Eklutna Lake Inflow Comparison

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The Hydro Operations Modeling Study (Section 3.9) portion within the draft plan states the need to develop an operations model to simulate alternative operational scenarios and quantify changes in flows through the power plant and impacts to generation. The draft plan states planned use of "historical reservoir inflow and available flow data." **We are submitting comments about our concerns using these historic inflow data.**

APU has measured discharge from the 'upper' Eklutna River (East and West Fork) since 2009 as well as Eklutna Glacier mass balance. We compared our data to assumed inflow/outflow and found dramatic differences. We outline these differences, assumptions as to why, and present a low-cost solution to improve discharge measurements. **Accurate input data is critical for any planning/modeling future decision making of water resources.**

Eklutna Lake monthly inflow reported by the utilities is computed from the difference in lake storage at the start and end of each month with the volume of water withdrawn to produce power added back to that difference. We compared our monthly discharge totals to this utility computed inflow for summer months (2013-2016). **APU discharge totals are consistently greater than utility projected inflow.** Figure 1 depicts APU observations to utility inflow calculations.

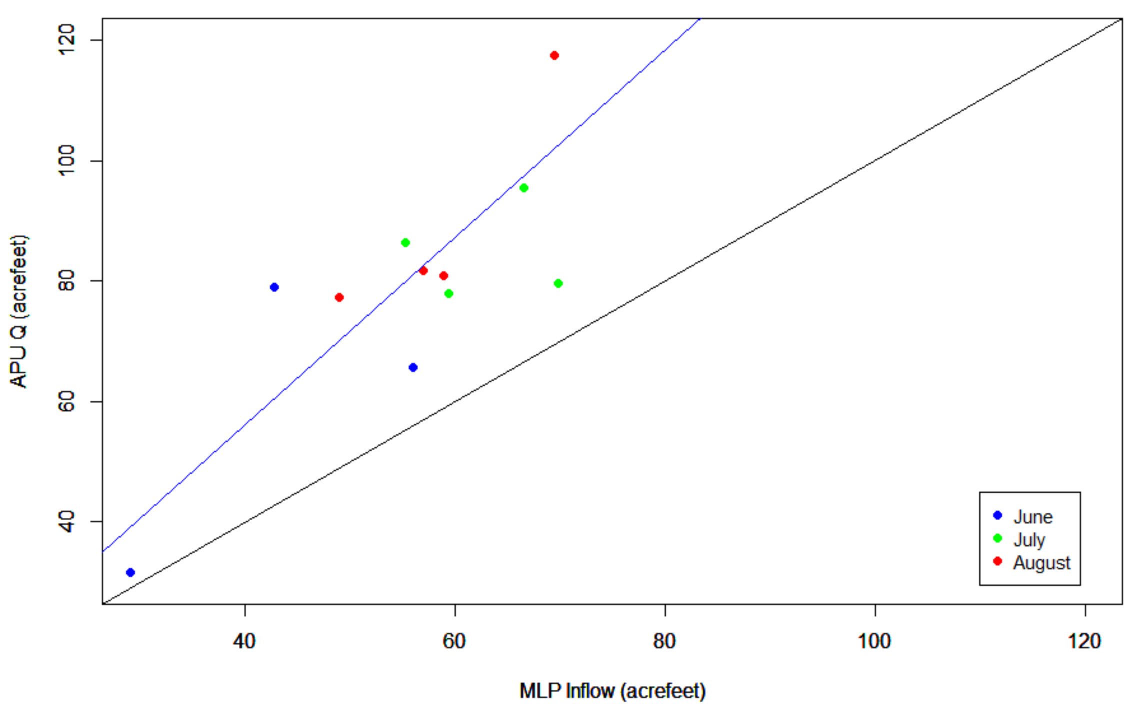

Figure 1. APU monthly summed observations (acre-feet) compared to utility inflow calculations for 2013 – 2016 period. Black line represents one-to-one line, blue line is best-fit line.

There are several reasons why the utility calculated inflow may differ from the APU inflow observations. Note APU inflow is the sum of continuous measured discharge in the WF Eklutna and EF Eklutna creeks (WFEF):

1. Utility inflow is estimated by a change in lake storage and outflow (specific example provide at end of document). Here are the general steps:
    a. Applying the measured USGS 15278000 reservoir elevation at the beginning and end of the month to an Alaska Power Administration (APA) storage-elevation curve (‘rating’) that may pre-date the 1967 transfer of power from USBR to APA (Brabets, 1992; https://www.eklutnahydro.com/)
    b. Calculating the difference in storage between months, e.g. June 1 to June 30,
    c. Summing monthly energy produced (MWH Used) by the hydro plant (and AWWU) and converting units to volume of water (acre-feet used) based on internal calculations (e.g. average equals approximately 0.65 MWH/ acre-feet; Ori, 2013, personal communication).

    In both steps a) and c) there is significant potential to introduce error considering the age of the ‘rating’ and the variable conversion from MWH to acre-feet, respectively.

2. A bathymetric survey in 1986 validated the APA rating within 5% at 860 ft a.m.s.l. (145,400 ac-ft; Brabets, 1992) but the rating has not been updated since then using more recent bathymetric surveys, e.g. APU 2009 (Larquier, 2010), USGS 2016-17 (Boes et al, 2017). When plotting the rating curve from Table 8 within Brabets (1992), we found a simple linear equation where a 0.1-foot increase in lake stage result in ~325 acre-feet change. It is safe to assume that present lake bathymetry differs, and therefore the storage-elevation relationship, considering sediment input from the glacier headwaters, excessive bank erosion at near-capacity lake elevation, and recent tectonic events.

3. Utility inflow computation assumes a static and linear difference in reservoir elevation between the beginning and end of the month and may not account for mid- month fluctuations. The APU continuous discharge time series is a straight sum calculated from the measured river stage applied to stage-discharge relationships built from over 100 measurements from nearly a decade of monitoring.
    a. We found a 44% average percent difference between APU summed WFEF discharge and Utility inflow for June-August 2013-2016; with the 5% difference found in 1986 applied to Utility reservoir storage, the average difference narrows to 37%.
        i. APU measured data is temporally incomplete. APU has not attempted to produce discharge estimates during winter months when the stage is affected by ice, nor when erroneous data were measured from e.g. instrument burial or channel alteration from floods. For this analysis we only used months with a complete discharge record.
4. We compared melt season (May-September) daily mean APU discharge (2009-2019) to USGS-measured discharge (1961-62 and 1985-1988) at WF Eklutna Creek (WF) and

EF Eklutna Creek (EF). We found a significant discharge increase between periods at both WF and EF(Figure #2; approximately 47.7% and 39.7%, respectively, primarily during the freshet and glacier melt maximum periods, with the least change during atmospheric- driven events and baseflow dominant periods. This suggests that the earlier storage or inflow rating model may no longer be accurate given the current inflow.

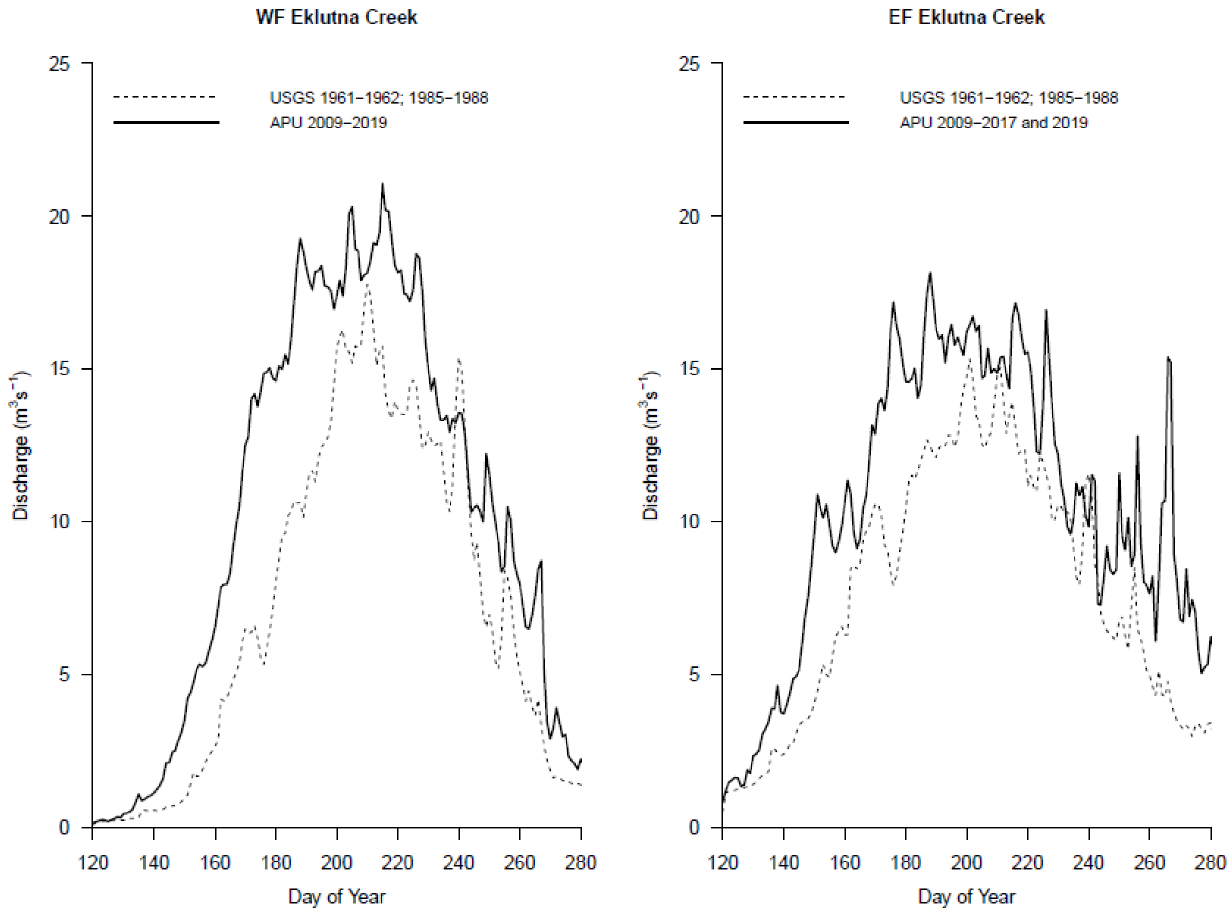

Figure 2. WF Eklutna Creek and EF Eklutna Creek average melt season (May-September) discharge comparison between historic (1961-62 and 1985-1988) and present (2009-2019) periods.

5. We evaluated changes in USGS 15278000 day of year mean reservoir elevation for pre-APU (1983-2008) and APU (2009-2019) project periods (Figure 3). We found that during the APU project period the lake level was on average approximately 2 m higher than the earlier period. Eklutna Lake has only overtopped its spillway (265 m a.m.s.l.) six times since 1983; four times in the 24 year pre-APU project period (1989,1990,1995,1997) and twice in the decade since (2012, 2013) with two near-spills in 2016 and 2019. These two findings suggest that reservoir management based on the old inflow rating model may no longer be accurate.

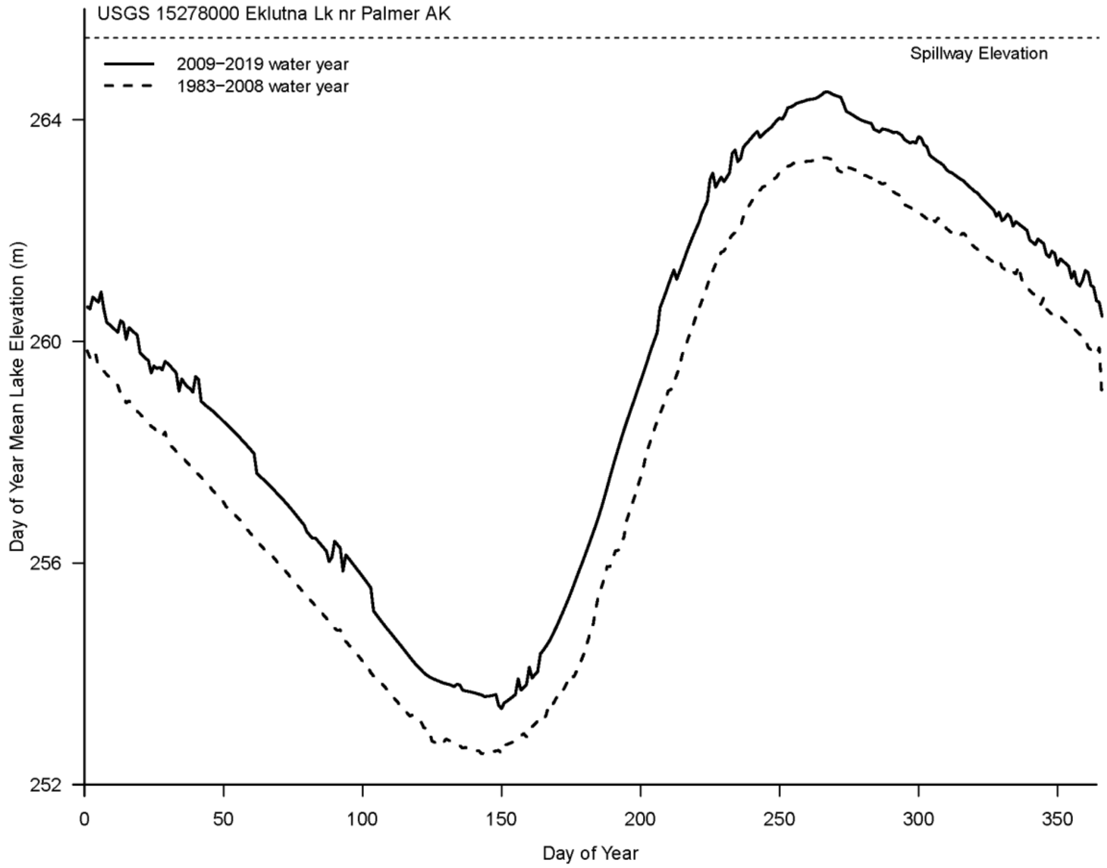

Figure 3. [USGS 15278000](#) day of year mean reservoir elevation for pre-APU (1983-2008) and APU (2009-2019) project periods; spillway elevation delineated at 265 m a.m.s.l.

We propose funding to assist with continued collection of discharge data at both forks of 'upper' Eklutna Rivers at $12,000. While APU has a long-term monitoring program for studying Eklutna Glacier mass balance and discharge since 2009, the discharge portion has always been challenging. A Fall 2017 flood event on the East Fork altered channel dramatically and changing existing stage-discharge curve. Another October 2020 flood shifted channels to new flow patterns. Thus, this spring we will have to change pressure transducer sensor locations. Basically, we will be starting over with stage measurements and building a new stage/discharge curve at both forks. However, our requested funding would allow purchasing of a two iGage sensors (~$1,500 per sensor) that are mounted on bridges versus within rivers (https://stilltek.com/index.php/a-homepage-section). These sensors also communicate near-real time data via Iridium Satellites with data available on a website. Funding would also allow hiring of an undergraduate/grad student to conduct more frequent discharge observations at modest costs. **Knowledge of flow contributions from these two rivers is critical for all aspects of the Eklutna Hydroelectric Project Study.**

EXAMPLE UTILITY INFLOW COMPUTATION:
From June-July 2012 from ML&P Annual Inflow Report

WATER YEAR 2012/2013	STARTING ELEV.		'ENDING ELEV.		CHANGE	MWH USED*	AC-FT USED*	INFLOW	INFLOW	HISTORIC INFLOW	AMT. OVER/(UNDER)	CUM. DEVIATION
	(FT)	STORAGE (AC-FT)	(FT)	STORAGE (AC-FT)	IN STORAGE (AC-FT)			AC-FT	MWH	(NWS PREDICTION) (AC-FT)	(AC-FT)	FOR WATER YR. (AC-FT)
JUNE	833.80	57,150	842.90	84,550	27,400	10,587	17,010	44,410	27,641	36,390	8,020	8,020
JULY	842.90	84,550	856.30	126,344	41,794	10,494	16,150	57,944	37,663	68,478	-10,534	-2,514

INFLOW AC-FT = LakeStorage_end - LakeStorage_begin + AC-FT Used,
where
LakeStorage_end and LakeStorage_begin is of each month and read from rating table, and AC-FT Used is computed from MWH produced (derived reported average 0.64 MWH/AC-FT),
44,010 AC_FT= 84,550 - 57,150 + 17,010

References

Boes, Evelien & Van Daele, Maarten & Moernaut, Jasper & Schmidt, Sabine & Jensen, Britta & Praet, Nore & Kaufman, Darrell & Haeussler, P. & Loso, Michael & Batist, Marc. (2017). Varve formation during the past three centuries in three large proglacial lakes in south-central Alaska. GSA Bulletin. 130. 10.1130/B31792.1.

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Larquier, AM (2011), Differing Contributions of Heavily and Moderately Glaciated Basins to Water Resources of the Eklutna Basin, Alaska, *Alaska Pacific University*, *M. Sc. Thesis*, 1-65, Anchorage, Alaska. *Unpublished*.

https://www.eklutnahydro.com/background/