

**Appendix D5**  
**Estimated Conditions for**  
**Flow-Dependent Ecological Systems**

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# Appendix D5 — Estimated Conditions for Flow-Dependent Ecological Systems

## 1.0 Introduction

The Nature Conservancy (TNC) developed approximations of flow conditions to support ecological systems for the Yampa River near Maybell, Colorado (Maybell), Yampa River near Deerlodge Park, Colorado (Deerlodge Park), and the Little Snake River near Lily, Colorado (Lily). These quantifications are based on TNC's interpretation of how the Yampa River Programmatic Biological Opinion (PBO) (U.S. Fish and Wildlife Service [USFWS], 2005) could be expanded to quantify flow conditions for the full flow regime for Maybell and two additional locations in the Yampa River Basin: Deerlodge Park and Lily. It should be noted that these quantifications are not required under the PBO.

Additionally, TNC developed approximations of flow conditions to support ecological systems at White River near Watson, Utah. These quantifications include estimated flow conditions based on USFWS flow recommendations that are currently under development through the Upper Colorado River Endangered Fish Recovery Program.

The methodology section describes how the monthly flow conditions were quantified, and the results of these quantifications are presented in the section on estimated flow conditions.

## 2.0 Methodology

### 2.1 Yampa River Basin

The PBO covers specified levels of future increases in water use through 2045 within the Yampa River Basin. The methodology described here assumes that depletions from the Yampa River expand to these levels by the year 2045. The range of simulated future flows in the river, assuming historical hydrology and the specified future depletions, are the basis for computing the estimated flows for ecological systems. The additional depletions specified in the PBO include 23,428 acre-feet (af) above Lily and 30,104 af above Maybell, for a total of 53,532 af above Deerlodge Park. The year-round flows are estimated for the entire Yampa River Basin (at the Maybell, Lily and Deerlodge Park gages), while ensuring that the base flow target at Maybell (USFWS, 2008) is met. The method used to develop the estimated flow targets is detailed below.

TNC used the 2009 update to the State of Colorado's Statemod<sup>1</sup> model to simulate future flows within the Yampa River Basin which formed the basis of estimating the year-round flows for ecological systems. The model was run using data representing the depletions specified in the PBO (2045-level demands) and assumed future flows according to the historical 84-year period 1922 to 2005<sup>2</sup> to simulate flows in the year 2045. The following steps were then taken to develop flow targets based on model results from the Statemod simulations:

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<sup>1</sup> Statemod is the State of Colorado's surface water allocation and accounting model.

<sup>2</sup> Statemod results are sensitive to the chosen period of record, and as such, any resulting estimated flow condition would require further analysis to quantify this sensitivity.

1. Sum all simulated monthly flows in 2045 at Deerlodge to compute annual total volumes. Rank the annual volumes to determine the probability of exceedance and classify each year as shown in table D5-1. The years are separated by exceedance level to allow the flow targets to vary based on hydrologic year type.

TABLE D5-1  
Probability of Exceedance

Year Type	Probability of Exceedance
Wet	0–10%
Moderately Wet	10–30%
Average	30–70%
Moderately Dry	70–90%
Dry	90–100%

2. Retrieve the simulated shortages in 2045 above each gage.
3. Adjust the simulated flow in 2045 to assume no shortages will occur (for each month at each gage) as: 2045 simulated flow at the gage minus the 2045 shortage from (2) above the gage<sup>3</sup>. Adjusted flow must be > 0.
4. Further adjust monthly flows computed in (3) to ensure that base flows at Maybell are at least equal to 120 cubic feet per second<sup>4</sup>.
5. Average all simulated then further adjusted flows (4) within a given year type, then aggregate the April through July flows to a total runoff-season target. Targets for a particular month do not always increase from dry to wet year types due to the elimination of negatives in (3).

## 2.2 White River

The Upper Colorado River Endangered Fish Recovery Program is in the process of developing flow recommendations for the White River near Watson, Utah. The current draft flow recommendations include daily targets. These draft recommendations were aggregated to monthly flow targets consistent with methods used for the monthly approximations of daily recommendations for the threatened and endangered species attribute of interest appendix D3.

## 3.0 Estimated Flow Conditions

The monthly estimated flow conditions for Maybell, Lily, and Deerlodge Park are presented in tables D5-2, D5-3, and D5-4, respectively. Table D5-5 lists the targets for the White River near Watson. The purpose of aggregating the April through July flow targets was to capture the runoff volume in one target value.

<sup>3</sup> Shortages are subtracted to follow the assumption in the PBO that they will be satisfied in 2045 and decrease the remaining flow.

<sup>4</sup> See appendix D3 for the simplification of the base flow targets at Maybell. The base flow targets at Maybell are assumed to extend downstream to Deerlodge Park in this quantification.

TABLE D5-2  
Estimated Flow Conditions (af) for the Yampa River near Maybell, Colorado

Category Exceedance	Dry 90–100%	Moderately Dry 70–90%	Average 30–70%	Moderately Wet 10–30%	Wet 0–10%
<b>January</b>	9,248	10,915	13,635	14,374	22,341
<b>February</b>	13,489	13,684	16,243	16,548	25,824
<b>March</b>	25,180	40,997	36,046	44,670	73,206
<b>April–July</b>	368,981	604,472	870,646	1,179,492	1,458,585
<b>August</b>	7,379	7,379	8,438	16,316	31,482
<b>September</b>	7,141	7,141	7,141	7,141	23,472
<b>October</b>	8,320	13,101	15,444	17,028	31,916
<b>November</b>	11,895	15,588	16,541	16,913	30,254
<b>December</b>	8,580	12,960	14,819	15,687	22,470

TABLE D5-3  
Estimated Flow Conditions (af) for the Little Snake River near Lily, Colorado

Category Exceedance	Dry 90–100%	Moderately Dry 70–90%	Average 30–70%	Moderately Wet 10–30%	Wet 0–10%
<b>January</b>	2,758	3,983	5,330	6,065	7,823
<b>February</b>	4,121	5,236	6,054	7,517	10,938
<b>March</b>	12,416	22,196	19,732	26,924	33,688
<b>April–July</b>	100,287	199,559	318,873	444,742	530,698
<b>August</b>	564	1,146	2,386	2,240	6,320
<b>September</b>	361	900	1,230	2,277	6,492
<b>October</b>	1,288	3,824	6,145	7,635	11,981
<b>November</b>	3,813	4,833	7,170	8,469	11,153
<b>December</b>	3,752	4,809	6,258	7,155	8,399

TABLE D5-4  
Estimated Flow Conditions (af) for the Yampa River near Deerlodge Park, Colorado

Category Exceedance	Dry 90–100%	Moderately Dry 70–90%	Average 30–70%	Moderately Wet 10–30%	Wet 0–10%
<b>January</b>	11,861	13,865	17,671	19,068	31,769
<b>February</b>	17,891	17,449	21,844	22,255	39,675
<b>March</b>	34,061	56,019	49,568	61,300	118,118
<b>April–July</b>	457,535	772,084	1,150,079	1,570,554	1,993,638
<b>August</b>	7,379	7,379	11,635	22,697	44,258
<b>September</b>	7,141	7,141	7,141	8,248	29,901
<b>October</b>	11,900	18,890	21,818	24,363	44,280
<b>November</b>	16,910	21,537	23,487	24,244	44,678
<b>December</b>	12,307	17,989	20,964	22,272	32,739

TABLE D5-5  
Estimated Flow Conditions (af) for the White River near Watson, Utah

Category Exceedance	Dry 90–100%	Moderately Dry 70–90%	Average 30–70%	Moderately Wet 10–30%	Wet 0–10%
<b>January</b>	18,447	18,453	19,051	22,605	25,365
<b>February</b>	16,661	19,128	18,656	25,483	28,397
<b>March</b>	18,447	21,521	24,595	30,744	36,777
<b>April–July</b>	120,233	203,189	237,841	362,771	503,589
<b>August</b>	12,348	19,005	21,916	30,437	36,893
<b>September</b>	16,618	18,926	19,122	27,537	35,703
<b>October</b>	18,447	21,521	22,608	30,623	35,860
<b>November</b>	17,852	20,803	20,377	27,409	32,372
<b>December</b>	18,284	18,797	18,878	24,223	25,021

## 4.0 References

- U.S. Fish and Wildlife Service (USFWS). 2005. *Final Programmatic Biological Opinion on the Management Plan for Endangered Fishes in the Yampa River Basin.*
- U.S. Fish and Wildlife Service (USFWS). 2008. *Rationale for Management of Water Releases from the Elkhead Reservoir Endangered Fish Pool to Augment August-October Base Flows in the Yampa River.*