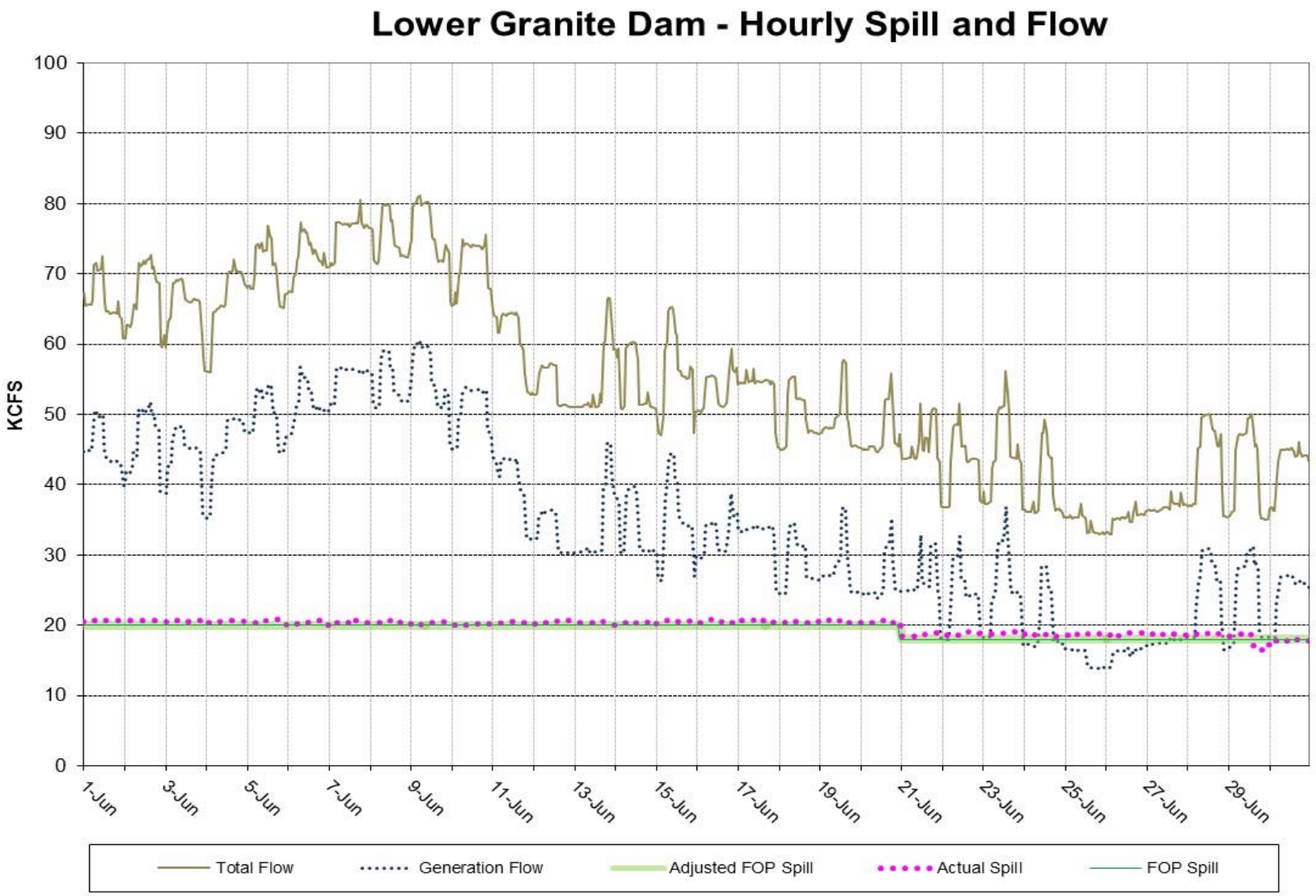

Lower Granite Dam - Hourly Spill and Flow
KCFS
100
90
80
70
60
50
40
30
20
10
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 2

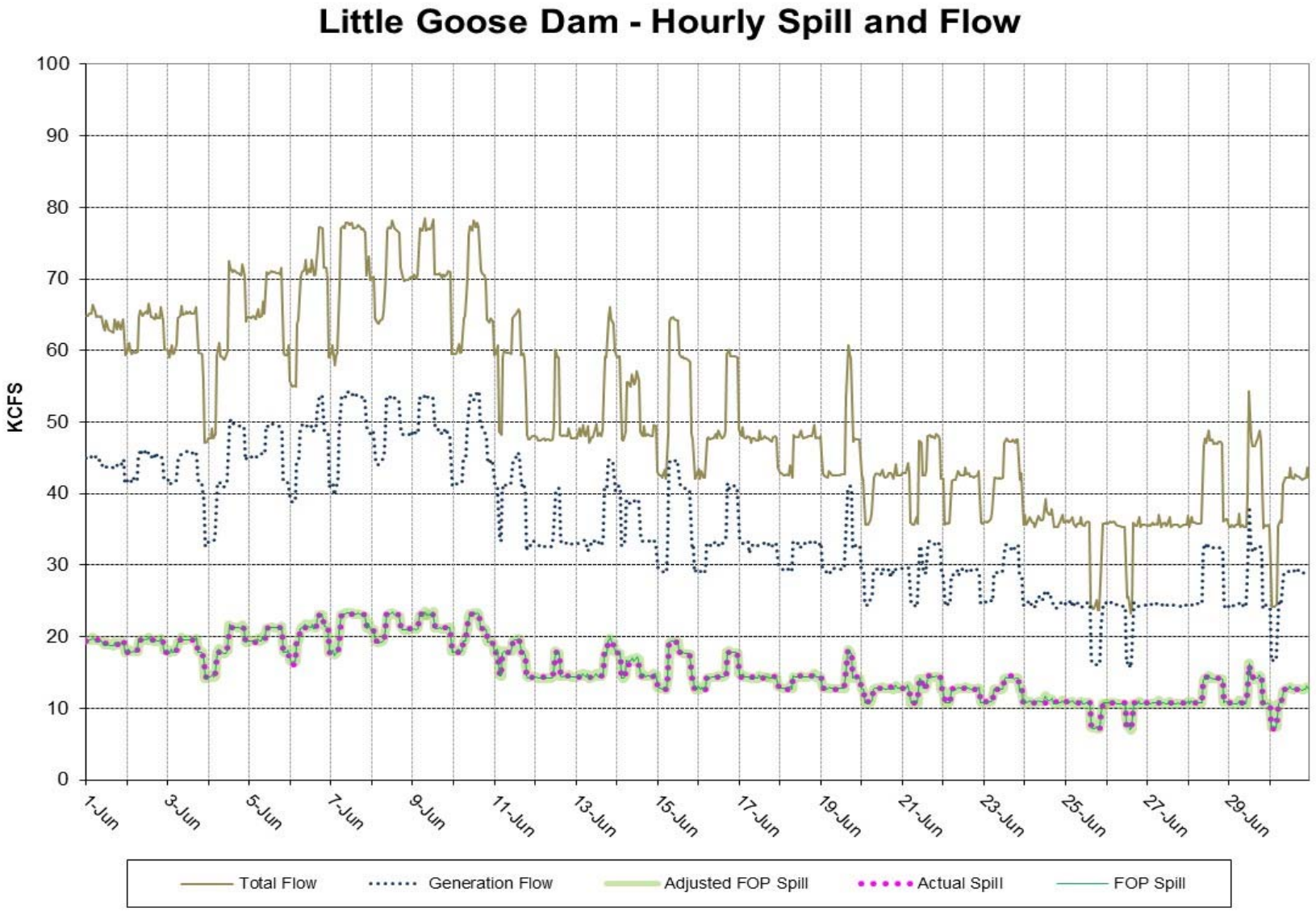

Little Goose Dam - Hourly Spill and Flow
KCFS
100
90
80
70
60
50
40
30
20
10
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 3

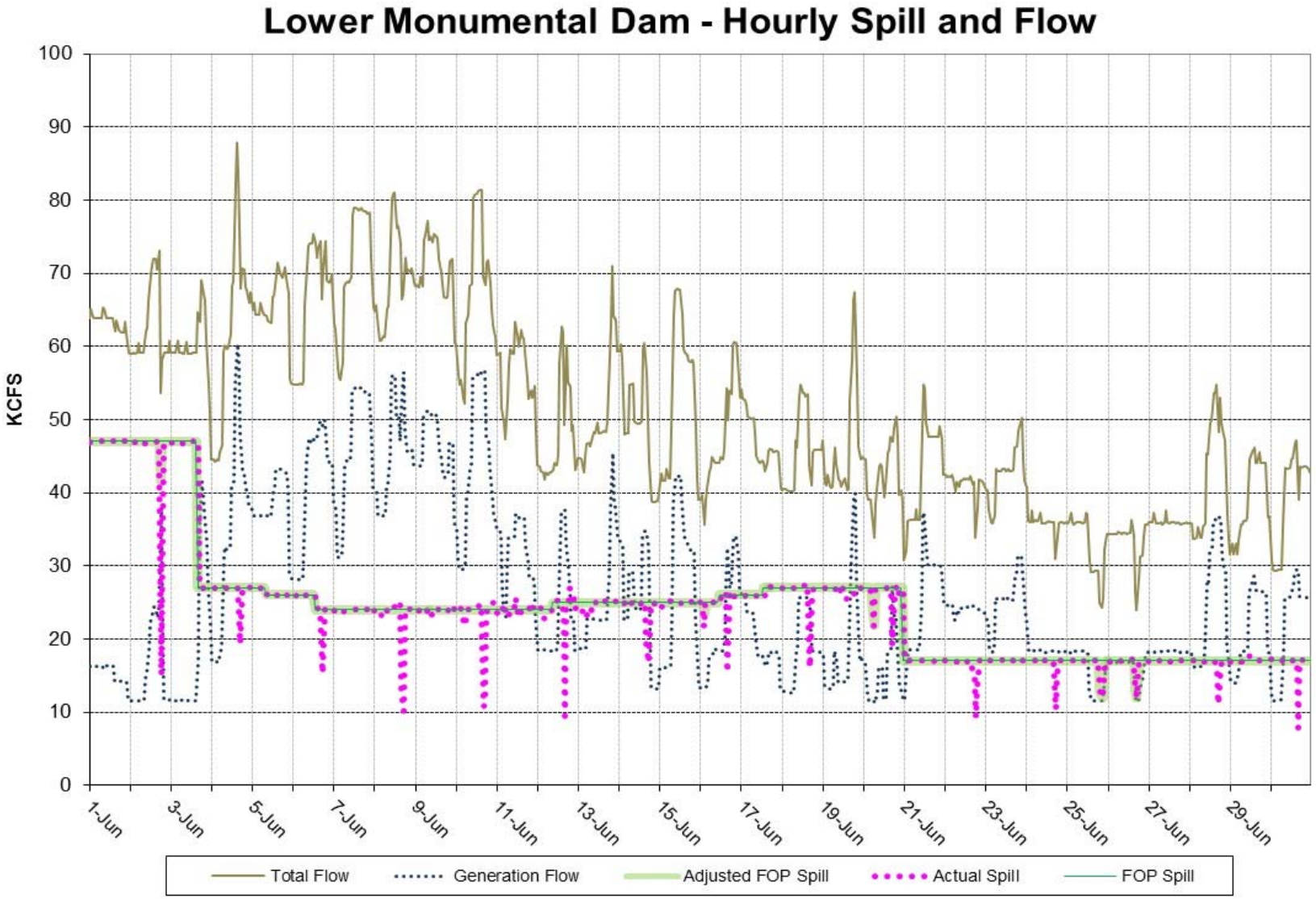

Lower Monumental Dam - Hourly Spill and Flow
KCFS
100
90
80
70
60
50
40
30
20
10
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 4

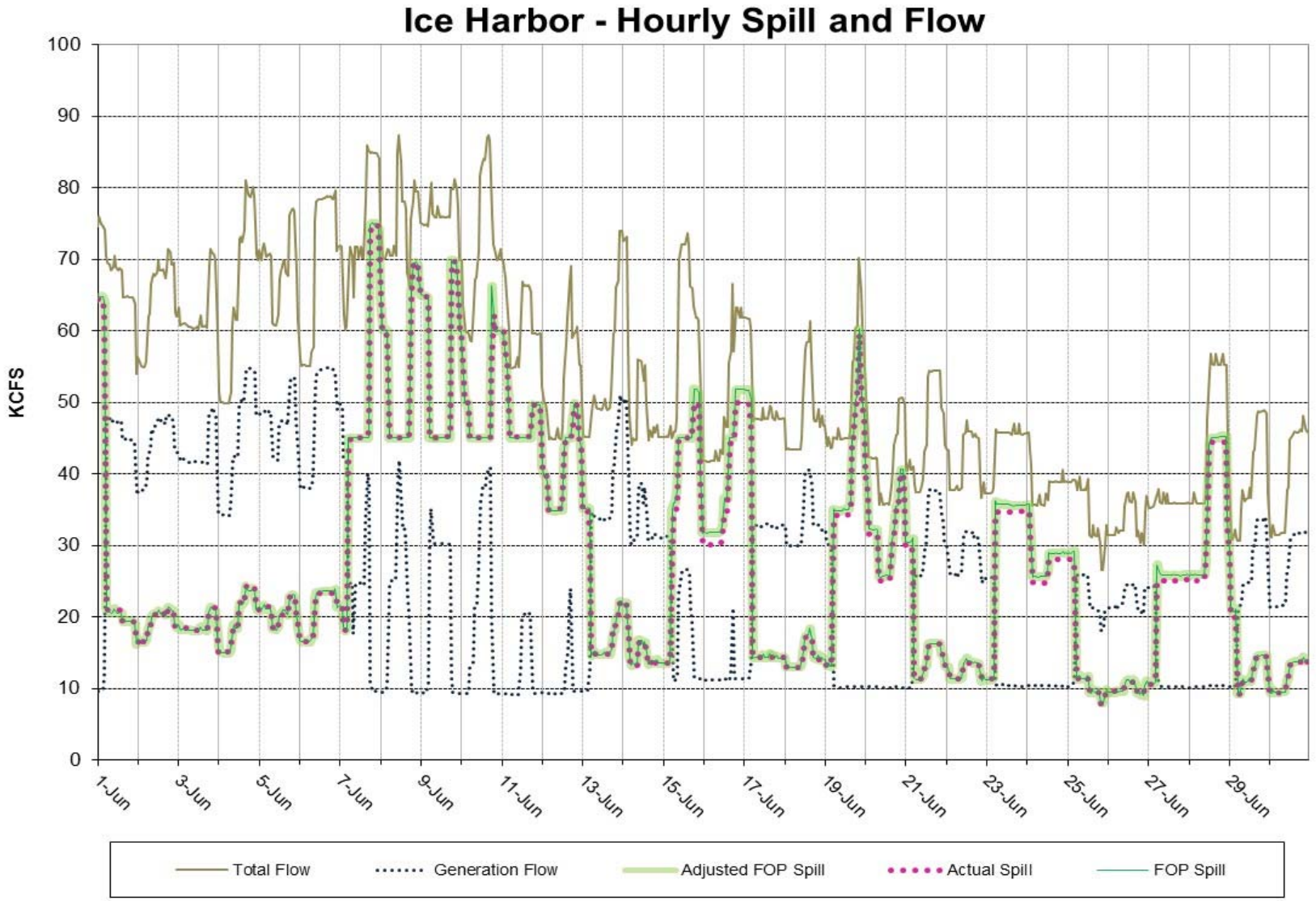

Ice Harbor - Hourly Spill and Flow
KCFS
100
90
80
70
60
50
40
30
20
10
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 5

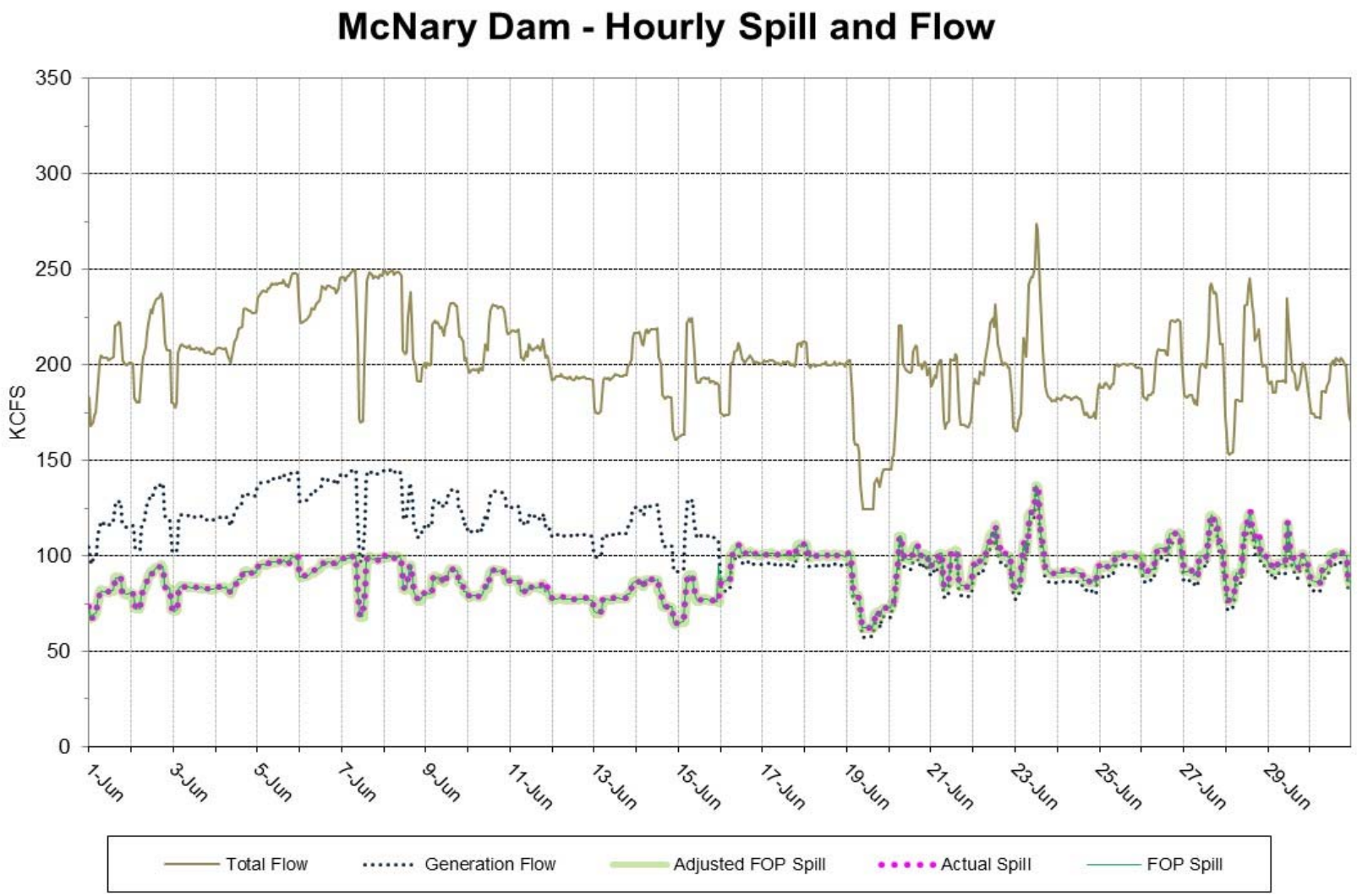

McNary Dam - Hourly Spill and Flow
KCFS
350
300
250
200
150
100
50
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 6

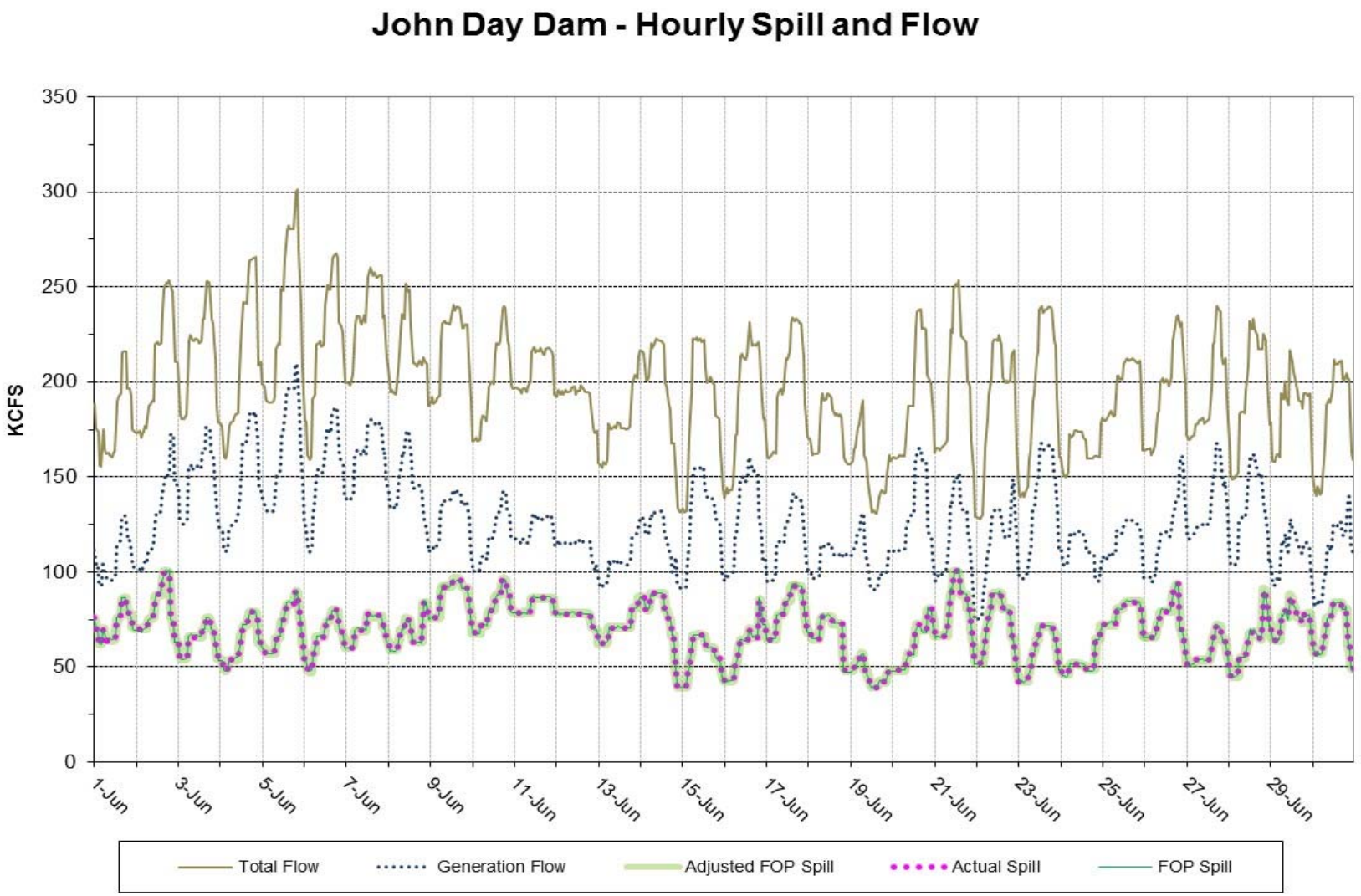

John Day Dam - Hourly Spill and Flow
KCFS
350
300
250
200
150
100
50
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 7

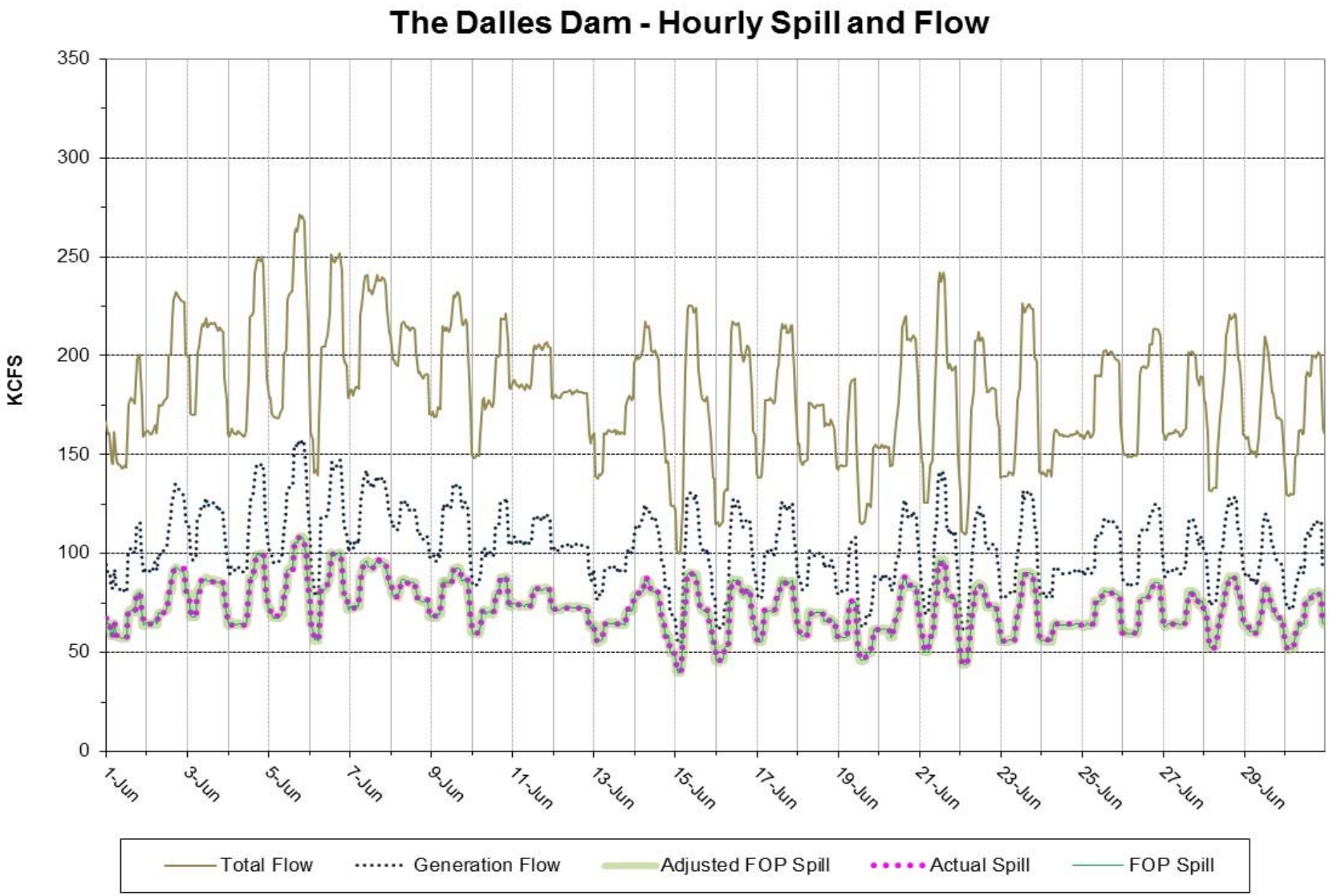
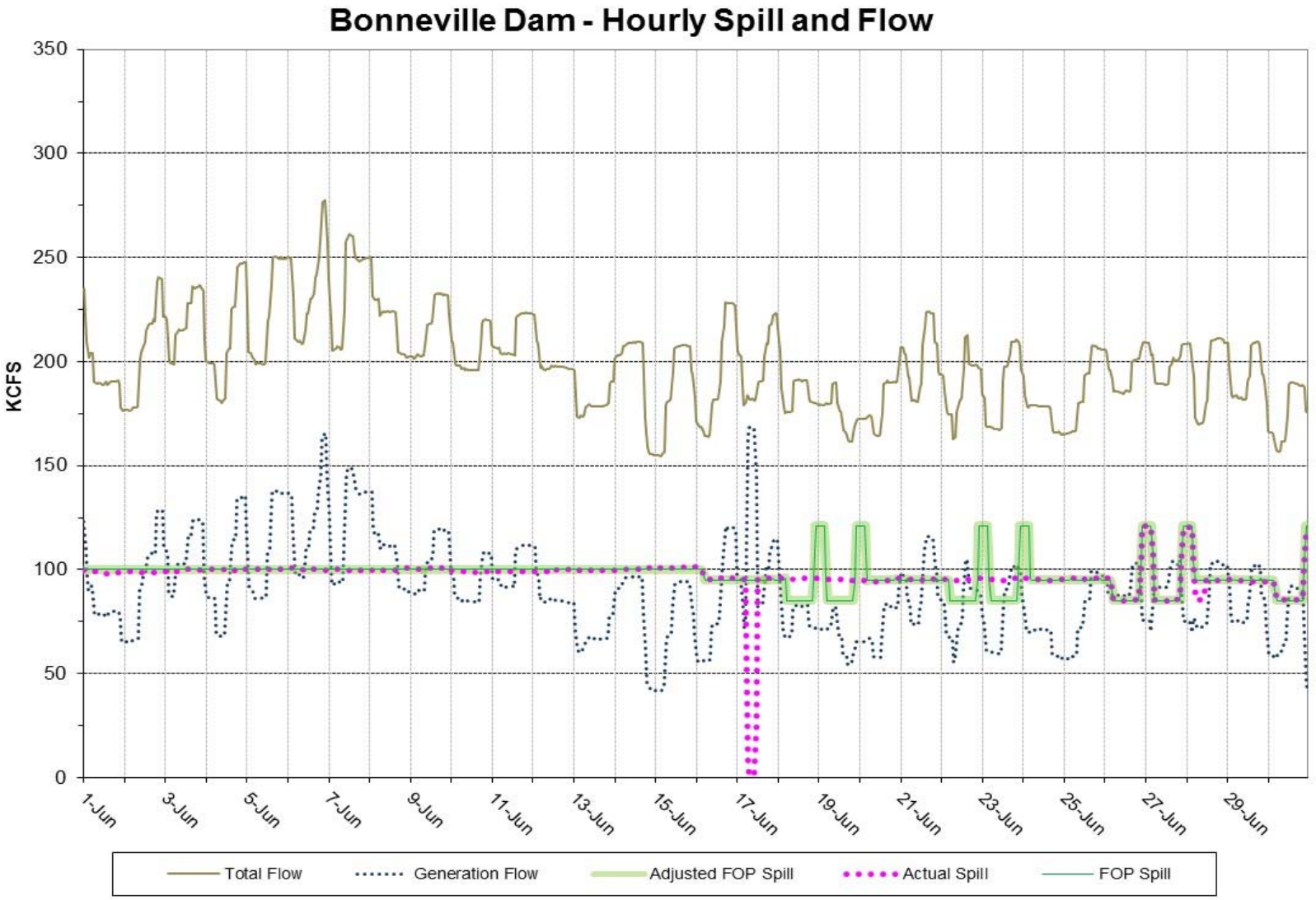

The Dalles Dam - Hourly Spill and Flow
KCFS
350
300
250
200
150
100
50
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 8


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