TZA Water Engineers, Inc.

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MEMORANDUM

To: Ron McLaughlin **DRAFT**

From: John Faux

Date: March 20, 2012

Re: Modeled Outflow from Proposed Trout Creek Reservoir

Monthly inflow to and outflow from proposed Trout Creek Reservoir (aka Energy Fuels Reservoir No. 2) was estimated using a spreadsheet analysis combined with selected outputs from the Yampa River Basin Water Resources Planning Model (built using StateMod).

Trout Creek Reservoir was granted a conditional decree in Case No. W-1256-77. This reservoir is planned for construction on Trout Creek, just upstream of its confluence with Fish Creek and about four miles upstream of the Yampa River.

Components of Analysis

The Yampa River Model built for the Colorado Decision Support Systems used a correlation factor of 0.307 to convert Elk River at Clark flows to Trout Creek flows at Trout Creek Reservoir. Analysis by TZA Water Engineers in 2010 indicated that streamflows on Trout Creek are less than the amount included in the CDSS work. Recent work by TZA applying regional analysis to 14 nearby USGS gages indicated that a more accurate conversion factor is about 0.105 (see TZA dated March 20, 2012 regarding Revised Estimate of Runoff on Trout Creek).

A spreadsheet model was used to estimate inflow and outflow from Trout Creek Reservoir based on the 0.105 conversion factor applied to Elk River at Clark streamflows as tabulated in the Yampa River model. From the Trout Creek virgin flows thereby estimated, the spreadsheet model subtracted consumptive uses on Trout Creek upstream of Trout Creek Reservoir as modeled by the Yampa River Model.

The Trout Creek Reservoir was modeled with a capacity of 13,560 acre-feet. Evaporation was modeled at the following average monthly volumes (in acre-feet) as estimated in the June 2010 modeling performed by TZA Water Engineers.

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
98	0	0	0	0	47	117	220	314	307	225	193	1,520

A fully consumptive water demand of 500 acre-feet per month, year-round, was applied to Trout Creek Reservoir for use by Peabody. Downstream demands, averaging 224 acre-feet per year, associated with senior downstream water rights, as estimated in the June 2010 TZA modeling, were also included.

Results of Modeling

Table 1 summarizes modeled inflow to Trout Creek Reservoir. Table 2 summarizes modeled outflow from Trout Creek Reservoir. Figure 1 shows the modeled end-of-month reservoir contents. Figure 2 illustrates the probability of exceedance for the rate of monthly outflow from the reservoir.

Table 1 - Trout Creek Reservoir Modeled Inflows (AF)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1950	378	445	450	373	384	368	1,675	5,504	10,187	2,189	220	138	22,310
1951	168	323	388	340	236	326	1,107	6,710	6,994	3,025	444	0	20,061
1952	364	321	335	308	243	266	1,802	9,457	10,880	1,702	559	18	26,255
1953	99	208	201	227	214	329	859	3,919	7,951	1,323	136	0	15,466
1954	0	264	245	256	268	291	1,786	4,747	2,610	440	195	247	11,349
1955	421	306	289	251	209	366	2,075	5,938	5,314	1,093	263	0	16,524
1956	259	306	327	320	277	476	2,722	9,014	7,289	1,139	345	0	22,475
1957	64	270	260	255	229	309	636	6,090	13,194	7,176	1,424	261	30,167
1958	479	433	433	401	358	374	910	10,206	7,788	649	0	153	22,185
1959	159	267	284	254	219	263	738	4,746	7,087	896	266	265	15,445
1960	840	603	335	333	309	451	2,883	5,595	7,073	940	78	50	19,492
1961	229	286	220	208	189	344	643	4,664	4,735	359	0	1,019	12,896
1962	1,318	796	589	446	420	372	4,296	8,837	7,739	2,699	207	0	27,718
1963	269	298	262	271	268	325	981	5,471	4,368	314	200	0	13,027
1964	0	224	173	192	204	230	452	6,350	7,412	2,139	277	0	17,653
1965	0	213	252	269	243	2,802	896	6,954	11,363	4,505	1,096	731	29,324
1966	666	266	550	126	467	728	2,170	6,211	3,499	477	56	0	15,218
1967	196	299	250	264	488	554	991	5,640	8,604	3,162	135	0	20,584
1968	271	351	480	90	334	435	595	4,224	9,964	2,497	560	7	19,807
1969	391	472	723	268	449	703	2,318	8,533	5,649	1,698	385	657	22,245
1970	146	453	542	509	14	406	652	7,765	10,733	3,672	492	278	25,661
1971	721	425	610	677	153	784	1,758	6,842	11,193	3,465	394	171	27,194
1972	393	489	651	236	446	894	1,282	5,554	6,552	504	30	169	17,200
1973	390	392	638	172	360	490	781	6,814	7,779	2,895	342	0	21,052
1974	0	403	560	144	615	457	1,417	11,619	8,243	874	177	0	24,507
1975	0	286	480	122	324	518	713	6,233	11,027	5,752	729	0	26,186
1976	6	381	549	304	171	569	1,429	5,640	4,583	1,202	56	0	14,891
1977	27	289	99	486	307	268	1,068	1,727	1,759	67	162	14	6,273
1978	236	380	294	201	217	360	1,442	7,218	14,128	5,521	546	91	30,633
1979	251	310	326	300	166	260	1,125	7,641	8,991	3,262	478	43	23,154
1980	320	307	339	264	324	304	833	8,577	10,488	2,480	253	94	24,582
1981	247	362	301	311	321	392	1,046	2,955	3,625	342	0	0	9,902
1982	539	403	544	320	392	600	1,652	7,298	9,503	5,992	1,429	854	29,527
1983	842	848	527	465	407	721	990	6,064	13,485	6,391	1,135	434	32,310
1984	908	937	648	504	374	181	813	12,391	12,549	6,375	1,071	709	37,459
1985	770	470	630	666	307	200	3,439	9,254	7,308	1,441	0	136	24,620
1986	640	484	713	586	377	595	3,976	8,995	12,813	3,967	905	698	34,747
1987	1,101	731	530	611	406	322	2,172	3,844	2,256	296	135	345	12,748
1988	344	400	424	422	394	289	1,491	6,077	6,500	591	0	0	16,933
1989	0	374	405	295	364	609	2,333	3,903	2,920	198	0	27	11,428
1990	124	326	355	349	314	395	2,165	3,432	6,232	791	0	0	14,484
1991	239	237	178	360	250	493	790	5,651	6,659	579	310	125	15,871
1992	181	398	304	422	381	713	1,520	5,071	2,406	934	79	0	12,409
1993	368	436	447	456	373	674	1,694	9,354	9,764	3,336	236	181	27,318
1994	451	402	437	423	380	894	1,794	5,334	2,801	0	77	0	12,995
1995	310	311	295	368	181	725	942	7,521	13,918	7,819	831	348	33,570
1996	425	580	461	526	483	723	1,906	8,907	9,528	2,531	106	299	26,474
1997	403	559	514	549	391	1,013	1,648	10,031	13,878	3,134	1,159	1,651	34,930
1998	1,244	743	554	617	556	1,332	1,771	7,444	7,487	3,209	453	79	25,489
1999	373	545	456	534	428	1,019	2,179	7,915	8,792	2,319	329	227	25,114
2000	331	331	454	502	381	670	2,436	8,815	4,454	122	0	92	18,588
2001	210	320	416	397	411	739	1,948	8,845	3,340	0	0	0	16,625
2002	307	309	402	386	305	563	1,294	3,386	2,028	0	0	7	8,988
2003	276	390	267	400	362	648	2,385	9,067	7,373	1,059	181	0	22,406
2004	87	360	389	419	347	1,195	1,798	4,913	3,453	886	0	346	14,193
2005	636	596	534	553	336	663	2,252	7,721	9,354	2,050	263	0	24,958
Average	365	409	416	363	327	571	1,598	6,761	7,636	2,187	343	196	21,172
Max	1,318	937	723	677	615	2,802	4,296	12,391	14,128	7,819	1,429	1,651	37,459
Min	0	208	99	90	14	181	452	1,727	1,759	0	0	0	6,273

Table 2 - Trout Creek Reservoir Modeled Outflow (AF)
Peabody Downstream Demand = 500 AF/month

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1950	500	500	500	500	500	500	500	500	6,409	1,882	500	500	13,290
1951	500	500	500	500	500	500	500	4,556	6,680	2,718	500	500	18,454
1952	500	500	500	500	500	500	500	8,141	10,566	1,395	500	500	24,602
1953	500	500	500	500	500	500	500	1,234	7,637	1,016	500	500	14,387
1954	500	500	500	500	500	500	500	2,593	2,296	500	1,279	500	10,668
1955	500	500	500	500	500	500	500	3,751	5,000	786	500	500	14,037
1956	500	500	500	500	500	2,186	500	6,880	6,975	832	500	500	20,873
1957	500	500	500	500	500	500	500	3,058	12,880	6,869	1,199	500	28,005
1958	500	500	500	500	500	500	500	9,181	7,475	500	878	500	22,033
1959	500	500	500	500	500	500	500	1,149	6,773	589	500	1,057	13,569
1960	500	500	500	500	500	500	1,049	5,376	6,760	633	776	692	18,286
1961	500	500	500	500	500	500	500	1,044	4,421	500	584	500	10,549
1962	500	584	589	500	500	1,845	2,524	8,618	7,425	2,392	500	640	26,616
1963	500	500	500	500	500	500	500	2,812	4,054	500	1,165	641	12,673
1964	501	500	500	500	500	500	500	1,325	7,098	1,832	500	500	14,756
1965	500	500	500	500	500	500	500	6,506	11,050	4,198	871	537	26,662
1966	568	500	500	500	500	500	1,644	5,992	3,186	500	975	507	15,871
1967	500	500	500	500	500	500	500	2,527	8,291	2,855	500	500	18,173
1968	500	500	500	500	500	500	500	1,515	9,650	2,190	500	500	17,856
1969	500	500	500	500	500	500	1,210	8,313	5,335	1,391	500	500	20,250
1970	500	500	500	500	500	500	500	6,129	10,419	3,365	500	500	24,412
1971	500	500	500	500	500	500	1,219	6,623	10,880	3,158	500	500	25,879
1972	500	500	500	500	500	500	500	5,110	6,238	500	500	500	16,348
1973	500	500	500	500	500	500	500	4,533	7,466	2,588	500	500	19,086
1974	500	500	500	500	500	500	500	10,156	7,929	567	500	500	23,152
1975	500	500	500	500	500	500	500	3,454	10,714	5,445	504	500	24,117
1976	500	500	500	500	500	500	500	4,375	4,269	895	500	500	14,039
1977	500	500	810	500	500	500	500	500	500	502	1,182	743	7,237
1978	500	500	500	500	500	500	500	2,521	13,814	5,214	500	500	26,048
1979	500	500	500	500	500	500	500	5,617	8,677	2,955	500	819	22,068
1980	500	500	500	500	500	500	500	6,072	10,174	2,173	500	500	22,918
1981	500	500	500	500	500	500	500	883	3,311	500	550	561	9,305
1982	500	500	500	500	500	500	500	5,772	9,190	5,685	1,204	661	26,012
1983	745	848	527	500	500	546	873	5,844	13,171	6,084	910	500	31,049
1984	550	937	648	504	500	500	500	11,875	12,236	6,068	846	515	35,679
1985	672	500	599	666	500	500	2,782	9,034	6,994	1,134	500	500	24,382
1986	500	500	500	500	500	500	2,826	8,775	12,499	3,660	680	504	31,945
1987	1,003	731	530	611	500	500	1,735	3,625	1,942	500	500	500	12,677
1988	500	500	500	500	500	500	500	4,412	6,186	500	500	500	15,598
1989	551	500	500	500	500	500	500	2,616	2,606	500	500	687	10,461
1990	500	500	500	500	500	500	500	1,292	5,919	500	1,092	500	12,802
1991	500	500	500	500	500	500	500	2,190	6,345	500	500	500	13,535
1992	500	500	500	500	500	500	500	3,797	2,092	627	965	672	11,653
1993	500	500	500	500	500	500	500	7,843	9,450	3,029	500	500	24,822
1994	500	500	500	500	500	500	520	5,115	2,487	500	1,188	529	13,338
1995	500	500	500	500	500	500	500	3,809	13,604	7,512	606	500	29,531
1996	500	500	500	500	500	500	1,497	8,688	9,214	2,224	500	500	25,622
1997	500	500	500	500	500	500	802	9,811	13,564	2,827	934	1,457	32,396
1998	1,146	743	554	617	556	1,286	1,654	7,225	7,173	2,902	500	872	25,228
1999	500	500	500	500	500	500	1,012	7,695	8,478	2,012	500	500	23,197
2000	500	500	500	500	500	500	980	8,596	4,141	500	794	500	18,510
2001	500	500	500	500	500	500	500	7,000	3,026	500	756	500	15,282
2002	500	500	500	500	500	500	500	500	1,705	568	668	842	7,783
2003	500	500	500	500	500	500	500	7,016	7,059	752	1,359	722	20,407
2004	500	500	500	500	500	500	500	3,207	3,140	579	943	500	11,869
2005	500	500	500	500	500	500	792	7,502	9,040	1,743	500	565	23,143
Average	531	524	514	507	501	569	770	5,076	7,243	2,024	686	575	19,520
Max	1,146	937	810	666	556	2,186	2,826	11,875	13,814	7,512	1,359	1,457	35,679
Min	500	500	500	500	500	500	500	500	500	500	500	500	7,237

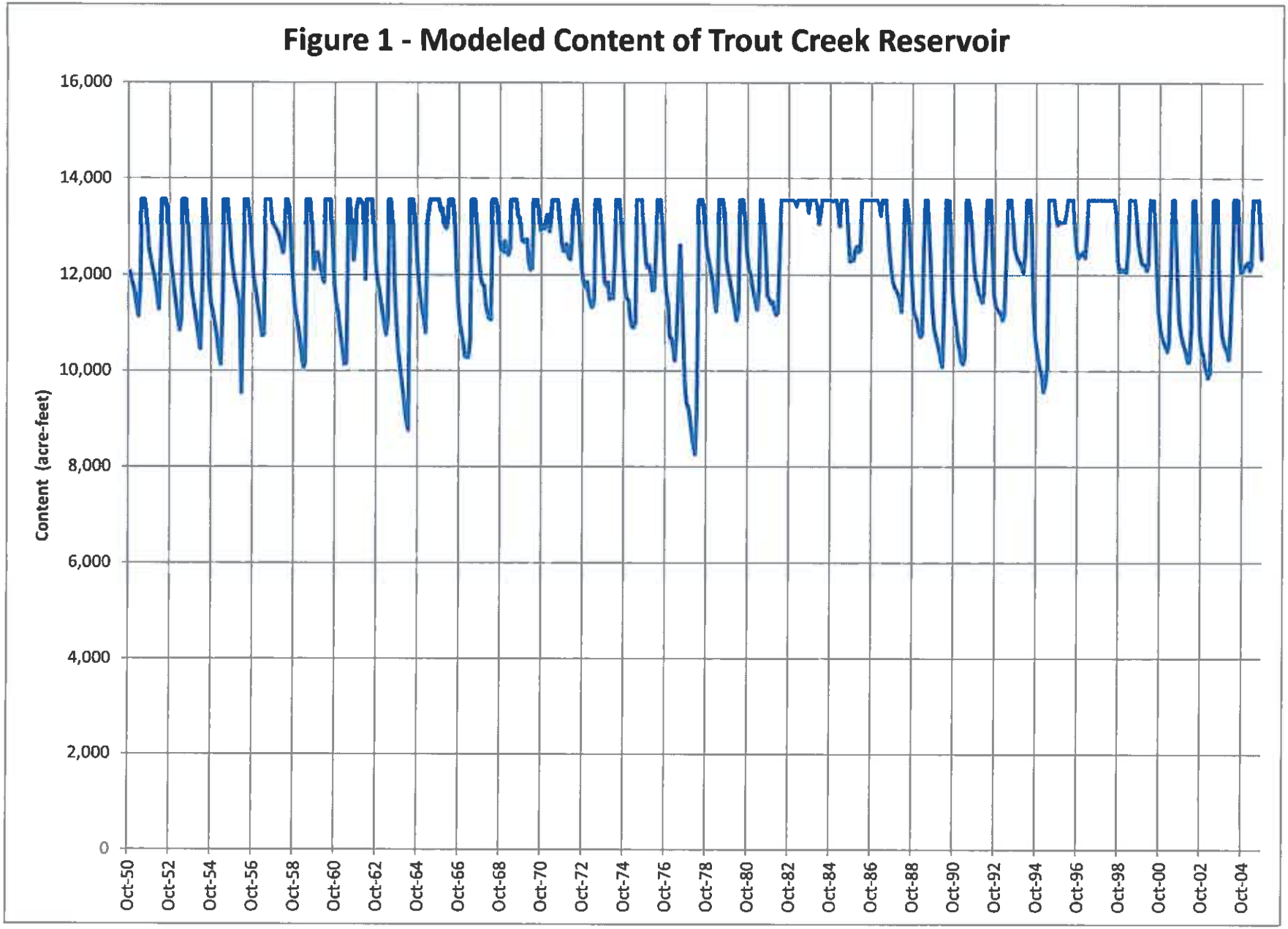
Figure 1 - Modeled Content of Trout Creek Reservoir
Content (acre-feet)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Oct-50
Oct-52
Oct-54
Oct-56
Oct-58
Oct-60
Oct-62
Oct-64
Oct-66
Oct-68
Oct-70
Oct-72
Oct-74
Oct-76
Oct-78
Oct-80
Oct-82
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Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04

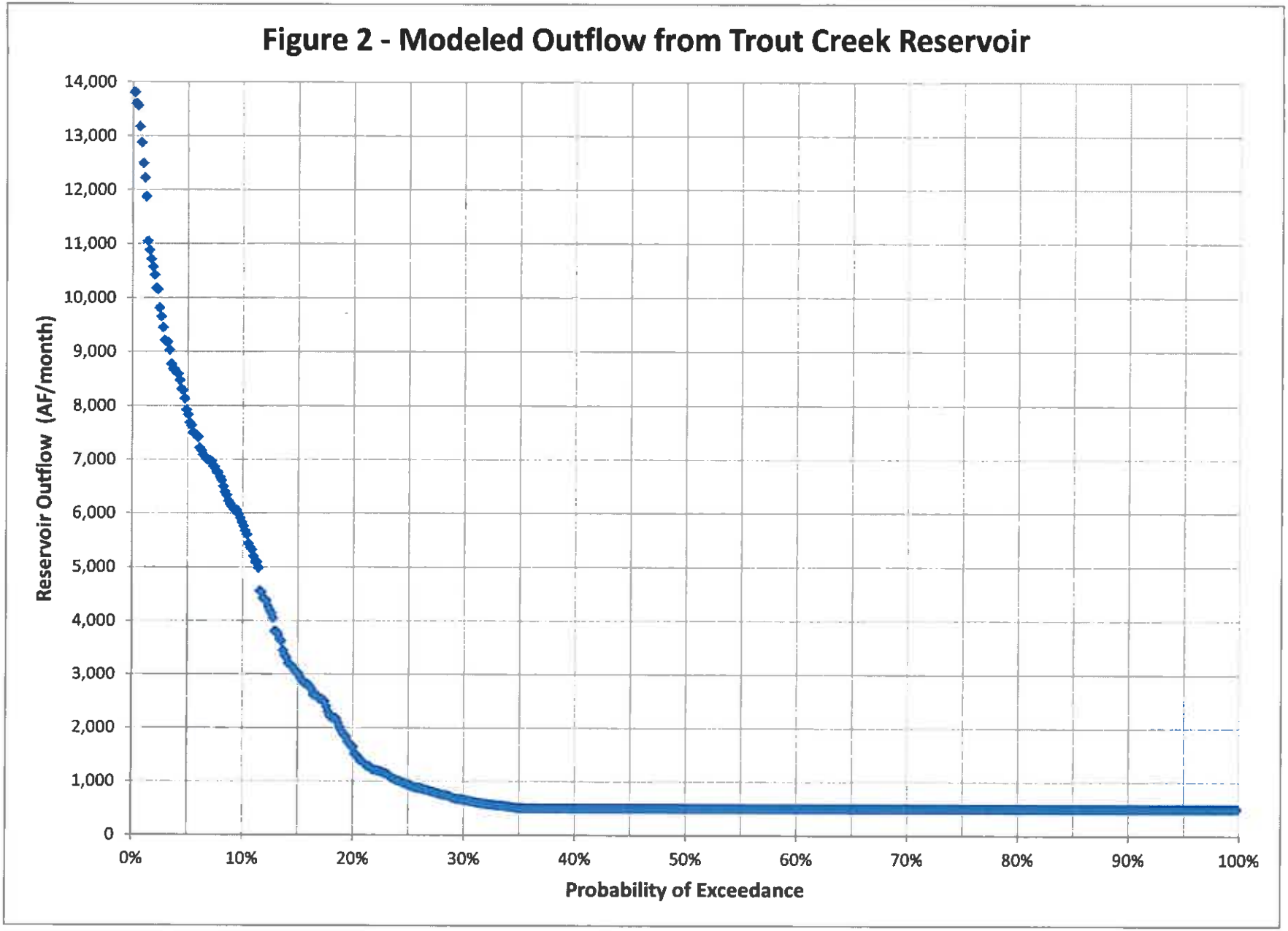
Figure 2 - Modeled Outflow from Trout Creek Reservoir
Reservoir Outflow (AF/month)
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Probability of Exceedance