"Analysis of Water Consumption Associated with Hydroelectric Power Generation in the United States"

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Abstract

Hydroelectric power generation constituted approximately 6% of the electricity generation in the United States in 2013. Hydropower generation often requires the creation of an artificial reservoir and an associated evaporative flux to the atmosphere that consumes water resources that might otherwise have been used downstream in river networks. The impact of hydropower generation on the hydrologic cycle and water resource consumption was analyzed using data for all hydropower producing reservoirs in the United States. Hydropower facilities were divided into three categories—facilities generating power using the run-of-the-river, facilities generating power from artificial multipurpose reservoirs, and facilities generating power from artificial dedicated reservoirs. Water consumption in run-of-the-river facilities is negligible as they require no increased exposed water surface area. Water consumption in dedicated and multipurpose reservoirs was determined to consume 10.2 and 22.7 gallons per kWh of power produced, respectively. Water consumption in the multipurpose reservoirs was then allocated between hydropower and the other purposes by assuming similar water consumption requirements to dedicated facilities (10.2 gallons per kWh). A production-weighted average amongst the three categories was used to arrive at a final estimate of 9.85 gallons of water consumption on average in the United States to produce a kWh of electricity in hydroelectric power plants.

Introduction

Hydroelectric power plants supply a significant share of the electricity in the United States by capturing gravitational potential energy from the movement of water across land surfaces. Reservoirs created by the construction of hydroelectric dams possess a large exposed water surface area that generates an artificial evaporative flux to the atmosphere thereby consuming water that would otherwise flow downstream. Previous analysis of the water consumption associated with evaporation from these reservoirs concluded that over 18 gal of water are consumed per kWh of electricity generated versus 0.47 gal per kWh in thermoelectric power plants on average in the United States (Torcellini et al., 2003). Thermoelectric power plants represented 45% of the total water withdrawals in the United States in 2010 (Maupin et al., 2014). Despite having substantially higher water intensity than thermoelectric power generation, hydropower water consumption receives relative little attention in the literature. The reason for this lack of attention may be the perception of reservoirs as suppliers of water rather than consumers. However, in fully allocated river networks the construction of excess storage capacity may decrease regional water availability. Given the large quantities of water involved, a detailed investigation of the impact of hydropower generation on water resources is warranted.

Most attempts to quantify evaporation from reservoirs used to generate hydroelectricity have focused on individual facilities. Only a few attempts have been made previously to estimate and analyze water

consumption associated with hydropower generation at regional scale (Gleick, 1992; Torcellini et al., 2003). Torcellini et al. (2003) used average yearly pan evaporation data to estimate evaporation from individual reservoirs, which were then aggregated to compute a nationwide rate of 34.3 billion L of water per day from reservoirs used to produce hydroelectric power. Torcellini et al. (2003) combined the evaporation estimate with a net annual power generation of 179,082 kWh to arrive at a national average water consumption factor of 18.27 gal per kWh. This approach suffers several major shortcomings, however. Land surfaces consume water naturally through both evaporation of water directly and transpiration from indigenous vegetation. These combined processes are collectively termed evapotranspiration. The gross reservoir evaporation approach does not represent the anthropogenic increase in water flux to the atmosphere because it does not account for the background evapotranspiration on the land surface prior to dam construction as shown in Figure 1. The approach also fails to allocate the water consumption burden to other economically-beneficial purposes of reservoirs such as navigation, flood control, municipal water supply, irrigation, and recreation.

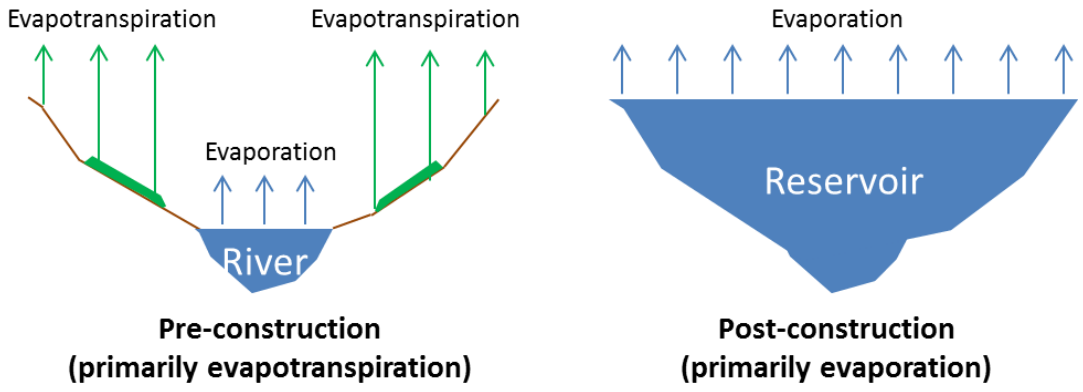

Figure 1. Net change in water resource availability due to reservoir construction.

Bakken et al. (2013) recently reviewed estimates of hydropower and criticized previous approaches for estimating hydropower water consumption based on the method of dividing gross evaporation by annual power generation. Some issues that were identified include inconsistent system boundaries, lack of allocation of water consumption burden amongst multiple purposes in multipurpose reservoirs, and attribution of water consumption in natural water bodies. Bakken et al. (2013) suggested subtracting the background evapotranspiration rate from the gross reservoir evaporation rate to appropriately account for the anthropogenic influence of the hydropower facility on the hydrologic cycle. Bakken et al. (2013) found only one study (Pasqualetti and Kelley, 2008) that allocated water consumption in a multipurpose reservoir. In that study, economic values of hydropower generation, recreation, agriculture, and municipal supply for Lake Powell were used to allocate 55%, 24%, 19%, and 2% of the water consumption burden to each purpose, respectively. Thus the majority of the economic value of the dam (and the associated environmental burden) was attributed to electricity generation.

Hydropower Water Consumption Estimation Methodology

Herein, an analysis of the water consumption associated with evaporation from reservoirs created for all hydroelectric dams in the United States is presented. Methodological approaches were developed to address the issues raised by Bakken et al. (2013). The net evaporation for each hydropower reservoir in United States was determined by subtracting the gross reservoir evaporation from the background evapotranspiration. The water consumption burden for multipurpose facilities was then allocated between hydropower and other purposes. Individual water consumption factors were developed using the water consumption per unit electricity generated. The nationwide average water consumption intensity was then computed using allocated water consumption and electricity generated for all facilities. The approach is summarized in Figure 2.

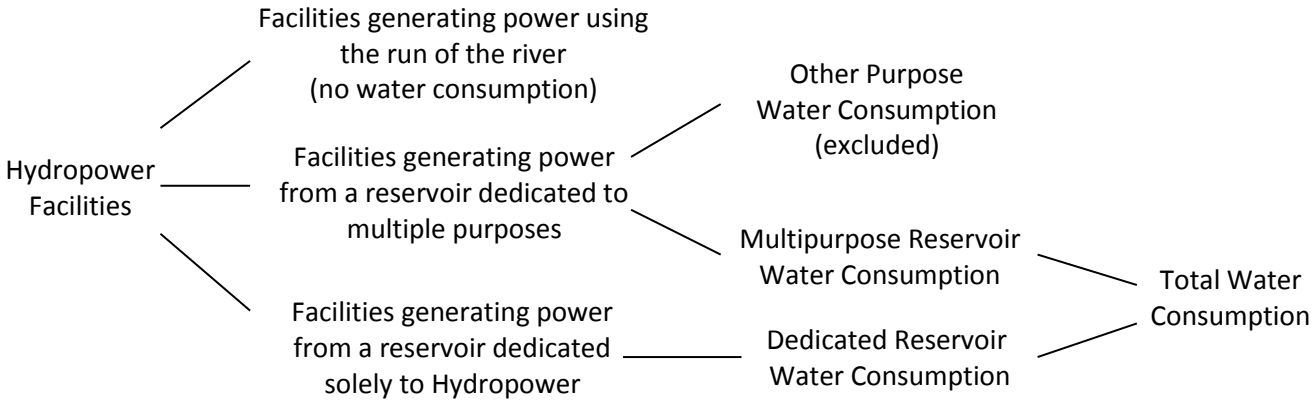

Figure 2. Hydropower Water Consumption Calculation Methodology

Hydropower Generation and Reservoir Data

Data for individual hydropower reservoirs in the United States were taken from two sources, the National Inventory of Dams (Army Corps of Engineers, 2013) (NID) and the Emissions & Generation Resource Integrated Database (Environmental Protection Agency, 2015) (eGRID). The NID lists the geographic location, average reservoir surface area, and purpose(s) for each dam including irrigation, hydroelectricity generation, flood control, navigation, water supply, recreation, fire protection, fish and wildlife protection, debris control, tailings control, and grade stabilization. The most recent eGRID database provides estimates of net annual power generation for all technologies including hydropower dams from the year 2010. As shown in Figure 2, for this analysis hydropower facilities in the United States were divided into three categories—facilities using the run of the river, facilities producing power from multipurpose reservoirs, and facilities producing power from reservoirs dedicated solely to hydropower. The run-of-the-river facilities listed in Table 1 produce power with no artificial reservoir and thus exhibit no water consumption burden. These facilities generate hydropower from natural

water bodies or had no surface area in the NID database. Water consumption per unit power generated was computed for each of the facilities utilizing multipurpose and dedicated reservoirs as described below.

Table 1: Run-of-the-River Hydropower Facilities and Generation

Facility	State	Power Generation (MWhr)
Trenton Falls	NY	140,691
Deerfield 3	MA	23,216
Deerfield 4	MA	22,678
Putts Bridge	MA	12,708
Robert Moses Niagara	NY	13,613,142
Saint Marys Falls	MI	164,569
Edison Sault	MI	117,959
J Strom Thurmond	SC	677,299
Thomson	MN	197,934
Cutler	UT	48,987
Tuxedo	NC	16,672
Turner Shoals	NC	14,736
Redbridge	MA	12,979
Radford	VA	3,080
Total		**15,066,650**

Gross Reservoir Evaporation Rates

Annual evaporation rates for reservoirs were estimated using pan evaporation data from a National Climate Data Center (NCDC) report previously used to produce a map of annual evaporation in the contiguous 48 states (Farnsworth et al., 1982). The study compiled annual pan evaporation at 40 select stations to represent climatic conditions across the 48 contiguous states using data from 1956-1970. The data are summarized in Table 2. The station data were assigned to individual states based on geographic proximity to determine state-level estimates of lake evaporation. In larger states with multiple stations such as California and Texas the values were averaged to generate a state-level evaporation rate. The assignments are shown in Table 2. The pan evaporation data were extended to lake evaporation estimates using a pan coefficient of 0.75 to account for excess heat absorption on the sides of the pan (Stanhill, 1976). The results appear in

Table 3.

Table 2: Compiled Annual Pan Evaporation Estimates (Farnsworth et al., 1982) and State Assignments

Station Name	Annual Pan Evaporation (in)	State Assignments

Station Name	Annual Pan Evaporation (in)	State Assignments
Fairhope 2NE, AL	50.97	AL, FL
Bartlett Dam, AZ	121.3	AZ
Bacus Ranch, CA	120.56	CA
Sacramento, CA	69.7	CA
Wagon Wheel Gap, CO	50.95	CO
Hartford, CT	42.52	CT, NJ, NH, VT
Tamiami Trail, FL	56.48	FL
Experiment, GA	64.65	GA, SC
Moscow, U of I, ID	45.25	ID
Pocatello, ID	60.98	ID
Ames, IA	50.1	IA
Toronto Dam, KS	61.19	KS
Tribune, KS	92.98	KS
Madisonville, KY	55.26	KY
Urbana, IL	49.46	IL, IN
Woodworth State Forest, LA	48.86	LA
Caribou, ME	22.25	ME, NH, VT
Rochester, MA	35.71	MA, RI
East Lansing Hort. Farm, MI	44.53	MI
Scott, MS	60.99	AR, MS
Weldon Springs Farm, MO	48.08	MO
Bozeman Agric. Col., MT	47.06	MT
Medicine Creek Dam, NE	70.6	NE
Boulder City, NV	109.73	NV
Topaz Lake, NV	82.07	NV
Elephant Butte Dam, NM	116.86	NM
El Vado Dam, NM	57.91	NM
Aurora Research Farm, NY	41.08	MD, NY, PA
Chapel Hill, NC	52.89	MD, NC, VA, WV
Wooster Exp. Sta., OH	46.12	OH, VA, WV
Canton Dam, OK	77.51	OK
Detroit Power House, OR	39.74	OR, WA
Redfield, SD	51.83	MN, ND, SD
Neptune, TN	46.47	TN
Grapevine, TX	84.81	TX
Welasco, TX	85.7	TX
Ysletta, TX	108.76	TX
Utah Lake, UT	56.12	UT
Templeau Dam, WI	39.29	MN, WI
Heart Mountain, WY	49.36	WY

Background Evapotranspiration Calculation

The background land surface evapotranspiration was estimated using a method described by Sanford and Selnick (2013), who performed a geospatial characterization of evapotranspiration across the conterminous United States and used the results to develop a correlation between observed evapotranspiration (*ET*) and mean annual daily temperature (T_m), mean annual daily maximum temperature (T_x), mean annual daily minimum temperature (T_n), and mean daily precipitation (*P*). The regression was fit to the following equation:

$$\frac{ET}{P} = \frac{\tau\Delta}{\tau\Delta + \Pi} \quad (1)$$

Where τ, Δ, and Π are defined as follows:

$$\tau = (T_m + T_o)^m / ((T_m + T_o)^m + a) \quad (2)$$

$$\Delta = (T_x - T_n)/(T_x - T_n + b) \quad (3)$$

$$\Pi = (P/P_o)^n \quad (4)$$

The fitted values of the parameters T_o, P_o, m, n, a, and b were 13.735, 505.87, 2.4721, 1.9044, 10,000, and 18.262, respectively. Background evapotranspiration was calculated for each state using the regression and then assigned to each reservoir in the state. State-level estimates of T_m, T_x, and T_n were taken from the NCDC Climate Normals Database (National Climatic Data Center, 2015a) using average values from the entire period of record (1895 to 2015). State-level estimates of *P* were developed with data from the NCDC climate time series database (National Climatic Data Center, 2015b) using average values from the entire period of record (1895 to 2015). The resulting annual evapotranspiration estimates for each state are shown in

Table 3.

State-level Water Consumption Factor Estimation

The state-level background evapotranspiration values were subtracted from the reservoir evaporation rates to account for natural water consumption. The resulting values represent the induced water consumption associated with reservoirs in each state as shown in Table 3. Water consumption was taken as negligible in cases where the background evapotranspiration exceeded evaporation (Maine).

Table 3: State-level climate data and estimated water consumption rates

State	Pan Evaporation (cm/yr)[1]	Lake Evaporation (cm/yr)	T_m (°C)[2]	T_x (°C)[2]	T_n (°C)[2]	*P* (cm/yr)[3]	*ET* (cm/yr)	Reservoir Water Consumption (cm/yr)

[1] (Farnsworth et al., 1982)
[2] (National Climatic Data Center, 2015a)

State	Pan Evaporation (cm/yr)[1]	Lake Evaporation (cm/yr)	T_m (°C)[2]	T_x (°C)[2]	T_n (°C)[2]	*P* (cm/yr)[3]	*ET* (cm/yr)	Reservoir Water Consumption (cm/yr)
AL	129.5	97.1	17.5	23.9	10.8	140	86.1	11.0
AR	154.9	116.2	16.1	22.2	9.7	126	80.3	35.8
AZ	308.1	231.1	15.6	23.6	7.8	32	30.9	200.2
CA	241.6	181.2	14.7	21.7	7.8	57	50.4	130.8
CO	129.4	97.1	7.8	15.6	0.0	46	40.5	56.6
CT	108.0	81.0	10.0	15.6	4.4	119	64.8	16.2
FL	136.5	102.3	21.7	27.5	15.8	136	89.4	12.9
GA	164.2	123.2	17.8	24.2	11.1	127	84.0	39.2
IA	127.3	95.4	8.9	14.7	3.3	82	56.6	38.9
ID	134.9	101.2	6.4	13.1	-0.3	61	47.0	54.2
IL	125.6	94.2	11.4	16.9	5.8	95	63.9	30.3
IN	125.6	94.2	11.4	16.9	5.6	101	65.6	28.6
KS	195.8	146.8	12.8	19.7	5.8	69	56.9	90.0
KY	140.4	105.3	13.3	19.7	7.2	119	74.1	31.1
LA	124.1	93.1	19.4	25.3	13.6	145	87.8	5.3
MA	90.7	68.0	9.2	14.7	3.9	113	61.9	6.2
MD	119.3	89.5	12.8	18.3	7.2	108	69.2	20.3
ME	56.5	42.4	5.6	11.1	0.0	107	52.2	0.0
MI	113.1	84.8	7.2	12.8	1.7	79	52.9	31.9
MN	115.7	86.8	5.3	11.1	-0.6	66	46.5	40.3
MO	122.1	91.6	12.8	18.9	6.9	103	69.0	22.6
MS	154.9	116.2	17.6	24.0	10.9	141	86.4	29.7
MT	119.5	89.6	5.8	12.5	-0.8	47	39.7	49.9
NC	134.3	100.8	15.3	21.4	9.2	125	78.4	22.4
ND	131.6	98.7	4.7	11.1	-1.4	44	36.8	62.0
NE	179.3	134.5	9.7	16.7	2.5	58	48.5	86.0
NH	82.3	61.7	6.9	12.5	0.8	110	57.1	4.6
NJ	108.0	81.0	11.9	17.5	6.4	114	68.6	12.4
NM	222.0	166.5	12.5	20.8	4.2	36	33.7	132.8
NV	243.6	182.7	10.3	18.1	2.8	26	25.2	157.5
NY	104.3	78.3	8.1	13.3	2.5	102	58.2	20.0
OH	117.1	87.9	10.8	16.4	5.3	97	63.5	24.4
OK	196.9	147.7	15.8	22.5	9.2	86	67.8	79.9
OR	100.9	75.7	8.6	15.0	2.2	82	57.4	18.3
PA	104.3	78.3	9.7	15.6	3.9	107	63.7	14.6
RI	90.7	68.0	10.3	15.6	5.6	115	63.2	4.8
SC	149.3	112.0	17.5	23.6	10.8	122	81.9	30.1
SD	131.6	98.7	7.5	14.2	1.1	48	41.3	57.4
TN	118.0	88.5	14.7	20.8	8.3	131	78.7	9.8
TX	236.4	177.3	18.9	25.8	11.9	69	60.0	117.3
UT	142.5	106.9	9.2	16.7	2.2	34	32.1	74.8

[3] (National Climatic Data Center, 2015b)

State	Pan Evaporation (cm/yr)[1]	Lake Evaporation (cm/yr)	T_m (°C)[2]	T_x (°C)[2]	T_n (°C)[2]	P (cm/yr)[3]	ET (cm/yr)	Reservoir Water Consumption (cm/yr)
VA	125.7	94.3	13.3	19.4	7.2	109	71.7	22.6
VT	82.3	61.7	6.1	11.9	0.6	106	54.2	7.5
WA	100.9	75.7	8.1	13.6	2.8	107	58.6	17.1
WI	99.8	74.8	6.7	12.5	0.8	79	52.5	22.3
WV	125.7	94.3	11.4	17.5	5.3	113	69.0	25.3
WY	125.4	94.0	5.6	12.8	-1.7	40	35.5	58.6

Hydropower Facility-Level Water Consumption Factors

The state-level water consumption estimates were used with reservoir surface areas to calculate the water consumption per unit hydropower produced in both dedicated hydropower and multipurpose reservoirs. Table 4 and Table 5 show NID identifiers, eGRID hydropower facility names, rivers, states, and surface areas from the NID database, state-level water consumption estimates from Table 3, 2010 power generation from the eGRID database, and reservoir net water consumption in million gallons per year (MGY) for the dedicated and multipurpose reservoirs, respectively. In several instances multiple facilities are located on the same reservoir. In these instances (all of which were facilities with dedicated hydropower reservoirs), the water consumption burden was allocated to one facility with the receiving no water consumption burden. These facilities are listed in Table 6.

Table 4: Water Consumption and Power Generation from Reservoirs Dedicated to Solely to Hydropower

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
ME00006	Deer Rips	ANDROSCOGGIN RIVER	ME	130	0.0	35,378	0
ME00035	West Buxton	SACO RIVER	ME	131	0.0	33,735	0
ME00089	Wyman Hydro	KENNEBEC RIVER	ME	3240	0.0	405,628	0
ME00106	Messalonskee 3	MESSALONSKEE STREAM	ME	3600	0.0	3,036	0
ME00090	Harris	KENNEBEC RIVER	ME	3666	0.0	260,348	0
ME00024	Aziscohos Hydroelectric Project	MAGALLOWAY RIVER	ME	8320	0.0	37,823	0
ID83074	Upper Salmon A	SNAKE RIVER	ID	1.0	54.2	123,562	0.6
NY13001	Chateaugay High Falls Hydro	CHATEAUGAY RIVER	NY	2.9	20.0	7,753	0.6
WA83048	Box Canyon	PEND OREILLE	WA	5.0	17.1	392,441	0.9
NY01529	Rainbow Falls	AUSABLE RIVER	NY	4.8	20.0	17,103	1.0
CT00228	Bulls Bridge	HOUSATONIC RIVER	CT	7.0	16.2	38,341	1.2

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
NC00337	Thorpe	W FK TUCKASEGEE R	NC	8.0	22.4	70,619	1.9
NY00196	Prospect	WEST CANADA CREEK	NY	9.0	20.0	71,615	1.9
VT00026	Searsburg	DEERFIELD RIVER	VT	30	7.5	13,497	2.4
ID83073	Upper Salmon B	SNAKE RIVER	ID	5.0	54.2	108,094	2.9
VT00029	Middlesex 2	WINOOSKI RIVER	VT	42	7.5	12,083	3.4
MA00464	Deerfield 2	DEERFIELD RIVER	MA	63.5	6.2	28,308	4.2
CA00420	Murphys	ANGELS CREEK	CA	3.0	130.8	16,328	4.2
VT00261	Bolton Falls	WINOOSKI RIVER	VT	70	7.5	31,215	5.6
NY00178	Ephratah	CAROGA CREEK	NY	30	20.0	11,849	6.4
WA00238	South Fork Tolt	SOUTH FORK TOLT-OFFSTREAM	WA	37	17.1	53,774	6.8
WI05000	Superior Falls	MONTREAL	MI	21	31.9	12,148	7.2
NC00333	Queens Creek	QUEENS CR,NANTAHALA R	NC	37	22.4	3,300	8.8
NY00234	Kent Falls	SARANAC RIVER	NY	43	20.0	62,606	9.2
NC00335	Tennessee Creek	E FK TUCKASEGEE R	NC	40	22.4	23,463	9.6
MA00975	Fife Brook	DEERFIELD RIVER	MA	152	6.2	31,678	10
VT00031	Peterson	LAMOILLE RIVER	VT	136	7.5	31,694	11
NC00348	Mission	HIWASSEE R	NC	61	22.4	3,147	14.6
NY00415	South Edwards	EAST BRANCH OSWEGATCHIE RIVER	NY	81	20.0	21,121	17.3
WA83006	Swift 1	LEWIS R	WA	95	17.1	733,908	17.4
VA16101	Niagara	ROANOKE	VA	75.5	22.6	10,549	18.2
ID00155	Moyie Springs	MOYIE R	ID	34	54.2	25,669	19.7
NY00247	High Falls	SARANAC RIVER	NY	93	20.0	82,028	19.9
NH00199	Jackman	NORTH BRANCH CONTOOCOOK RIVER	NH	486	4.6	8,760	24
NH01361	Newfound Hydroelectric	PEMIGEWASSET RIVER	NH	500	4.6	6,000	24
NC00334	Cedar Cliff	E FK TUCKASEGEE R	NC	121	22.4	19,719	29
NE01024	Johnson 1	TRI-COUNTY CANAL OFF PLATTE R	NE	37	86.0	101,814	34.0
NY00201	Beardslee	EAST CANADA CREEK	NY	173	20.0	46,395	37
NY00075	Central Hudson High Falls	WALLKILL RIVER	NY	189	20.0	5,226	40
MO30040	Taum Sauk	E FK BLACK	MO	200	22.6	403,397	48
NY00413	Flat Rock	EAST BRANCH OSWEGATCHIE RIVER	NY	228	20.0	17,653	49

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
WY01294	Kortes	NORTH PLATTE RIVER	WY	83	58.6	137,858	52.0
TN00906	Calderwood	LITTLE TENNESSEE R	TN	536	9.8	540,920	56
VT00033	Milton	LAMOILLE RIVER	VT	740	7.5	45,086	59
MN00603	Fond Du Lac	ST LOUIS	MN	160	40.3	39,477	69
NY00485	Waterport	OAK ORCHARD CREEK	NY	335	20.0	13,743	72
CA00328	Poe	NORTH FORK FEATHER RIVER	CA	53	130.8	529,896	74.1
NC83011	Haw River Hydro	HAW R	NC	325	22.4	5,470	78
SC01075	Gaston Shoals	BROAD R	SC	251	30.1	13,788	81
NC00318	Walters	PIGEON R	NC	350	22.4	286,946	84
NY00304	Soft Maple	BEAVER RIVER	NY	400	20.0	34,146	86
NY00119	Johnsonville	HOOSIC RIVER	NY	450	20.0	7,458	96
CA00401	Tiger Creek	NORTH FORK MOKELUMNE RIVER	CA	70	130.8	253,410	97.9
NY00217	Franklin	SARANAC RIVER	NY	485	20.0	9,088	104
MI00826	Little Quinnesec Falls Hydro Project	MENOMINEE	WI	440	22.3	53,369	105
NC00336	Bear Creek	E FK TUCKASEGEE R	NC	476	22.4	26,548	114
SC01074	99 Islands	BROAD R	SC	433	30.1	69,862	139
SC00140	Great Falls	CATAWBA	SC	450	30.1	6,132	145
NC00393	Cheoah	LITTLE TENNESSEE R	NC	615	22.4	424,395	147
SC00559	Hollidays Bridge Hydro	SALUDA RIVER	SC	466	30.1	10,224	150
SC00024	Saluda	SALUDA RIVER	SC	475	30.1	7,265	153
CA00418	Chili Bar	SOUTH FORK AMERICAN RIVER	CA	110	130.8	31,785	154
CA00330	Cresta	NORTH FORK FEATHER RIVER	CA	118	130.8	290,320	165
MN00512	Rapidan Hydro Facility	BLUE EARTH	MN	415	40.3	33,720	179
MI00535	Constantine	ST JOSEPH	MI	525	31.9	6,143	179
NC00394	Lookout Shoals	CATAWBA	NC	835	22.4	84,938	200
MI00538	Berrien Springs	SAINT JOSEPH RIVER	MI	600	31.9	36,780	205
MI00206	Webber	GRAND	MI	660	31.9	10,111	225
ID00178	Ashton	HENRYS FORK	ID	404	54.2	22,728	234
SC01071	Cedar Creek	CATAWBA RIVER	SC	800	30.1	139,207	257
IN03011	Twin Branch	ST JOSEPH	IN	1065	28.6	26,392	326
NY00238	Union Falls	SARANAC RIVER	NY	1630	20.0	13,169	349
MI00150	Alcona	AU SABLE	MI	1075	31.9	22,596	367
MI00550	Edenville	TITTABAWASSEE	MI	1526	31.9	14,981	521

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
MI00151	Allegan Dam	KALAMAZOO	MI	1600	31.9	14,063	546
CA00264	Donnells	MIDDLE FORK STANISLAUS RIVER	CA	418	130.8	209,039	584
GA83023	Flint River	MUCKAFOONEE CREEK, FLINT RIVER	GA	1400	39.2	23,939	587
MI00169	Foote	AU SABLE	MI	1800	31.9	24,713	614
MI00174	Hodenpyl	MANISTEE	MI	2025	31.9	39,738	691
ID00060	Soda	BEAR RIVER	ID	1223	54.2	13,592	709
VA14301	Leesville	ROANOKE R	VA	3270	22.6	67,411	789
NE00628	Spencer	NIOBRARA RIVER	NE	864	86.0	13,777	794
NC00329	Oxford	CATAWBA	NC	3463	22.4	105,080	828
NC00104	Rhodhiss	CATAWBA	NC	3515	22.4	62,164	841
MT00224	Thompson Falls	CLARK FK,PEND OREILLE R	MT	1580	49.9	465,209	844
CA83310	Rock Creek LP	SOUTH FORK AMERICAN RIVER	CA	630	130.8	3,850	881
GA83003	Stevens Creek	SAVANNAH R	GA	2200	39.2	71,282	922
GA00837	Oliver Dam	CHATTAHOOCHEE	GA	2280	39.2	193,505	955
KY00316	Dix Dam	DIX RIVER	KY	2940	31.1	35,921	979
CA00263	Beardsley	MIDDLE FORK STANISLAUS RIVER	CA	720	130.8	54,763	1,007
SC01072	Fishing Creek	CATAWBA	SC	3370	30.1	137,826	1,084
SC01069	Parr Hydro	BROAD R	SC	3550	30.1	59,314	1,142
NC83002	Bridgewater	LINVILLE R	NC	6510	22.4	57,055	1,557
CA00265	Tulloch	STANISLAUS RIVER	CA	1260	130.8	95,628	1,762
WA00581	Cowlitz Falls	COWLITZ RIVER	WA	10000	17.1	242,917	1,826
GA00850	Lloyd Shoals	OCMULGEE	GA	4500	39.2	70,319	1,886
GA00831	Lake Blackshear Project	FLINT R	GA	8700	39.2	41,623	3,645
NE01036	Jeffrey	None	NE	5756	86.0	124,170	5,291
MI00520	Cheboygan	CHEBOYGAN RIVER	MI	18150	31.9	5,263	6,195
SC00224	Saluda	SALUDA R	SC	48000	30.1	125,976	15,442
AZ10309	Davis Dam	COLORADO RIVER	AZ	28500	200.2	1,129,158	60,991
Totals						**10,158,051**	**119,205**

Table 5: Water Consumption and Power Generation from Reservoirs with Multiple Purposes Including Hydropower

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
ME00070	North Gorham	PRESUMPSCOT RIVER	ME	29,184	0.0	11,461	0.0

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
ME00133	Brassua Hydroelectric Project	MOOSE RIVER	ME	9,700	0.0	21,502	0.0
ME00234	Squa Pan Hydro Station	SQUA PAN STREAM	ME	5,043	0.0	1,250	0.0
ME00007	Gulf Island	ANDROSCOGGIN RIVER	ME	2,862	0.0	142,061	0.0
ME00084	Shawmut	KENNEBEC RIVER	ME	1,310	0.0	52,001	0.0
ME00085	Weston	KENNEBEC RIVER	ME	930	0.0	65,685	0.0
ME00141	PPL Milford Hydro Station	PENOBSCOT RIVER	ME	918	0.0	48,839	0.0
ME00095	Gardiner	COBBOSSEECONTE E STREAM	ME	856	0.0	5,032	0.0
ME00033	Skelton	SACO RIVER	ME	488	0.0	102,912	0.0
ME00108	Lockwood Hydroelectric Facility	SEBASTICOOK RIVER	ME	417	0.0	32,371	0.0
ME00036	Bonny Eagle	SACO RIVER	ME	347	0.0	46,542	0.0
ME83029	PPL Veazie Hydro Station	PENOBSCOT RIVER	ME	325	0.0	55,894	0.0
ME00263	PPL Ellsworth Hydro Station	UNION RIVER	ME	125	0.0	30,418	0.0
IL50078	Upper Sterling	ROCK RIVER	IL	0	30.3	3,365	0.0
CO02194	Sugarloaf Hydro Plant	LAKE FORK CREEK	CO	0	56.6	4,797	0.0
MA00886	Cosgrove Intake and Power Station	WACHUSETT RESERVOIR	MA	0	6.2	5,353	0.0
OH00385	Auglaize Hydro	AUGLAIZE RIVER	OH	0	24.4	8,884	0.0
UT00514	Quail Creek Hydro Plant #1	QUAIL CREEK & PIPELINE	UT	0	74.8	9,277	0.0
TX01912	H 4	GUADALUPE RIVER	TX	0	117.3	11,209	0.0
MA00068	Cobble Mountain	COBBLE MOUNTAIN RES.	MA	0	6.2	18,809	0.0
MA00848	Turners Falls	TURNERS FALLS POND	MA	0	6.2	22,082	0.0
MN00653	International Falls Power	RAINY RIVER	MN	0	40.3	51,991	0.0
CO01296	Tesla	TR\MONUMENT CR	CO	0	56.6	70,131	0.0
AZ10437	Headgate Rock	COLORADO RIVER	AZ	0	200.2	77,910	0.0
PA00007	York Haven	CODORUS CREEK	PA	0	14.6	123,337	0.0
SC82201	St Stephen	COOPER/SANTEE	SC	0	30.1	191,018	0.0

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
MT01190	Rainbow	TR-MISSOURI RIVER	MT	0	49.9	252,528	0.0
WA00148	Yale	LEWIS R	WA	0	17.1	629,932	0.0
WA00170	Diablo	SKAGIT R	WA	0	17.1	718,580	0.0
NC05535	Fontana Dam	LITTLE TENNESSEE RIVER	NC	0	22.4	838,745	0.0
CA10017	Coyote Creek	CARBON CANYON CREEK	CA	1	130.8	5,779	1.4
CA00220	Yorba Linda	OFFSTREAM	CA	1	130.8	7,306	1.4
CA00220	Valley View	OFFSTREAM	CA	1	130.8	8,851	1.4
CA10025	Sepulveda Canyon	LOS ANGELES RIVER	CA	1	130.8	20,863	1.4
CA10021	Mojave Siphon	WEST FORK MOJAVE RIVER	CA	1	130.8	61,777	1.4
CA83174	Chicago Park	BEAR RIVER	CA	1	130.8	167,567	1.4
NY00755	Fourth Branch Hydroelectric Facility	PISCAWAN KILL	NY	7	20.0	15,202	1.5
NC00320	Metropolitan Sewerage District	FRENCH BROAD RIVER-TR	NC	11	22.4	7,065	2.6
TN13903	Ocoee 2	OCOEE RIVER	TN	39	9.8	51,072	4.1
TN13903	Ocoee 3	OCOEE RIVER	TN	39	9.8	157,172	4.1
CA00431	Big Creek 2	BIG CREEK	CA	3	130.8	360,339	4.2
CA00430	Big Creek 1	BIG CREEK	CA	3	130.8	382,375	4.2
CA00431	Big Creek 2A	BIG CREEK	CA	3	130.8	523,882	4.2
NJ00244	Great Falls Hydro Project	YANTECAW BROOK	NJ	33	12.4	18,119	4.4
VA04147	Brasfield	TR-APPOMATTOX RIVER	VA	21	22.6	9,788	5.1
TN01904	Wilbur	WATAUGA RIVER	TN	59	9.8	11,832	6.2
TN01904	Watauga	WATAUGA RIVER	TN	59	9.8	108,071	6.2
OR00555	Soda Springs	N UMPQUA R	OR	32	18.3	51,896	6.3
OR00555	Toketee Falls	N UMPQUA R	OR	32	18.3	188,950	6.3
NH00093	Gregg Falls	PISCATAQUOG RIVER	NH	138	4.6	9,160	6.7
CA00553	Deadwood Creek	GRIZZLY CREEK	CA	6	130.8	3,167	8.4
CA00336	Balch 2	NFK KINGS RV	CA	7	130.8	557,545	9.8
CA00120	Dion R Holm	TUOLUMNE RIVER	CA	7	130.8	788,899	9.8
NH00725	EHC West Hopkinton	CONTOOCOOK RIVER	NH	220	4.6	2,694	10.7
CA00258	Dutch Flat	TR BEAR RIVER	CA	8	130.8	89,882	11.2
CA00258	Dutch Flat 2	TR BEAR RIVER	CA	8	130.8	105,818	11.2

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
NC00099	Lake Lure	BUFFALO CREEK	NC	50	22.4	8,520	11.9
OR00551	Faraday	CLACKAMAS	OR	70	18.3	181,947	13.7
CA00421	Drum 1	BEAR RIVER	CA	10	130.8	87,703	14.0
CA00421	Drum 2	BEAR RIVER	CA	10	130.8	301,211	14.0
MA00043	Sherman	DEERFIELD RIVER	MA	218	6.2	29,518	14.3
MN00590	Hennepin Island	MISSISSIPPI RIVER	MN	35	40.3	60,407	15.1
VT00052	Wrightsville Hydro Plant	NORTH BRANCH WINOOSKI RIVER	VT	190	7.5	2,726	15.2
CA00273	Forbestown	SFK FEATHER RV	CA	12	130.8	174,683	16.8
WA00001	Condit	WHITE SALMON RIVER	WA	92	17.1	95,220	16.8
VT00002	Ottauquechee Hydro	OTTAUQUECHEE RIVER	VT	215	7.5	5,431	17.2
CA01128	Angels	TR ANGELS CREEK	CA	13	130.8	6,658	18.2
OR00554	Clearwater 2	NORTH UMPQUA	OR	97	18.3	29,705	19.0
OR00554	Lemolo 2	NORTH UMPQUA	OR	97	18.3	138,473	19.0
NH00003	Franklin Industrial Complex	PEMIGEWASSET RIVER	NH	440	4.6	4,700	21.4
NH00003	Eastman Falls	PEMIGEWASSET RIVER	NH	440	4.6	25,288	21.4
WI05009	Saxon Falls	MONTREAL	MI	63	31.9	9,661	21.5
CA00391	Stanislaus	TR STANISLAUS R	CA	16	130.8	376,423	22.4
CA00343	Forks of Butte Hydro Project	MIDDLE BUTTE CR	CA	17	130.8	63,549	23.8
CA00343	De Sabla	MIDDLE BUTTE CR	CA	17	130.8	79,553	23.8
NY00258	Five Falls	RAQUETTE RIVER	NY	120	20.0	96,895	25.7
GA00844	Terrora	TALLULAH	GA	63	39.2	43,181	26.4
GA00844	Tallulah Falls	TALLULAH	GA	63	39.2	152,578	26.4
NH00166	Mcindoes	CONNECTICUT RIVER	NH	543	4.6	49,561	26.4
WA00146	Cushman 2	HOOD CANAL(N F SKOKOMISH RIVER	WA	150	17.1	236,922	27.4
CA00442	Portal	TR SFK SAN JOAQUIN	CA	20	130.8	23,701	28.0
CA00817	Camino	SILVER CREEK	CA	20	130.8	390,368	28.0
CO01654	Flatiron	CHIMNEY HOLLOW CREEK	CO	47	56.6	170,742	28.4
OR00552	River Mill	CLACKAMAS	OR	150	18.3	113,007	29.3
CA00075	Franklin	FRANKLIN CANYON	CA	22	130.8	9,334	30.8
CA00824	El Dorado	BRUSH CREEK	CA	22	130.8	79,793	30.8
CA00225	Red Mountain	RECHE CREEK	CA	23	130.8	31,394	32.2
VT00046	Marshfield 6	MOLLYS BROOK	VT	411	7.5	4,904	32.8

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
NY00367	Lighthouse Hill	SALMON RIVER	NY	170	20.0	19,772	36.4
NY00367	Bennetts Bridge	SALMON RIVER	NY	170	20.0	86,525	36.4
NY00661	Jarvis (Hinckley)	WEST CANADA CREEK	NY	176	20.0	28,741	37.7
CT00541	Goodwin Hydroelectric	WEST BRANCH FARMINGTON RIVER	CT	220	16.2	17,631	38.1
NY00183	Inghams	EAST CANADA CREEK	NY	188	20.0	28,478	40.3
CA00122	Moccasin Low Head Hydro Project	MOCCASIN CREEK	CA	29	130.8	8,708	40.5
CA00432	Big Creek 8	SAN JOAQUIN RIVER	CA	29	130.8	260,726	40.5
CA00122	Moccasin	MOCCASIN CREEK	CA	29	130.8	375,977	40.5
CA00432	Mammoth Pool	SAN JOAQUIN RIVER	CA	29	130.8	708,585	40.5
MA00234	Lawrence Hydroelectric Associates	MERRIMACK RIVER	MA	655	6.2	45,014	43.1
WI05002	Big Quinnesec 61	MENOMINEE	MI	127	31.9	1,108	43.3
WI05002	Big Quinnesec 92	MENOMINEE	MI	127	31.9	86,589	43.3
CA00402	Pit 5	PIT RIVER	CA	32	130.8	713,130	44.7
WA00242	Elwha Hydroelectric Project	ELWHA RIVER	WA	267	17.1	62,994	48.8
NC00548	Falls	YADKIN R	NC	204	22.4	117,034	48.8
CA00335	Balch 1	NFK KINGS RV	CA	35	130.8	145,051	48.9
CA00335	Haas	NFK KINGS RV	CA	35	130.8	624,936	48.9
CA00333	Bucks Creek	GRIZZLY CREEK	CA	38	130.8	213,296	53.1
NH00165	Comerford	CONNECTICUT RIVER	NH	1,093	4.6	376,208	53.2
VA03501	Byllesby 2	NEW R	VA	242	22.6	28,237	58.4
CA00413	Caribou 1	NFK FEATHER RV	CA	42	130.8	99,181	58.7
CA00859	Oxbow	MFK AMERICAN RV	CA	45	130.8	31,118	62.9
CA00859	Ralston	MFK AMERICAN RV	CA	45	130.8	362,654	62.9
NY00141	Sherman Island	HUDSON RIVER	NY	305	20.0	184,547	65.3
WV01901	Hawks Nest Hydro	NEW RIVER	WV	243	25.3	498,411	65.9
AL01422	Thurlow Dam	TALLAPOOSA	AL	574	11.0	223,951	67.5
NH00320	Milton Hydro	SALMON FALLS RIVER	NH	1,400	4.6	797	68.2

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
OR00550	North Fork Hydro	CLACKAMAS	OR	350	18.3	2,282	68.4
OR00550	North Fork	CLACKAMAS	OR	350	18.3	207,836	68.4
OR00550	Oak Grove	CLACKAMAS	OR	350	18.3	241,935	68.4
WI05008	Brule	BRULE	WI	297	22.3	13,758	70.8
NY00329	Moshier	BEAVER RIVER	NY	340	20.0	35,998	72.8
OR00327	PHP 1	BULL RUN R	OR	386	18.3	55,053	75.5
WA00144	Glines Hydroelectric Project	ELWHA RIVER	WA	440	17.1	65,920	80.4
WA00068	Nine Mile	SPOKANE R	WA	440	17.1	101,430	80.4
CA00278	La Grange	TUOLUMNE RIVER	CA	58	130.8	23,250	81.1
NY00215	Upper Mechanicville	HUDSON RIVER	NY	380	20.0	88,895	81.4
OR00317	PHP 2	BULL RUN R	OR	418	18.3	43,527	81.7
OR00556	Lemolo 1	N UMPQUA R	OR	419	18.3	111,394	82.0
OR00559	John C Boyle	KLAMATH R	OR	420	18.3	193,133	82.1
WA00197	H M Jackson	CHAPLAIN CREEK	WA	450	17.1	382,612	82.2
AL01413	Point A	CONECUH R/PATSALIGA	AL	700	11.0	15,022	82.3
CA01283	J S Eastwood	WFK BALSAM CR	CA	60	130.8	228,795	83.9
TN16307	Fort Patrick Henry	SOUTH FORK HOLSTON RIVER	TN	808	9.8	92,792	84.9
MI00203	Victoria	W BR ONTONAGON	MI	250	31.9	54,190	85.3
NY00088	Normanskill Hydro Project	NORMANS KILL	NY	430	20.0	2,526	92.1
AL01981	Bankhead Dam	BLACK WARRIER	AL	790	11.0	100,981	92.9
NY00497	Rio	MONGAUP RIVER	NY	460	20.0	20,931	98.5
GA00846	Nacoochee	TALLULAH	GA	240	39.2	11,194	101
PA00514	Piney	CLARION RIVER	PA	653	14.6	50,520	102
NY00149	Stewarts Bridge	SACANDAGA RIVER	NY	480	20.0	107,957	103
PA00115	FirstEnergy Allegheny Hydro Partners Ltd	ALLEGHENY RIVER	PA	660	14.6	35,220	103
NY00143	Feeder Dam Hydro Plant	HUDSON RIVER	NY	493	20.0	28,936	106
OR00548	Pelton	DESCHUTES	OR	540	18.3	424,330	106
TN17704	Great Falls	CANEY FORK RIVER	TN	1,010	9.8	105,120	106
CA00389	Phoenix	SULLIVAN CREEK	CA	76	130.8	10,078	106
CO01662	Estes	BIG THOMPSON RIVER	CO	185	56.6	91,036	112

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
OR83046	Galesville Project	COW CR, UMPQUA RIVER	OR	633	18.3	4,388	124
PA00101	Conemaugh Hydro Plant	CONEMAUGH RIVER	PA	800	14.6	45,645	125
NY83074	Stark	RAQUETTE RIVER	NY	586	20.0	97,296	125
CT00506	Colebrook Hydroelectric	WEST BRANCH FARMINGTON RIVER	CT	750	16.2	5,147	130
MA83030	Cabot	TURNERS FALLS CANAL	MA	2,000	6.2	321,058	132
MD00138	FirstEnergy Dam 5	POTOMAC RIVER	WV	490	25.3	4,079	133
CA00296	Toadtown	LITTLE BUTTE CR	CA	96	130.8	5,328	134
GA00851	Yonah	TUGALOO	GA	325	39.2	51,050	136
NY00136	Spier Falls	HUDSON RIVER	NY	638	20.0	242,238	137
CA00866	Narrows 2	DOBBINS CREEK	CA	98	130.8	196,835	137
TN13905	Ocoee 1	OCOEE RIVER	TN	1,315	9.8	78,936	138
WI00851	Appleton	FOX	WI	582	22.3	13,129	139
CA00274	Kanaka	SFK FEATHER RV	CA	103	130.8	1,614	144
ID00053	Bliss	SNAKE R	ID	255	54.2	336,360	148
CA00397	Pit 4	PIT RIVER	CA	106	130.8	407,562	148
MA83002	Chemical	HOLYOKE CANAL	MA	2,290	6.2	3,519	151
MA00973	Boatlock	CONNECTICUT RIVER	MA	2,290	6.2	9,230	151
MA83002	Riverside	HOLYOKE CANAL	MA	2,290	6.2	23,768	151
MA00973	Hadley Falls	CONNECTICUT RIVER	MA	2,290	6.2	192,789	151
NY00257	Rainbow Falls	RAQUETTE RIVER	NY	710	20.0	99,497	152
PA00118	Allegheny Hydro No 8 LP	ALLEGHENY RIVER	PA	1,010	14.6	75,771	157
MI00207	White Rapids	MENOMINEE	MI	465	31.9	29,425	159
CA00098	Pleasant Valley	OWENS RIVER	CA	115	130.8	7,951	161
PA00119	Allegheny Hydro No 9 LP	ALLEGHENY RIVER	PA	1,040	14.6	92,286	162
TN16306	Boone Dam	SOUTH FORK HOLSTON RIVER	TN	1,547	9.8	148,008	162
VT00025	Harriman	DEERFIELD RIVER	VT	2,039	7.5	101,902	163
NH00414	S C Moore	CONNECTICUT RIVER	NH	3,490	4.6	302,436	170
MI00184	Michigamme Falls	MICHIGAMME	MI	505	31.9	22,472	172
MT00016	Broadwater Power Project	MISSOURI R	MT	327	49.9	52,843	175
ID83077	Gem State	SNAKE RIVER-	ID	305	54.2	108,210	177

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
MD00078	FirstEnergy Dam 4	POTOMAC RIVER	WV	675	25.3	5,018	183
CT00023	Stevenson	HOUSATONIC RIVER	CT	1,063	16.2	88,710	184
CT00023	Shepaug	HOUSATONIC RIVER	CT	1,063	16.2	122,344	184
WI00023	St Croix Falls	SAINT CROIX RIVER	WI	780	22.3	106,629	186
WV03907	London	KANAWHA RIVER	WV	700	25.3	66,688	190
WI00728	Cornell	CHIPPEWA	WI	800	22.3	98,266	191
WI00748	Alexander	WISCONSIN	WI	803	22.3	19,118	192
PA00116	Allegheny No 6 Hydro Partners	ALLEGHENY RIVER	PA	1,260	14.6	38,845	196
MI00534	Hydro Plant	ST JOSEPH	MI	580	31.9	8,513	198
OR00006	Dexter	MIDDLE FORK WILLAMETTE RIVER	OR	1,025	18.3	72,580	200
MI00177	Kingsford	MENOMINEE	MI	595	31.9	23,652	203
NH00097	Vernon	CONNECTICUT RIVER	VT	2,550	7.5	160,566	204
WA00302	Wynoochee	WYNOOCHEE RIVER	WA	1,126	17.1	36,320	206
NH00015	Lochmere Hydroelectric Plant	WINNIPESAUKEE RIVER	NH	4,264	4.6	3,419	208
KY03019	Mother Ann Lee	KENTUCKY RIVER	KY	625	31.1	8,806	208
NY00696	Swinging Bridge 2	MONGAUP RIVER	NY	1,000	20.0	9,851	214
CA00340	Kerckhoff 2	SAN JOAQUIN RIVER	CA	160	130.8	551,886	224
NH00112	Bellows Falls	CONNECTICUT RIVER	VT	2,804	7.5	263,646	224
NY00170	Vischer Ferry	MOHAWK RIVER	NY	1,050	20.0	58,429	225
OR00258	Oxbow	SNAKE RIVER	OR	1,150	18.3	975,054	225
WI00729	Jim Falls	CHIPPEWA	WI	950	22.3	147,629	227
CA00399	Potter Valley	SOUTH EEL RIVER	CA	163	130.8	27,308	228
AL01421	Yates Dam	TALLAPOOSA	AL	2,000	11.0	149,429	235
NY00773	Phoenix Hydro Project	OSWEGO RIVER	NY	1,109	20.0	11,332	238
MT00562	Mystic	W ROSEBUD CR	MT	446	49.9	46,138	238
MI00188	Ninth Street Hydropower Project	THUNDER BAY	MI	700	31.9	6,341	239
NC00181	Apalachia	HIWASSEE RIVER	NC	1,015	22.4	398,680	243
CA10324	Santa Ana 3	SANTA ANA RIV	CA	177	130.8	4,985	247

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
NH00259	Wilder	CONNECTICUT RIVER	VT	3,100	7.5	172,567	248
OH00751	O'Shaughnessy Hydro	SCIOTO	OH	950	24.4	6,749	248
GA00843	Tugalo	TALLULAH	GA	597	39.2	107,549	250
CA00450	Rush Creek	RUSH CREEK	CA	185	130.8	54,054	259
WI05010	Chalk Hill	MENOMINEE	MI	766	31.9	26,279	261
WI00736	Dells	CHIPPEWA	WI	1,100	22.3	52,610	262
MI00193	Prickett	STURGEON	MI	773	31.9	6,751	264
GA11101	Blue Ridge	TOCCOA RIVER	GA	636	39.2	34,545	266
WV06128	FirstEnergy Lake Lynn Power Station	CHEAT RIVER	PA	1,729	14.6	88,229	269
MI00178	Loud	AU SABLE	MI	790	31.9	16,047	270
ID00068	Oneida	BEAR RIVER	ID	480	54.2	28,335	278
WI00759	Caldron Falls	PESHTIGO	WI	1,180	22.3	11,701	281
MI00186	Mio	AU SABLE	MI	860	31.9	9,537	294
CA01325	James B Black	TR PIT RIVER	CA	211	130.8	714,470	295
OR00465	Wallowa Falls	WALLOWA RIVER	OR	1,530	18.3	7,925	299
OR00596	Sullivan	WILLAMETTE R	OR	1,532	18.3	136,187	300
WA00009	Boundary	PEND OREILLE	WA	1,668	17.1	3,138,414	305
GA00842	Morgan Falls	CHATTAHOOCHEE	GA	750	39.2	38,500	314
NY00348	Neversink	NEVERSINK RIVER	NY	1,472	20.0	36,154	315
AL01414	Gantt	CONECUH R	AL	2,767	11.0	6,509	325
ID00041	Little Wood Hydro Project	LITTLE WOOD RIVER	ID	572	54.2	6,204	332
WV03908	Marmet	KANAWHA RIVER	WV	1,300	25.3	56,492	352
CA00414	Pit 6	PIT RIVER	CA	265	130.8	334,962	371
PA00854	PPL Holtwood	SUSQUEHANNA RIVER	PA	2,400	14.6	558,883	374
WI05016	Twin Falls	MENOMINEE	MI	1,120	31.9	27,387	382
MN00593	Twin Cities Hydro LLC	MISSISSIPPI	MN	900	40.3	114,177	387
AL01426	Holt Dam	BLACK WARRIOR RIVER	AL	3,300	11.0	128,109	388
WI00754	High Falls	PESHTIGO	WI	1,670	22.3	13,053	398
WA00172	Lower Baker	BAKER	WA	2,218	17.1	366,338	405
WA00172	Ross	BAKER	WA	2,218	17.1	645,726	405
WA00172	Gorge	BAKER	WA	2,218	17.1	870,367	405
WA00152	Mayfield	COWLITZ RIVER	WA	2,250	17.1	695,270	411
CA00388	Spring Gap	SK STANISLAUS R	CA	300	130.8	41,658	419
NY00171	Crescent	MOHAWK RIVER	NY	2,000	20.0	61,419	428
IN00452	Norway	TIPPECANOE	IN	1,400	28.6	20,869	429

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
WI00737	Menomonie	RED CEDAR	WI	1,800	22.3	20,201	429
WI00734	Cedar Falls	RED CEDAR	WI	1,800	22.3	29,029	429
CA00242	McSwain	MERCED RIVER	CA	310	130.8	3,289	433
ID00052	Lower Malad	SNAKE RIVER	ID	748	54.2	106,970	434
ID00052	Lower Salmon	SNAKE RIVER	ID	748	54.2	225,212	434
PA00109	Yough Hydro Power	YOUGHIOGHENY RIVER	PA	2,840	14.6	40,999	442
CA00036	Lime Saddle	FEATHER RIVER	CA	323	130.8	4,914	452
CA00036	Thermalito Diverson Dam	FEATHER RIVER	CA	323	130.8	9,187	452
NY00051	Kensico	BRONX RIVER	NY	2,145	20.0	39	459
WA00273	Tieton Dam Hydro Electric Project	TIETON RIVER	WA	2,525	17.1	38,855	461
WI00794	Big Falls	FLAMBEAU	WI	1,952	22.3	33,575	466
OR00250	Hells Canyon	SNAKE RIVER	OR	2,412	18.3	1,891,439	472
TN10502	Melton Hill	CLINCH RIVER	TN	4,570	9.8	147,569	480
CO01689	Morrow Point	GUNNISON RIVER	CO	817	56.6	271,640	494
WI00815	Biron	WISCONSIN	WI	2,078	22.3	30,524	496
MN00599	Blanchard	MISSISSIPPI	MN	1,152	40.3	97,507	496
TX01601	Abbott TP 3	GUADALUPE RIVER	TX	396	117.3	13,237	497
CA00249	Combie South	BEAR RIVER	CA	360	130.8	7,091	503
TN16305	South Holston	SOUTH FORK HOLSTON RIVER	TN	4,860	9.8	98,143	510
TX01602	Dunlap TP 1	GUADALUPE RIVER	TX	410	117.3	19,986	514
NC00419	Hiwassee Dam	HIWASSEE RIVER	NC	2,180	22.4	251,222	521
MI00229	C W Tippy	PINE	MI	1,540	31.9	54,546	526
MO30088	Ozark Beach	WHITE	MO	2,200	22.6	88,104	531
MN00601	Sylvan	CROW WING	MN	1,280	40.3	12,037	551
WA00257	Alder	NISQUALLY RIVER	WA	3,065	17.1	227,217	560
WA00257	LaGrande	NISQUALLY RIVER	WA	3,065	17.1	357,945	560
MI00189	Four Mile Hydropower Project	THUNDER BAY	MI	1,700	31.9	8,912	580
MI00189	Norway Point Hydropower Project	THUNDER BAY	MI	1,700	31.9	12,593	580
MI00161	Cooke	AU SABLE	MI	1,700	31.9	22,061	580
CO01664	Ruedi	FRYINGPAN RIVER	CO	998	56.6	15,384	604
WA00084	Rock Island	COLUMBIA R	WA	3,320	17.1	2,177,620	606
NC00550	Tuckertown	YADKIN R	NC	2,560	22.4	103,710	612
MN00514	Byllesby	CANNON	MN	1,430	40.3	13,611	616
IN00451	Oakdale	TIPPECANOE	IN	2,040	28.6	29,025	625

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AR00535	Remmel	OUACHITA R	AR	1,642	35.8	27,003	629
CA00440	Big Creek 4	SAN JOAQUIN RIVER	CA	465	130.8	487,279	650
CA00440	Big Creek 3	SAN JOAQUIN RIVER	CA	465	130.8	841,970	650
GA29101	Nottely	NOTTELY RIVER	GA	1,560	39.2	28,904	654
CA00415	Pit 7	PIT RIVER	CA	470	130.8	483,569	657
WI00746	Tomahawk	WISCONSIN	WI	2,773	22.3	10,232	661
OR00612	Lost Creek	ROGUE RIVER	OR	3,430	18.3	244,825	671
OR00004	Detroit	NORTH SANTIAM RIVER	OR	3,490	18.3	287,863	682
IL82201	Lockport Powerhouse	CHICAGO SANITARY & SHIP CANAL	IL	2,112	30.3	36,330	685
NC00392	Santeetlah	CHEOAH R	NC	2,863	22.4	135,806	685
CA00194	San Dimas Wash Generating Station	WALNUT CREEK	CA	490	130.8	3,236	685
AL01424	Mitchell Dam	COOSA	AL	5,850	11.0	411,104	688
GA00830	Bartletts Ferry	CHATTAHOOCHEE	AL	5,850	11.0	427,335	688
VA08901	Philpott Lake	SMITH RIVER	VA	2,880	22.6	27,566	695
CA10181	South	SACRAMENTO RIVER	CA	500	130.8	17,216	699
MI00547	Secord	TITTABAWASSEE	MI	2,087	31.9	3,504	712
WA00149	Merwin	LEWIS R	WA	3,921	17.1	559,382	716
OR00010	Green Peter	MIDDLE SANTIAM RIVER	OR	3,720	18.3	166,456	727
WA00145	Cushman 1	N FK SKOKOMISH RIVER	WA	4,010	17.1	156,186	732
CA10174	Nimbus	AMERICAN RIVER	CA	540	130.8	59,698	755
WV06702	Gauley River Power Partners	GAULEY RIVER	WV	2,790	25.3	171,276	756
NC00787	Mountain Island	CATAWBA	NC	3,235	22.4	112,499	774
OR00549	Round Butte	DESCHUTES	OR	4,000	18.3	1,000,545	782
TN02101	Cheatham	CUMBERLAND RIVER	TN	7,450	9.8	139,849	782
CA00200	San Gabriel Hydro Project	SAN GABRIEL RIVER	CA	560	130.8	22,782	783
CA00272	Sly Creek	LOST CREEK	CA	562	130.8	37,010	786
AL01423	Jordan Dam	COOSA	AL	6,800	11.0	327,599	799
AL01423	Walter Bouldin Dam	COOSA	AL	6,800	11.0	434,527	799
MI00175	James R Smith	DEAD	MI	2,429	31.9	7,981	829

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MI00175	Hoist	DEAD	MI	2,429	31.9	9,636	829
OR00009	Lookout Point	MIDDLE FORK-WILLAMETTE RIVER	OR	4,360	18.3	268,930	853
CA00041	Thermalito	FEATHER RIVER - OS	CA	630	130.8	175,481	881
ID00049	Swan Falls	SNAKE R	ID	1,525	54.2	124,623	884
CA10160	Spring Creek	SACRAMENTO RIVER	CA	640	130.8	323,355	895
CA10160	Keswick	SACRAMENTO RIVER	CA	640	130.8	378,586	895
WA00174	Upper Baker	BAKER R	WA	4,985	17.1	360,505	910
WA00021	Long Lake	SPOKANE R	WA	5,060	17.1	479,748	924
WI00781	Stevens Point	WISCONSIN	WI	3,915	22.3	24,562	934
NC00391	Chatuge	HIWASSEE RIVER	NC	3,930	22.4	26,153	940
UT10131	Wanship	WEBER RIVER	UT	1,189	74.8	8,130	951
CT83022	Rocky River	ROCKY RIVER	CT	5,600	16.2	9,492	970
CA00358	Spaulding 2	SFK YUBA RIVER	CA	698	130.8	12,742	976
CA00358	Spaulding 3	SFK YUBA RIVER	CA	698	130.8	32,375	976
CA00358	Spaulding 1	SFK YUBA RIVER	CA	698	130.8	35,122	976
MD00004	Deep Creek	DEEP CREEK	MD	4,500	20.3	22,037	979
WV07906	Winfield	KANAWA RIVER	WV	3,738	25.3	95,950	1,013
CA00253	Scott Flat	DEER CREEK	CA	725	130.8	4,344	1,014
WI00732	Holcombe	CHIPPEWA	WI	4,300	22.3	101,613	1,026
TN11502	Nickajack	TENNESSEE RIVER	TN	9,930	9.8	492,353	1,043
MI00191	Peavy Falls	MICHIGAMME	MI	3,160	31.9	36,678	1,079
VA15502	Claytor	NEW RIVER	VA	4,472	22.6	210,911	1,079
NC00827	Roanoke Rapids	ROANOKE	NC	4,600	22.4	334,199	1,100
NC00827	Gaston	ROANOKE	NC	4,600	22.4	340,244	1,100
TN15501	Douglas Dam	FRENCH BROAD RIVER	TN	10,600	9.8	348,019	1,113
CA83165	Bowman	CANYON CREEK	CA	810	130.8	15,222	1,133
PA00855	Safe Harbor	SUSQUEHANNA RIVER	PA	7,360	14.6	988,475	1,146
CA00255	Rollins	BEAR RIVER	CA	828	130.8	68,535	1,158
GA00847	Burton	TALLULAH	GA	2,775	39.2	20,360	1,163
AL83001	Harris Dam	TALLAPOOSA	AL	10,661	11.0	159,540	1,253
TN15901	Cordell Hull	CUMBERLAND RIVER	TN	11,960	9.8	365,803	1,256
NC00547	Tillery	PEE DEE R	NC	5,260	22.4	189,580	1,258
NC00549	Narrows	YADKIN R	NC	5,355	22.4	446,979	1,281
TN10501	Fort Loudoun	TENNESSEE RIVER	TN	12,200	9.8	686,129	1,281
MN00607	Winton	KAWISHIWI	MN	2,983	40.3	8,962	1,284

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TN08903	Cherokee Dam	HOLSTON RIVER	TN	12,360	9.8	283,637	1,298
CA00325	Iron Gate	KLAMATH R	CA	944	130.8	96,256	1,320
AL01416	H Neely Henry Dam	COOSA	AL	11,235	11.0	176,953	1,321
GA00821	Carters	COOSAWATTEE RIVER	GA	3,220	39.2	539,044	1,349
MI00171	Hardy	MUSKEGON	MI	3,971	31.9	79,794	1,355
NY00776	Victory Mills	OWASCO OUTLET	NY	6,400	20.0	3,782	1,371
WV05301	Racine	OHIO RIVER	OH	5,300	24.4	137,165	1,382
WA00088	Priest Rapids	COLUMBIA R	WA	7,580	17.1	3,995,732	1,384
NY83028	Stillwater Reservoir Hydro	BEAVER RIVER	NY	6,490	20.0	5,233	1,390
CA00323	Copco 1	KLAMATH R	CA	1,000	130.8	67,544	1,398
CA00323	Copco 2	KLAMATH R	CA	1,000	130.8	88,801	1,398
FL00108	C H Corn Hydroelectric Facility	OCHLOCKONEE	FL	10,200	12.9	19,770	1,407
AL01434	Jones Bluff	ALABAMA RIVER	AL	12,300	11.0	272,954	1,446
WY01293	Guernsey	NORTH PLATTE RIVER	WY	2,380	58.6	20,580	1,490
TN03701	J P Priest	STONES RIVER	TN	14,200	9.8	56,107	1,491
WI00730	Wissota	CHIPPEWA	WI	6,300	22.3	154,227	1,503
WA00347	Ice Harbor	SNAKE RIVER	WA	8,375	17.1	1,498,679	1,530
WA00299	Chief Joseph	COLUMBIA RIVER	WA	8,400	17.1	9,115,556	1,534
WY01290	Alcova	NORTH PLATTE RIVER	WY	2,471	58.6	110,997	1,547
WY01290	Fremont Canyon	NORTH PLATTE RIVER	WY	2,471	58.6	243,289	1,547
TN01302	Norris Dam	CLINCH RIVER	TN	14,900	9.8	411,819	1,565
AL01418	Lay Dam	COOSA	AL	13,700	11.0	482,545	1,611
WA00349	Lower Granite	SNAKE RIVER	WA	8,900	17.1	1,836,807	1,625
CA00337	A G Wishon	NFK WILLOW CREEK	CA	1,165	130.8	89,863	1,629
ID00288	Lucky Peak Power Plant Project	BOISE RIVER	ID	2,820	54.2	285,584	1,634
CO01695	Vallecito Hydroelectric	LOS PINOS RIVER	CO	2,720	56.6	19,370	1,646
WI00784	Du Bay	WISCONSIN	WI	6,904	22.3	38,668	1,647
CA00833	Gosselin Hydro Plant	MAD RIVER	CA	1,180	130.8	6,970	1,650
NY00041	Ashokan	ESOPUS CREEK	NY	7,923	20.0	7,275	1,697
CA00857	French Meadows	RUBICON RIVER	CA	1,250	130.8	57,728	1,748

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CA00857	Middle Fork	RUBICON RIVER	CA	1,250	130.8	545,513	1,748
AL07702	Wilson Dam	TENNESSEE RIVER	AL	15,000	11.0	2,094,059	1,763
CA00395	Pit 3	PIT RIVER	CA	1,265	130.8	283,586	1,769
WA00098	Wells	COLUMBIA R	WA	9,700	17.1	3,526,019	1,772
WA00086	Rocky Reach	COLUMBIA R	WA	9,810	17.1	5,070,752	1,792
AL01417	Logan Martin Dam	COOSA	AL	15,263	11.0	306,988	1,794
ID00280	Arrowrock Hydroelectric Project	BOISE RIVER	ID	3,100	54.2	77,648	1,797
WV10301	New Martinsville Hannibal Hydro	OHIO RIVER	WV	6,650	25.3	198,296	1,802
WA00331	Little Goose	SNAKE RIVER	WA	10,025	17.1	1,880,977	1,831
ID00222	Cabinet Gorge	CLARK FORK	ID	3,203	54.2	941,484	1,856
MD00097	Conowingo	SUSQUEHANNA RIVER	MD	8,563	20.3	1,645,359	1,863
TN04102	Center Hill	CANEY FORK RIVER	TN	18,220	9.8	251,053	1,914
CO02005	Dillon Hydro Plant	BLUE CREEK	CO	3,300	56.6	6,875	1,997
KY03046	Laurel	LAUREL	KY	6,060	31.1	65,261	2,017
AL01435	Millers Ferry	ALABAMA RIVER	AL	17,200	11.0	302,175	2,022
MO82201	Clarence Cannon	SALT	MO	8,400	22.6	152,706	2,027
CA00820	Loon Lake	GERLE CREEK	CA	1,450	130.8	120,678	2,027
AZ10313	Mormon Flat	SALT RIVER	AZ	950	200.2	76,635	2,033
MT00561	Madison	MADISON R	MT	3,900	49.9	61,727	2,082
WA00151	Mossyrock	COWLITZ RIVER	WA	11,830	17.1	1,026,686	2,161
AR00165	Whillock	ARKANSAS	AR	5,660	35.8	148,926	2,169
MI00205	Way Dam	MICHIGAMME	MI	6,400	31.9	2,894	2,184
OR00002	The Dalles Fishway	COLUMBIA RIVER	OR	11,200	18.3	40,572	2,190
OR00002	The Dalles	COLUMBIA RIVER	OR	11,200	18.3	5,608,035	2,190
OR00002	John Day	COLUMBIA RIVER	OR	11,200	18.3	7,655,722	2,190
CA00326	Butt Valley	BUTT CREEK	CA	1,600	130.8	116,480	2,237
ID00223	Milner Hydro	SNAKE RIVER	ID	4,000	54.2	91,701	2,318
TN03702	Old Hickory	CUMBERLAND RIVER	TN	22,500	9.8	412,778	2,363
WV10702	Belleville	OHIO RIVER	WV	8,900	25.3	262,894	2,412
MT00559	Holter	MISSOURI R	MT	4,550	49.9	303,864	2,429
AL01420	Lewis Smith Dam	SIPSEY FORK/WARRIOR	AL	21,200	11.0	214,662	2,492
AR00163	Ellis	ARKANSAS	AR	6,820	35.8	143,431	2,613

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AR00534	Carpenter	OUACHITA R	AR	6,897	35.8	111,812	2,643
WA00085	Wanapum	COLUMBIA R	WA	14,590	17.1	4,198,171	2,665
TN06504	Chickamauga	TENNESSEE RIVER	TN	25,600	9.8	638,159	2,689
AZ10318	Stewart Mountain	SALT RIVER	AZ	1,264	200.2	37,391	2,705
CA10114	Kaweah 2	KAWEAH RIVER	CA	1,945	130.8	12,555	2,719
CA10114	Terminus Hydroelectric Project	KAWEAH RIVER	CA	1,945	130.8	52,794	2,719
ID00279	Anderson Ranch	SOUTH FORK BOISE RIVER	ID	4,741	54.2	121,656	2,748
AR00154	Narrows	LITTLE MISSOURI RIVER	AR	7,200	35.8	29,783	2,759
CA01224	Spicer Meadow Project	HIGHLAND CREEK	CA	1,998	130.8	19,746	2,794
CA00227	Camp Far West	BEAR RIVER	CA	2,050	130.8	27,786	2,866
TN02702	Dale Hollow	OBEY RIVER	TN	27,700	9.8	101,125	2,909
KY03031	Greenup Hydro	OHIO RIVER	OH	11,200	24.4	272,415	2,921
CA00164	Pardee	MOKELUMNE RIVER	CA	2,134	130.8	130,964	2,984
CA00044	Foothill Feeder	CASTAIC CREEK	CA	2,235	130.8	48,132	3,125
CA00044	Castaic	CASTAIC CREEK	CA	2,235	130.8	241,544	3,125
CA00054	Perris	BERNASCONI PASS	CA	2,340	130.8	14,846	3,272
CA00276	Woodward Power Plant	SIMMONS CREEK	CA	2,427	130.8	5,000	3,393
CA10113	Tulare Success Power Project	TULE RIVER	CA	2,450	130.8	2,439	3,425
TN12102	Watts Bar Hydro	TENNESSEE RIVER	TN	32,700	9.8	775,659	3,434
AL01415	Weiss Dam	COOSA	AL	30,200	11.0	193,703	3,550
WI00724	Castle Rock	WISCONSIN	WI	14,900	22.3	101,447	3,554
NC00388	High Rock	YADKIN R	NC	15,180	22.4	129,371	3,630
AR00171	Murray	ARKANSAS	AR	9,700	35.8	137,381	3,717
OR00582	Owyhee Dam Power Project	OWYHEE RIVER	OR	19,250	18.3	17,676	3,764
TN07101	Pickwick Landing Dam	TENNESSEE RIVER	TN	36,300	9.8	1,027,975	3,813
SC00685	Wylie	CATAWBA	SC	12,139	30.1	138,718	3,905
WA00454	Bonneville	COLUMBIA RIVER	OR	20,200	18.3	4,034,951	3,950
AR00164	Ozark	ARKANSAS	AR	10,600	35.8	146,965	4,062
AR00169	Dam 2	ARKANSAS	AR	10,600	35.8	431,239	4,062
MT00223	Noxon Rapids	CLARK FK,PEND OREILLE R	MT	7,940	49.9	1,503,127	4,240
SC00485	Wateree	CATAWBA RIVER	SC	13,250	30.1	201,972	4,263

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ID00054	C J Strike	SNAKE R	ID	7,500	54.2	423,822	4,347
ID00272	Island Park	HENRYS FORK	ID	7,794	54.2	18,055	4,517
CA00279	Turlock Lake	TR TUOLUMNE RV	CA	3,260	130.8	9,998	4,558
AL01425	Martin Dam	TALLAPOOSA	AL	40,000	11.0	397,804	4,702
WA00261	Main Canal Headworks	OFFSTREAM - UPPER GRAND COULEE	WA	27,000	17.1	95,627	4,931
WA00268	PEC Headworks	CRAB CREEK	WA	27,800	17.1	22,519	5,077
MN00594	Hastings City Hydroelectric	MISSISSIPPI RIVER	MN	11,810	40.3	17,425	5,083
AR00151	Degray	CADDO RIVER	AR	13,400	35.8	64,707	5,135
FL00435	J Woodruff	APALACHICOLA RIVER	FL	37,500	12.9	157,704	5,174
AL07701	Wheeler Dam	TENNESSEE RIVER	AL	45,450	11.0	1,096,591	5,343
CO01675	Blue Mesa	GUNNISON RIVER	CO	9,180	56.6	211,367	5,554
NY00146	E J West	SACANDAGA RIVER	NY	25,940	20.0	65,519	5,555
AZ10311	Horse Mesa	SALT RIVER	AZ	2,660	200.2	145,079	5,692
KY03033	Markland	OHIO RIVER	IN	19,000	28.6	359,051	5,818
SC00706	Keowee	KEOWEE	SC	18,372	30.1	73,463	5,910
MO30200	Stockton	SAC RIVER	MO	24,900	22.6	11,579	6,008
WA00004	Chelan	CHELAN R	WA	32,980	17.1	387,365	6,023
NY00230	Lachute Hydro Lower	LA CHUTE RIVER	NY	28,160	20.0	15,221	6,031
CA10109	New Hogan Power Plant	CALAVERAS RIVER	CA	4,400	130.8	4,305	6,152
KY03034	Ohio Falls	OHIO RIVER	KY	18,840	31.1	236,520	6,272
GA00836	Sinclair Dam	OCONEE	GA	15,330	39.2	124,374	6,423
CA01410	Diamond Valley Lake	DOMENIGONI VALLEY CR	CA	4,860	130.8	4,032	6,795
CA10154	Friant Hydro Facility	SAN JOAQUIN RIVER	CA	4,900	130.8	76,039	6,851
OR00616	McNary Fish	COLUMBIA RIVER	WA	38,800	17.1	82,045	7,086
AL09501	Guntersville	TENNESSEE RIVER	AL	62,000	11.0	645,316	7,289
OR00616	McNary	COLUMBIA RIVER	OR	38,800	18.3	4,599,712	7,587
WY01291	Glendo	NORTH PLATTE RIVER	WY	12,365	58.6	100,110	7,739
NC00132	Cowans Ford	CATAWBA	NC	32,510	22.4	158,899	7,775
TX00986	Marble Falls	COLORADO RIVER	TX	6,375	117.3	20,208	7,994
TX00986	Granite Shoals	COLORADO RIVER	TX	6,375	117.3	30,131	7,994
CA00813	Nacimiento Hydro Project	SAN ANTONIO RIVER	CA	5,720	130.8	12,204	7,997
GA03742	Allatoona	ETOWAH	GA	19,200	39.2	121,614	8,045
CA10112	Pine Flat	KINGS RIVER	CA	5,970	130.8	512,545	8,347

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
AR00159	Norfork	NORTH FORK OF THE WHITE	AR	22,000	35.8	234,712	8,430
ID00056	Brownlee	SNAKE RIVER	ID	14,621	54.2	2,245,004	8,474
MT00576	Yellowtail	BIGHORN RIVER	MT	17,300	49.9	830,746	9,237
OK00134	Markham	NEOSHO R	OK	10,900	79.9	277,762	9,309
ID00273	Palisades	SNAKE RIVER	ID	16,150	54.2	606,219	9,360
MT00579	Tiber Dam Hydroelectric Plant	MARIAS RIVER	MT	17,886	49.9	41,868	9,550
ID00287	Dworshak	NORTH FORK CLEARWATER RIVER	ID	17,090	54.2	1,289,227	9,905
OK10304	Webbers Falls	ARKANSAS RIVER	OK	11,640	79.9	171,851	9,941
CA00240	Exchequer	MERCED RIVER	CA	7,130	130.8	33,024	9,969
TX00004	Canyon	GUADALUPE RIVER	TX	8,240	117.3	21,272	10,332
MO30202	Table Rock	WHITE	MO	43,100	22.6	558,043	10,400
CA00173	Camanche	MOKELUMNE RIVER	CA	7,700	130.8	41,275	10,766
AR00174	Beaver	WHITE	AR	28,220	35.8	189,500	10,814
GA00820	West Point	CHATTAHOOCHEE RIVER	GA	25,864	39.2	103,053	10,837
OK10311	Tenkiller Ferry	ILLINOIS RIVER	OK	12,900	79.9	119,492	11,017
GA00068	Richard B Russell	SAVANNAH RIVER	GA	26,653	39.2	557,302	11,168
VA11701	John H Kerr	ROANOKE RIVER	VA	48,900	22.6	506,304	11,799
AR00173	Greers Ferry Lake	LITTLE RED	AR	31,460	35.8	218,386	12,056
OK10307	Broken Bow	MOUNTAIN FK RIVER	OK	14,200	79.9	107,927	12,127
WY01297	Seminoe	NORTH PLATTE RIVER	WY	20,291	58.6	156,861	12,700
MT00565	Hungry Horse	SOUTH FORK FLATHEAD RIVER	MT	23,800	49.9	834,213	12,708
IL01238	Keokuk	MISSISSIPPI RIVER	IA	30,845	38.9	930,304	12,818
AR00162	Dardanelle	ARKANSAS	AR	34,300	35.8	706,781	13,144
MO30014	Osage	OSAGE	MO	55,342	22.6	813,835	13,354
MO20725	Harry Truman	OSAGE RIVER	MO	55,600	22.6	394,738	13,416
OK20509	Kaw Hydro	ARKANSAS RIVER	OK	16,750	79.9	109,998	14,305
WA00262	Grand Coulee	COLUMBIA RIVER	WA	82,300	17.1	18,351,775	15,031
AR00150	Blakely Mountain	OUACHITA RIVER	AR	40,100	35.8	74,975	15,366
CA10148	Jones Fork	AMERICAN RIVER	CA	11,180	130.8	19,960	15,631
CA10148	Union Valley	AMERICAN RIVER	CA	11,180	130.8	127,564	15,631
CA10148	Folsom	AMERICAN RIVER	CA	11,180	130.8	566,959	15,631

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
CA10148	Jaybird	AMERICAN RIVER	CA	11,180	130.8	585,707	15,631
CA10106	Isabella Hydro Project	KERN RIVER	CA	11,200	130.8	40,478	15,659
ID00283	Cascade	NORTH FORK PAYETTE RIVER	ID	27,700	54.2	35,781	16,055
OR00557	East Side	KLAMATH RIVER	OR	85,000	18.3	4,399	16,621
KY03010	Wolf Creek	CUMBERLAND	KY	50,250	31.1	642,846	16,728
OK10314	Fort Gibson	GRAND RIVER	OK	19,900	79.9	251,691	16,995
CA10246	New Melones	STANISLAUS RIVER	CA	12,500	130.8	339,801	17,477
MT00568	Canyon Ferry	MISSOURI RIVER	MT	32,798	49.9	368,871	17,512
CA00281	Don Pedro	TUOLUMNE RIVER	CA	12,960	130.8	527,932	18,120
CA00281	R C Kirkwood	TUOLUMNE RIVER	CA	12,960	130.8	557,200	18,120
TX00015	Robert D Willis	NECHES RIVER	TX	14,700	117.3	23,490	18,433
AL01432	Walter F George	CHATTAHOOCHEE RIVER	GA	45,181	39.2	358,836	18,931
OK10309	Keystone	ARKANSAS RIVER	OK	22,420	79.9	295,717	19,148
KY03001	Barkley	CUMBERLAND	KY	57,920	31.1	506,250	19,282
GA00824	Buford	CHATTAHOOCHEE RIVER	GA	47,182	39.2	198,014	19,770
NV10123	Lahontan	CARSON RIVER	NV	12,121	157.5	4,531	20,406
CA00035	Kelly Ridge	FEATHER RIVER	CA	15,800	130.8	77,679	22,091
CA00035	Edward C Hyatt	FEATHER RIVER	CA	15,800	130.8	1,377,143	22,091
NM00120	Navajo Dam	SAN JUAN RIVER	NM	15,610	132.8	73,147	22,157
CA10196	Trinity	TRINITY RIVER	CA	16,535	130.8	320,533	23,118
GA01702	Hartwell Lake	SAVANNAH RIVER	GA	55,950	39.2	481,190	23,444
TX01087	Marshall Ford	COLORADO RIVER	TX	18,929	117.3	98,628	23,736
MT00652	Libby	KOOTENAI RIVER	MT	46,500	49.9	1,701,918	24,829
ID83002	Post Falls	SPOKANE R	ID	48,000	54.2	90,272	27,820
OK10301	Robert S Kerr	ARKANSAS RIVER	OK	32,800	79.9	619,454	28,012
NE01048	Kingsley	NORTH PLATTE	NE	30,500	86.0	79,701	28,037
AZ10312	Parker Dam	COLORADO RIVER	CA	20,390	130.8	439,316	28,508
TX00989	Buchanan	COLORADO RIVER	TX	23,060	117.3	3,151	28,916
TX00008	Lewisville	ELM FORK OF TRINITY	TX	23,280	117.3	7,448	29,191
SD01094	Gavins Point	MISSOURI RIVER	NE	32,000	86.0	584,337	29,416
TX00017	Whitney	BRAZOS RIVER	TX	23,560	117.3	88,152	29,542
SC00732	Spillway	SANTEE R	SC	100,000	30.1	14,801	32,170
ID00274	American Falls	SNAKE RIVER	ID	58,076	54.2	318,627	33,660
UT10121	Flaming Gorge	GREEN RIVER	UT	43,820	74.8	409,246	35,037
SD01092	Big Bend	MISSOURI RIVER	SD	60,000	57.4	939,594	36,815
CA00327	Caribou 2	NFK FEATHER RV	CA	28,257	130.8	357,165	39,508
OK00135	Pensacola	NEOSHO	OK	46,500	79.9	526,469	39,713

NID ID	Hydropower Facility	River Name	State	Surface Area (acres)	Net Water Consumption (cm/yr)	Power Generation (MWh)	Net Water Consumption (MGY)
CA10186	Shasta	SACRAMENTO RIVER	CA	29,743	130.8	1,840,067	41,585
KY15701	Kentucky Dam	TENNESSEE RIVER	KY	130,000	31.1	1,084,642	43,278
AZ10317	Roosevelt	SALT RIVER	AZ	21,493	200.2	129,529	45,996
MT00025	Fort Peck	MISSOURI RIVER	MT	93,000	49.9	584,252	49,657
NM00129	Elephant Butte	RIO GRANDE	NM	36,643	132.8	67,473	52,011
ID00319	Albeni Falls	PEND OREILLE RIVER	ID	94,600	54.2	203,978	54,829
MT00226	Kerr	FLATHEAD RIVER	MT	124,800	49.9	1,033,265	66,637
SD01093	Fort Randall	MISSOURI RIVER	SD	118,400	57.4	1,799,442	72,649
ND00145	Garrison	MISSOURI RIVER	ND	133,000	62.0	2,042,118	88,116
OK10317	Denison	RED RIVER	TX	86,910	117.3	263,933	108,979
TX02296	Amistad Dam & Power	RIO GRANDE	TX	89,000	117.3	147,000	111,599
OK10308	Eufaula Dam	CANADIAN RIVER	OK	143,000	79.9	328,427	122,127
TX00011	Sam Rayburn	ANGELINA RIVER	TX	114,500	117.3	90,113	143,574
TX00024	Falcon Dam & Power	RIO GRANDE	TX	115,400	117.3	115,303	144,703
AR00160	Bull Shoals	WHITE	AR	454,400	35.8	940,567	174,127
TX83005	Toledo Bend		TX	181,600	117.3	203,163	227,713
SD01095	Oahe	MISSOURI RIVER	SD	376,000	57.4	2,499,765	230,708
NV10122	Hoover Dam	COLORADO RIVER	NV	156,800	157.5	2,097,079	263,971
NV10122	Hoover Dam	COLORADO RIVER	AZ	156,800	200.2	1,517,486	335,558
AZ10307	Glen Canyon Dam	COLORADO RIVER	AZ	160,784	200.2	3,671,552	344,084
Totals						**198,608,287**	**4,500,269**

Table 6: Power Generation from Co-located Facilities Receiving no Water Consumption Burden

Hydropower Facility	State	Generation	Primary Facility
Rock Creek	CA	423,641	Cresta
Nantahala	NC	203,012	Queens Creek
Dearborn	SC	143,863	Great Falls
Highgate Falls	VT	51,957	Milton
Thousand Springs	ID	51,590	Upper Salmon B
Browns Falls	NY	50,128	Flat Rock
Sturgeon	NY	48,481	Central Hudson High Falls
Androscoggin 3	ME	25,293	Deer Rips
Sanford	MI	6,411	Edenville
Mill C	NY	26,719	Kent Falls
Cadyville	NY	24,412	Kent Falls
Messalonskee 2 (Oakland)	ME	5,175	Messalonskee

Hydropower Facility	State	Generation	Primary Facility
Messalonskee 5	ME	2,983	Messalonskee
Clark Falls	VT	18,808	Milton
Ayers Island	NH	44,913	Newfound Hydroelectric
Alice Falls Hydro Project	NY	5,492	Rainbow Falls
Tuckasegee	NC	6,172	Thorpe
Total		**1,139,050**	

US Average Hydropower Water Consumption

The results summarized in Table 4 and Table 6 imply that 119,205 million gallons of water are consumed to generate 11,297,101 MWh of hydropower annually in reservoirs dedicated solely to hydropower generation, while the results shown in Table 5 imply that 4,500,269 million gallons of water are consumed to generate 198,608,287 MWh of hydropower annually in multipurpose reservoirs. An additional 15,066,650 MWh of electricity are generated by run-of-the-river facilities that exhibit no water consumption burden. Collectively, these results imply water consumption factors of 10.55 gal/kWh and 22.7 gal/kWh for dedicated and multipurpose facilities without allocation, respectively.

Multipurpose reservoirs were found to be more water intensive than those dedicated to hydropower production, which is not surprising given that the hydropower is not the primary design focus in such cases. Allocation of the water to other purposes is subjective and highly influences results. It can be argued that hydropower is a by-product of reservoir construction and deserves no allocation or alternatively that the hydropower generation should receive the entire water consumption burden. If the multipurpose reservoirs receive none of the burden, the production-weighted average water consumption factor for US hydropower production is 0.53 gal/kWh. Allocating the entire burden yields a water consumption factor of 20.53 gal/kWh. The water consumption intensity in the multipurpose reservoirs was assumed to be similar to the dedicated facilities, and the water consumption burden was allocated accordingly. In other words, 10.55 gal/kWh of the 22.7 gal/kWh associated with multiple purpose reservoirs was allocated to hydropower with the remainder allocated to the other purposes. The results of the analysis are summarized in Table 7. This value represents a water consumption attributed to hydropower generation that can be used in large-scale life cycle analysis of energy systems such as the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model (Argonne National Laboratory, 2014). The estimated total evaporation from the reservoirs was 9.07 trillion gallons per year, which represents an increase of 4.62 trillion gallons per year from the background evapotranspiration of 4.45 trillion gallons per year. The allocation of water amongst the different components is summarized in Figure 3.

Table 7: Summary of National Average Water Consumption associated with Hydropower Facilities

Parameter	Run-of-the-River Facilities	Dedicated Reservoir Facilities	Multiple Purpose Reservoir Facilities	Total

Evaporation (MGY)	0	258,358	8,810,923	9,069,281
Background Evapotranspiration (MGY)	0	139,153	4,310,654	4,449,807
Total Water Consumption (MGY)	0	119,205	4,500,269	4,619,474
Allocated Water Consumption (MGY)	0	119,205	2,095,682	2,214,887
Power Generation (TWh)	15.1	11.3	198.6	210
Water Consumption Intensity (gal/kWh)	0	10.55	10.55	9.85

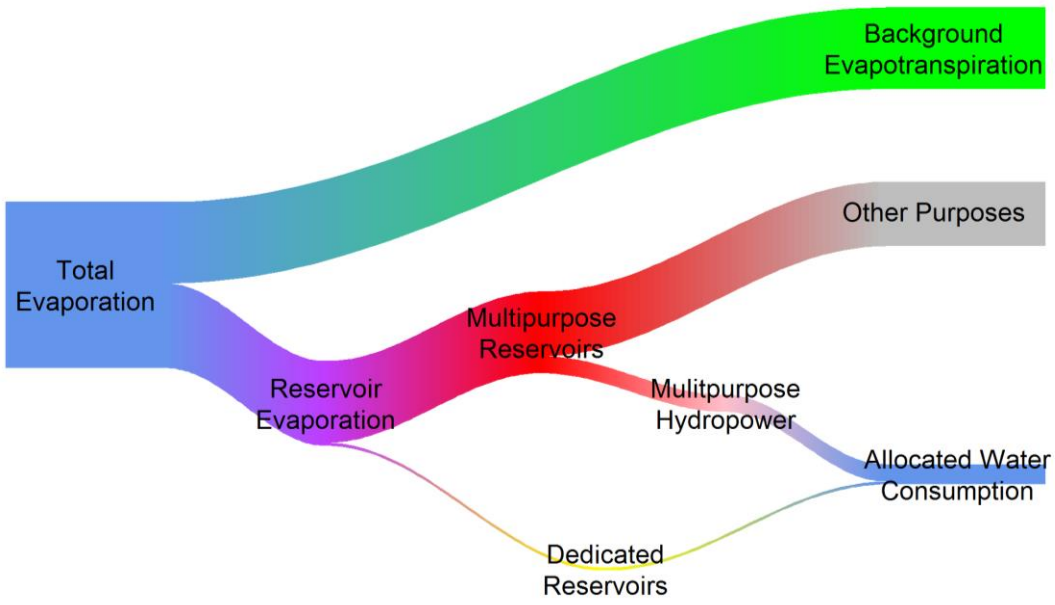

Figure 3. Allocation of hydropower water consumption.

Previous studies of water consumption associated with power generation have found relatively high water intensity for hydropower versus other technologies (Torcellini et al., 2003). A recent study compared the life cycle water consumption of various power generation technologies in the United States (Meldrum et al., 2013). The results of this analysis were compared with water consumption estimates for other power generation technologies as shown in Figure 4. The water consumption per unit generation was substantially higher for hydropower than all other technologies even after removing the background evapotranspiration and allocating the majority of the water consumed to other purposes in reservoirs created for reasons other than hydropower generation. The results highlight the

need to consider impacts of water resource consumption in river systems when planning the construction of hydropower reservoirs.

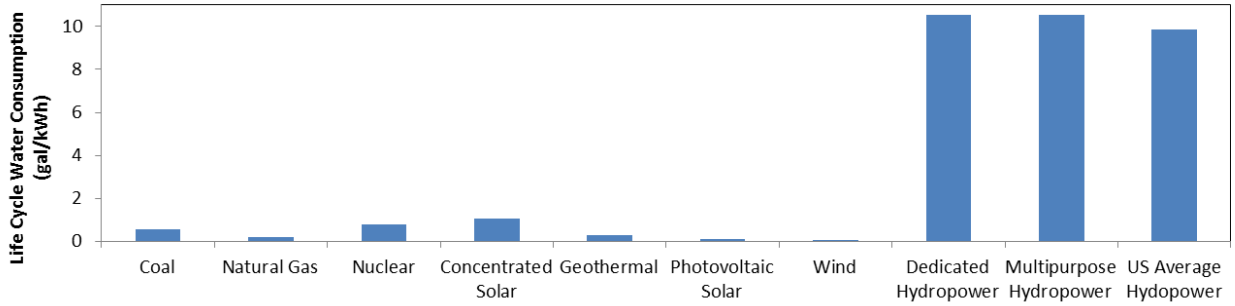

Figure 4. Comparison of Hydropower and Other Power Generation Technologies from Meldrum (2013).

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