IGD Calculator Documentation

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The Iron Gate Dam (IGD) Calculator is a multi-objective tool used to monitor and control releases on the Klamath River to meet irrigation deliveries, Biological Opinion (BiOp) compliance, flood control, and many other objectives. The IGD calculator is an Excel workbook comprised of many interconnected sheets containing all of the physical process, historical, and operating policy, and forecast data. Six or seven (depending on the time of year) sheets serve as the primary controls and display the desired results. Control sheets are used for adjusting values to better represent the physical system or assigning account capacities and reservoir releases and diversions. The results and analysis sheets show daily releases, diversions, and remaining water as well as previews of the end of month, season, and year account balances and projected values of threshold objectives. A general outline of using the IGD calculator is available on the "Instruction Sheet". Following is a list of the sheets used, typically in this order, when making a forecast and scheduling the system. Links are provided to the appropriate detailed sections.

- USBR Daily: This sheet contains base data for use by other sheets. The general format is daily inflows, outflows, storages, accretions, diversions, and demands as columns. There are some computations to sum accretions and total canal flows.

Equation Columns

The remainder of the USBR Daily worksheet contains calculations to process the data further.

Table 1. Computations performed on the USBR Daily worksheet.

Column	Description / calculation
From lost River to Klamath	If there is more water flowing through LRDC than at Station 48 and Miller Hill, then divert the difference back to the Klamath River. (CONDITION 1) Else, there is more water flowing through Station 48 and Miller Hill, then all the LRDC flow is diverted to Ag
Keno Net Accretions	The negative of the sum of (Link River and Keno Power Canal flow, LRDC flow, and F/FF return flow) minus the sum of (Station 48 flow, Miller Hill flow, North Canal flow, and Ady Canal flow).
Klamath Project Net Increase/Decrease in Flow to Klamath River	Sum of (LRDC flow and F/FF return flow) minus (Station 48 flow, Miller Hill Flow, and Ady Canal Flow)
LRDC to North Canal	When Condition 1 above is met, then all or a portion the flow through North Canal is supplied by return flow from the LRDC
LRDC to Ady Canal	When Condition 1 above is met, then all or a portion of the flow through Ady Canal is supplied by return flow from the LRDC
Net_LK accretion	If the flow through the LRDC is greater than the Link Canals * then the accretion is equal to the Sum of (LRDC flow, Keno Net Accretions, and F/FF return flow) minus the Link Canal flow * else the accretion is the F/FF return flow plus the Keno Net Accretions
Partial for Link Release for Igmax	Sum of the (North and Ady Canal) flow minus the sum of (LRDC flow, F/FF return flow, Keno Net Accretions, and Keno to IGD accretion estimate).

Column	Description / calculation
Link for IGD	If the flow through the LRDC is greater than the Link Canals, Then the Link for IGD is the sum of the Link River and Keno Power Canal flow Else the Link for IGD is the sum of the Link River, Keno Power Canal flow, and the LRDC minus the Link Canals
Extra Link Release for Increased IGD min	If the Sum of the (Link River and Keno Power Canal flow, Keno Net Accretions, and Keno to IGD Accretions) is greater than the Iron Gate Release, Then the extra Link release is 0 Else the extra Link release is the Iron Gate Release minus the sum of (Link River and Keno Power Canal flow, Keno Net Accretions, and Keno to IGD Accretions)

- Dashboard: This sheet is the main control page. The information entered here is used as inputs for the calculations on the other sheets including date, inflow scenario (dry, med, wet, or year select), accretion exceedance, and adjustment factors.
- UKL Inflow: This is a mass balance calculator for the Upper Klamath Lake. It is used to document and project UKL's inflows, outflows, elevation and storage. Based on forecasts and inputs, the goal is to deliver water to the project or stay above the minimum flow listed in the BiOp. Adjustment factors and coefficients can be changed in this sheet so conditions are satisfied.
- WillR Inflow: This sheet stores inflow into the Williamson River for both historical and forecasted data. Different scenarios are provided from forecasts as RFC 25%, 50%, 75%.
- Summer Calculator & Winter Calculator: These are the main operations tools. They possess all daily (historical and projected) information. Much of the information is referenced from other sheets and organized here. The operator can see the variables influencing their current operations and determine the releases at IGD to satisfy the targets and thresholds.
- Thresholds: This sheet tracks the historical and projected data under the current scenario compared to the minimums set by the BiOp. Visualization of this information is presented in graphs.
- Supply Calculator: This sheet computes the supply for the various classifications of water. Based on the UKL end of February Elevation, USGS forecasts are given for the Williamson River and UKL Inflows. Targets for the UKL elevation, EWA supply, and Project Supply are set from this information.
- ShadowOp_In_Out: The sheet assigns and tracks flow deductions to payback borrowed water. The deduction works on a trigger system which initiates values being assigned for a particular day. Differences between the regular and shadow volume as well as supply, pump, flushing, and borrowed flows are tracked here as well.
- Misc In_Out: This sheet tracks the intermittent or miscellaneous flows that feed into or out of the UKL Inflow. These may be refuge deliveries, dilution flows, surface flushing and etc. Most column are simple observation but other require computations.

The remainder of this document is organized by these sheets. For each sheet, there is a general description, followed by a table describing data or calculations.

> **Note:** The items highlighted in orange are items that need greater clarification/confirmation from KBAO (Have general idea but would like a better explanation).

USBR Daily

This sheet contains the base data that represents the state of the system on and before the day of operation. Much of the data is input or copy and pasted from another spreadsheet. The general format is daily

inflows, outflows, storages, accretions, diversions, and demands as columns. The following two sections list the base data and certain calculations performed on this sheet.

Data Columns

This sheet stores much of the timeseries data used in the calculator.

Table 2. Data stored in the USBR Daily sheet

Location	Data Columns
Williamson River	Flows (cfs)
UKL	• Actual Elevation (ft) • Storage (Acre-ft) • Inflow (CFS) • Inflow (TAF) • Keno Power Canal – an outflow (cfs) • A Canal – an outflow • To Ag Excess goes to Keno Net Accretions, based on what is supplied from LRDC • To Refuge
Link River	Inflow
Lost River	Diversion Channel (LRDC) • Outflow • Ag: Combination of North, Ady, & LRDC when LRDC is > than Station 48 + Miller Hill ; LRDC when < Station 48 + Miller Hill Miller Hill • Pump • Spill Station 48
Klamath River	• Inflow • North Canal - outflow • Ady Canal - outflow • F and FF pumps – inflow • LRDC Outflow
Keno Dam	• Keno Power Canal – an inflow • Outflow
Iron Gate	• Outflow • Keno to IGD Accretions
Ag Demand	• A Canal – inflow • Station 48 – inflow • MH Pump - Spill – inflow • North Canal – inflow • Ady Canal - Ady to refuge – inflow
Agency Lake Ranch	Flow to (cfs)

Equation Columns

The remainder of the USBR Daily worksheet contains calculations to process the data further.

Table 3. Computations performed on the USBR Daily worksheet.

Column	Description / calculation
From lost River to Klamath	If there is more water flowing through LRDC than at Station 48 and Miller Hill, then divert the difference back to the Klamath River. (CONDITION 1) Else, there is more water flowing through Station 48 and Miller Hill, then all the LRDC flow is diverted to Ag
Keno Net Accretions	The negative of the sum of (Link River and Keno Power Canal flow, LRDC flow, and F/FF return flow) minus the sum of (Station 48 flow, Miller Hill flow, North Canal flow, and Ady Canal flow).
Klamath Project Net Increase/Decrease in Flow to Klamath River	Sum of (LRDC flow and F/FF return flow) minus (Station 48 flow, Miller Hill Flow, and Ady Canal Flow)
LRDC to North Canal	When Condition 1 above is met, then all or a portion the flow through North Canal is supplied by return flow from the LRDC
LRDC to Ady Canal	When Condition 1 above is met, then all or a portion of the flow through Ady Canal is supplied by return flow from the LRDC
Net_LK accretion	If the flow through the LRDC is greater than the Link Canals * then the accretion is equal to the Sum of (LRDC flow, Keno Net Accretions, and F/FF return flow) minus the Link Canal flow * else the accretion is the F/FF return flow plus the Keno Net Accretions
Partial for Link Release for Igmax	Sum of the (North and Ady Canal) flow minus the sum of (LRDC flow, F/FF return flow, Keno Net Accretions, and Keno to IGD accretion estimate).
Link for IGD	If the flow through the LRDC is greater than the Link Canals, Then the Link for IGD is the sum of the Link River and Keno Power Canal flow Else the Link for IGD is the sum of the Link River, Keno Power Canal flow, and the LRDC minus the Link Canals
Extra Link Release for Increased IGD min	If the Sum of the (Link River and Keno Power Canal flow, Keno Net Accretions, and Keno to IGD Accretions) is greater than the Iron Gate Release, Then the extra Link release is 0 Else the extra Link release is the Iron Gate Release minus the sum of (Link River and Keno Power Canal flow, Keno Net Accretions, and Keno to IGD Accretions)

Dashboard

The Dashboard serves as the controller for the calculator. Here, the operator can enter and tweak scenarios, exceedances, and projections to best mimic the behavior of the Klamath Basin and thus enact proper actions to comply with the 2013 Biological Opinion (BiOp). The values input here are source data for most of the sheets throughout the calculator. As such, setting conditions in the dashboard is one of the first steps to running the calculator. In addition to its control function, numerous accounts can be tracked from this sheet, although the overview is quite basic.

General Input and Information Cells

At the top of the dashboard are the main inputs required to run the sheet. Here, the operator enters the day's date, the year's scenario, and exceedances at points along the Klamath River. The year scenarios are relatively basic, there is the choice between dry, med, wet, and selecting a specific year's data. As an

example, if selecting dry, projections for inflows or etc. will use the lower historical or CNRFC flows and vice versa for wet. Year select is the special case when the user specifically wants to model a chosen year's flows. Exceedances are the last input of this column, these will be adjusted when the projected accretions/inflows to the objects are not matching with the observed data. Hence, tweaking these are the most common points of system correction. It should be noted that the highlighted yellow cells are generally intended as data inputs for the operator. The other highlighted cells/inputs at the top of the dashboard are for the 2019 settings (same options as current year's) and the Winter Forecast, specifically the 50th percentile flows expected for January and February.

Table 4. Description of items on the top of the dashboard sheet

Column/Item	Description
Today's Date	The user specified current date or desired date for operation. This is one of the initial inputs for daily operation of the IGD Calculator, this input will determine the cutoff point where projected values are used instead of historical values.
UKL Inflow Scenario	The user specified type of scenario expected for the current year of operation. The options are to choose between dry, medium, wet, or selecting a specific year.
Exceedance	The user expected hydrologic exceedance (Ewauna accrete, LRDC to Klamath, Klamath from F/FF, Keno to IGD accrete) throughout the Klamath. This will be used on the Winter and Summer Calculator sheet calculation (likely others too). This is one example of a control for the operator to adjust projections based on recently observed values.
2019 (20##) Settings	Similar to the above, but these user specified values are used for the next year. In this case all the 2019 value are projected using these inputs.
Inflow (TAF)	The net and cumulative inflow at UKL for January through September. 1. Why do these reference the obsolete sheet and 2017 data?
Elevation	The elevation and BiOp threshold at UKL for January through September. This is to track compliance by ensuring the elevation exceeds the threshold. Thus, the difference should be positive.
Winter Forecasts	January and February 50 percentile flow forecasts for the Upper Klamath Lake.

2018 & 2019 Dashboard

The next two portions of the dashboard are relatively the same and can be covered together. In these boxes, the tracking section monitors most of the accounts in the calculator. For simplification, the accounts are categorized into two separate groups:

- Project Supply and Distribution: The project supply is an input, and the monthly usage seems to be set as well. The monthly usages are subject to some flex since the actual deliveries will not always equal those initial amounts. In this case, it seems the values are adjusted. Exceeding the project is a possibility and in which case the usage will be shown as greater than 100%. Representation of the percent usage per month are represented in the agriculture delivery flows. Application of those flow are set by the operator choosing 1 for yes and 0 for no.
- Shadow Operations: A similar setup is found for the shadow distribution, but additional columns are available for tracking payback to objects and correlation of deliveries to amounts set by the project supply account. Payback to accounts is initiated by switches selected by the operator. In total, there are 11 accounts that fall under the shadow operation. For most, the payback flow, start date, and timespan of delivery are controllable. There is a slight difference between the shadow supply and project supply, but the reason why is not apparent. The shadow operation paybacks are accomplished by deductions to the UKL inflows.

Table 5. 2018 Dashboard column descriptions

Column	Description
Past Delivery	Tracks the volume of water diverted for Agriculture requests for months prior to the input date. For example, the input date is 10/17/2018, thus October will be zero since there is still days left.
Days left	Tracks how many days are left in the month based on input date, when zero for a month it will initiate a value being calculated in the past delivery column.
Days in Month	Gives how many days are in a certain month, used in tandem with the days left column and input date to initiate the Past Delivery column.
Supply	First, enter the value for the total project supply for the beginning of the year. The below rows represent the portion of that supply used that month in percentage form. Since this can exceed the available supply (>100% summed), another column tracks the normalized percent usage per month (summed = 100%) 2. Why is 18 TAF added to the project Supply? Does the Apply Dist. have a function related to these calculations? 3. How are the Monthly usages calculated? Seems to switch periodically throughout the year (i.e. Apr -Jun= past delivery/supply, Jul – Sep = ?). Is the changed related to the green and red color coding for Jul & Oct
Ag Delivery Remaining Monthly	The volume of water delivered to the project for the month in cfs. If historical, it is the past delivery converted. Else, it is the total delivery converted.
Ag Delivery Total	The total measured or projected volume of water to be delivered for agriculture requests in a given month.
Shadow Supply	First, enter the value for the total project supply for the beginning of the year. The below rows are percent volume delivered to ag for the month, this row seems to be an input cell. Will go to calculate agriculture delivery volumes.
Monthly Agriculture Delivery	The volume of water delivered for agriculture request in a month, found in cfs and TAF. Function of the percentages enter in the Shadow Supply Row.
Monthly Correlation	Difference in total monthly delivery between the Shadow and Regular supply flow. Show how closely these values tend towards each other.
Daily Correlation	The monthly correlation divided by the days in that month. Same purpose as the Monthly Correlation.
Shadow Switch Definition	If this value is 0, no action is quantified in the shadow operation for this scenario. If this value is 1, an action is given by the shadow operation for this situation.
Shadow Inflow Switch Definition	If this value is 0, nothing is deducted from the UKL inflow. If this value is 1, the volume is deducted from the past inflow instead of the projected inflow. If the value is 2, the volume is deducted from the past and projected inflow.
Shadow Operation Accounts	Check the Shadow and Shadow Inflow Switches, see action based on definitions. That action will distribute the Quantity over the number set in the days cell, beginning at input in the Start Date cell. That distributed amount is shown in the Daily cell. Accounts Managed • Regulation • Agency Lake Pumping • LKNWR Return • Refuge Payback • Copco Withdrawal • Iron Gate Withdrawal • Pac Payback 1 • Pac Payback 2 • Surface Flushing Flow

Column	Description
	• Dilution Flow • Initial Shadow Storage Reduction

UKL Inflow

The main objective of the UKL Inflow is to allow the operator to track the Upper Klamath Lake Inflow mass balance. These values are of most concern on other sheets where they will be used to determine releases and available account usages. Referencing other sheets is common for the UKL Inflow, especially when using historical values. For projections though, the NRCS forecasts are used to give a percentile value for the chosen day.

The leftmost portion of the sheet is relatively simple, it is concerned with the three variables of inflow, elevation, and volume at the Upper Klamath Lake under varying circumstances. This variance is mostly caused by the season scenario which falls into one of the following four categories: dry, med, wet, and year specific. A short term or seasonal adjustment factor implements a slight effect as well, this is applied depending on how far out the cell is from the input date. Two categories are tracked for these three variables, they are the unaltered and shadow operation accounts. Similar in equation setup, the difference is in the shadow operation flow deduction which is brought over from the ShadowOp_In_Out sheet. Since inflow is just an observation or projection, it is the elevation and volume which does most of the interaction with the rest of the sheet. Here some mass balance is required.

In the center portion of the sheet is the Link releases, flood control, and ag demands. This is all the information needed to solve for the outflows and thus UKL elevation and volume. The Link release is function of the ag demands and flood control. This is represented by separating the Link releases by constraint into separate columns and taking the maximum of those values for the final output calculation. The maximum is taken since flood and rampdown require the flow to be increased to satisfy their regulation. Taking the difference between inputs “inflow and previous day’s elevation” and the outputs “Link + Ag Outflows, Misc. flows, and Link Release for IGD min” the volume is solved. The elevation is a simple reference equation using this value and an area capacity table. It should be noted that once again the shadow and unaltered columns differ slightly. In this case, the shadow operation uses the scenario Ag outflows whereas the unaltered uses the regular Ag outflows.

The far-right section of the sheet is the last part considered for the calculations of inflows. Here, the historical, percentile values for each are given for each day of a year. These values are found for every 5th percentile ranging from 1 to 99. Thus, the operator has considerable flexibility with the adjustment of values for the year scenarios. An example of exercising this flexibility may be as such: dry – hist25%, med – hist30%, and wet35% rather than a 40, 50, 60 split. In addition, a section that should be noted is the transposed inflows and elevations at the top of the sheet starting at column AS. These are the cells that will be referenced in the other sheets (Winter & Summer Calculator). Once again, those values can be altered by the adjustment factor deemed fit by the operator.

Shadow Operation

The shadow operation is the method KBAO uses to pay back the minor accounts in the Klamath Basin. These accounts are typically borrowed from to increase flows or releases at control points. In the UKL Inflow Sheet, the daily reflection of these operations is shown. If the specifics of overarching timeframe, quantity, and purposes are desired, the dashboard or ShadowOp_In_Out should be referenced.

Scenario vs Regular Ag Outflow

For a portion of the UKL Inflow sheet, columns are differentiated by whether they reference the Regular Ag Outflows or Scenario Ag Outflows. While not initially apparent, it should be noted the difference relates to which Supply is refenced from the dashboard. The Scenario Ag references the Ag Distribution Supply whereas the Regular Ag references the Shadow Distribution Supply. Hence, explaining the association of the Shadow columns with the Regular Ag Outflows.

Table 6. Description of columns in the UKL Inflow sheet

Column	Description
Projected Inflow	based on date, the cell is assigned a given constant for a short term or season long projection. This factor is multiplied by the historical data for that day, the frequency of which is determined by the year's scenario (wet, med, dry, year select). The product is thus the projected inflow. • Determine the inputs of Scenario (D, M, W, YS), Inflow Short Adjustment, and Inflow Seasonal Adjustment to determine the value • If Dry, take the select% of that day's Historical Net inflow as the value. Less than Med, for example the 40% inflow • If Med, take the select% of that day's Historical Net Inflow. Between the Dry and Wet, for example the 50% inflow • If Year Select, take the selected year's historical inflow • If Wet take the select% of that day's Historical Net inflow. More than Med, for example the 50% inflow
Inflow (Actual & Projected)	checks to see if the cell's datetime is less than the actual input datetime. If it is, take the actual value (on the USBR Daily sheet) multiplied by 1000 to give AF for this slot. Otherwise, it is the projected value.
Inflow (Actual & Proj) (Shadow)	The Actual/Proj Inflow for the selected date minus the deductions for the Shadow Operation.
UKL Elevation	Uses an area capacity look-up table to determine an elevation at Upper Klamath Lake from the ULK Volume column
UKL Volume	Same datetime check as Inflow, if less than then take the measured elevation otherwise take the projected volume.
Shadow UKL elev	Uses an area capacity look-up table to determine Shadow Upper Klamath Lake elevation from the Shadow ULK Volume column
Shadow UKL vol	A datetime check. If historical, take the difference between the measured volume and cumulative Shadow Operation. If projection, take the difference between the measured volume and date's Shadow Operation.
Measured elev & vol	Elevation references the USBR Daily sheet for the observed inflow for that date. The volume uses an area capacity table to convert the elevation to a volume.
Projected vol & elev	The volume is the difference between the "d_{-1} UKL volume, proj inflow, misc flows (+inflow,-outlfow)" and "Link & Ag outflows, Link for increased IGD min". The elevation uses an area capacity table to convert the volume to an elevation.
Shadow vol & elev	The exact same format as the projected volume and elevation except the d_{-1} Shadow UKL vol and Link & Reg Ag Outflows is referenced rather than d_{-1} UKL vol and Link & Scenario Ag Outflows.
Link + Regular Ag Outflows	Solely a projected value, will be listed as "N/A" if historical. It's the Sum of the max of "Link + Canal, Link for Rampdown, Max Flood Release", Ag from UKL, and Link Override Correction.
Link + Scenario Ag Outflows	Solely a projected value, will be listed as "N/A" if historical. The sum of the Scenario Ag from UKL and the greater of either "Link + Canal, Max Flood Release".
Link + Canal (W/o flood control or rampdown)	Flows through the Link River Dam and the diversion canals on the Klamath below it. Based on the season, it uses the target release found by the winter calculator or the calculated Link release w/o flood control determined by the summer calculator. If a historical date in the Spring/Summer season, the USBR Daily sheet is referenced.

Column	Description
Link Release for Rampdown	Only considered during the winter season, in which case it will be the incremental release of Link for rampdown.
Max Flood Release	Maximum release at link to prevent flooding at the Upper Klamath Lake. This is either the allowable max release at Link or the difference between the "d_{-1} UKL vol, UKL Inflow" and "UKL Flood Storage, Link for IGD min, Misc flows" which is converted to a flow. The ag and override correction are subtracted from this value since they do not need to be considered in this scenario.
User Override of Rampdown Due to Flood	Input that allows the operator to override the rampdown rules. If yes, will be a 1, if not, will be a 0.
Link Release (C1) Override Correction	The override correction flow assigned by the operator in specific scenarios. Can be manually input here or referenced from the Summer/Winter Calculator Sheets.
UKL Flood Level	Max allowable elevation at the Upper Klamath Lake before the Lake is susceptible to flooding. Dependent on month, day, and flood control curve adjustment.
UKL Flood Storage	Simply the volume of water the Upper Klamath Lake will be at once the elevation of the Lake is at the UKL Flood Level.
UKL Level Basis	The measured or projected elevation at UKL for the selected date.
UKL Flood Level/Storage w/ Correction	The flood level corrected to account for the rampdown rules. The storage uses an area capacity table to convert that elevation to a volume.
Flood Curve Rampdown Days	Days required to rampdown a UKL elevation that is greater than the flood level. Max is 7 days, and will start to decrease once the UKL elevation falls under the flood level correction.
Ag from UKL (regular, scenario, KID&TID, to Ady, to North)	These are agriculture demands from the Klamath which are referenced from the Ag Demand Sheet.
Ag from UKL (regular, scenario, KID&TID, to Ady, to North)	These are agriculture demands from the Klamath which are referenced from the Ag Demand Sheet.
Extra Link Release for increased IGD min	The increase of flow at link to meet the now enhanced minimum flows at IGD. This will be the difference between the enhanced mins and projected IGD flows.
Misc other flows 1 (+ for inflow, - for outflow)	Miscellaneous flows from the Klamath that are not otherwise tracked in the USBR Daily or UKL Inflow sheet. May be such as Surface flushing flows, Barnes/Agency Pumping, or Wood River Wetland diversion. Values are referenced from the Misc In_Out Sheet.
Shadow Operation (No Inflow Deduction, Projected Inflow Deduction, Total Inflow Deduction)	UKL Inflow deductions assigned by the ShadowOp_In_Out Sheet.
Summer Link Release for River Excluding Flood	The release at link excluding any flow volume that is assigned to prevent flooding. This is obtained from the Summer Calculator Sheets for the given year.
Hist. (x) %	The averaged historical inflow for the given date corresponding to the selected frequency (x). Runs from 1% to 99%, jumping 5%. Intermediate value can be found by interpolation.

WillR Inflow

This sheet shows the inflow into the Williamson River based on historical and forecasted data. Different scenarios are provided from forecasts as RFC 25%, 50%, 75%. Based on Williamson River inflow, the releases at IGD can be projected for the coming week (based on water's travel time through the river).

Table 7. Description of columns on the WillR Inflow sheet

Column	Description
Williamson Inflow	The inflow at Williamson river. If the cell's date falls before the input, this will be a historical value, otherwise, it uses the projected inflow.
Measured Inflow	The measured inflow at Williamson river. All values here are referenced from the USBR Daily sheet, will be zero if a future date.
Projected Inflow	Projects the inflow for the Williamson river. If there is a short-term projection available from the CNRFC site, this value will be used. Otherwise, the scenario will be checked and the corresponding percentile CNRFC value will be chosen (CNRFC 0.9, 0.75, 0.5, 0.25. 0.1). That value will be adjusted by either the season or short adjustment factor depending on how far it is out from the input date.
Short Term	A short-term projection of the inflow at the Williamson River taken from the CNRFC page on the NOAA website. Specifically, https://www.cnrfc.noaa.gov/graphicalRVF_tabular.php?id=WMSO3. This is only available for 7 days out from the current date. Input by the operator.
Hist#%	The historical percentile flow values for a given date. This will be used interchangeably with the CNRFC values to give projections of the flow at Williamson River. Ranges from 1 to 99%, providing every 5th percentile
CNRFC #	The California Nevada River Forecast Center percentile projected flow for a given date. This is separated into 5 categories, the CNRFC 0.9, 0.75, 0.5, 0.25, & 0.1 projection. In this case, for season scenarios, dry>med>wet.

Summer Calculator

The Summer Calculator allows the operator to track and assign the Environmental Water Account (EWA) and Iron Gate Dam (IGD) releases from the beginning of March through the end of September. Both accounts will reference sheet calculations of basin data to assign their daily values as well as from projection for the remainder of the season. For KBAO, this is the sheet used to track compliance with the BiOp on a day to day basis.

First, the projected volume of the EWA (EWA_River) is set for the season. Water from this volume is used to satisfy streamflow or lake elevations for the remainder of the period. Since the initial value is set by an NRCS forecast, it will be changed each month until June (last month forecast is available). A (EWA_Reserve) reserve volume is assigned specifically for the month of July through September to hinder excessive usage during the start of the season when projections are large. In the case of drought or large releases for flood control, a minimum volume is calculated so there will be water available to release at the end of the season (EWAremainmin). To track the EWA usage, a row (EWAuseddv) is assigned to sum of releases in the river flow up to the selected date. Thus, the remaining volume for the rest of the period (EWARemain) can be found by taking the difference of the volume and usage. In the months of July through September, that volume will be altered slightly to a set percentage of the general remaining calculation (EWA_Remain_JulSep) if water usage up to this date has already exceeded the EWA volume set at the beginning of the season or the remaining amount is less than the minimum remaining required.

The dependencies of EWA usage or LRD for IGD releases are in the upper calendar portion of the Summer Calculator. At the top, Williamson River Inflows and Upper Klamath Lake elevations (Will_Riv_inf & S1yestelev) are tracked and projected over the course of the season. These inputs assign releases at the LRD once their values are translated to adjustment factors (Fill_rate_ratio_spring, Will_prop_Cum). These factors along with accretions (Net_LK_accrete, IGmin and Ramping, flood control release) and EWA volume are input to find the preliminary calculated release at Link River Dam (Link River for IGD). The final calculated release (Calculated Link Release for River – Total) then accounts for project minimums (Link for Igmin_prj) and override corrections at both Link (C1 Override Correction) and Iron Gate Dam (C15_Override_Correction to Link). In the case that this is a historical value, the USBR Daily sheet is referenced instead (C1_MIF and C1_EXC). The total calculated flow is utilized to find the EWA usage up to that date (EWAuseddv) by excluding any flow for the project (Link for Igmin_prj) and in historical cases adding flow that been borrowed from the refuge (F/FF Reduction due to Refuge Borrow) or Pacificorp (Pacificorp Borrow).

Tracking of minimums, maximums, and ramping flows at the Iron Gate Dam are found in the central section of the Summer Calculator. The minimum flow (Igmin) was originally set by the BiOp but was later revised by KBOA (Igmin_prj) once requests determined this amount was insufficient for the accounts. Ramping (Rampdown limit) and max flows (IG_max) are both are dependent on the EWA volume and are assigned values based on which tier that quantity falls. Ramping is considered in unison with minimum flows (Max of Igmin(prj) and Ramping) as to prevent violation of daily IGD release reductions. In addition, maximum flows are only considered from July to September to avoid overdrawing from the limited EWA volume later in the season.

The final calculations for the IGD release are in the bottom portion of the Summer Calculator. Here, all the values' timeframe changes to a week ahead as to account for the flow travel time. The preliminary calculated release at the Iron Gate Dam (IGD-Prelim Calculated) is determined from the accretions (Keno Net Accrete, Keno to IGD Accrete), diversions (LRDC, F/FF, North Canal,& Ady Canal flows), control releases (flood control release), and LRD releases (Link River for IGD). This prelim flow is checked for violation of minimum and ramping flows (C15 flow with Igmin and C15 override) as well as adjusted to account for the override correction flows (C15 flow final includes C1 override, Corrected C15 flow) to give the final IGD release.

Additional rows are available for checks and accounting besides the final IGD release or EWA cumulative use. These may be such as analyzing the difference in calculated and actual flow at LRD (Actual LtoR – Calculated LtoR) or how much flow exceeds minimum at IGD (C15 flow above minimum) and the EWA (EWA spent above the minimums). Another tracked account is the total accretions for a given day, it collects the sum of the LRDC and F/FF flows (LRDC to Klamath, Klamath from F/FF) with the total accretions at Keno and IGD (Keno to IGD Accrete, Keno Net Accrete). The base accretion flows are done on supplemental sheets within the IGD Calculator based on whether it is a historical or projected value. A special function is included to smooth transition from the two types if the cell falls in the two-week period after the input date. Special release events are tracked in the bottom calculator section as well. For example, the flows required for the tribe's boat dance ceremony (Boat Dance Flows).

Variable Key

- S1 – Upper Klamath Lake
- C1 – Link River Dam
- C15 – Iron Gate Dam
- C91 – LRDC
- C131 – F/FF
- D11 – North Canal
- D12A – Ady Canal

Table 8. Description of rows in the Summer Calculator

Row	Description
EWA River	The EWA that is set by monthly forecasts, updated on the first day of the month from March – June. It is the projected water to be delivered for stream flows and elevations over the season.
EWA Reserve	Projected volume of water to be reserved for the Environmental Water Account (References value in EWA_Reserve sheet based on EWA_River value for the day) to used June through September. Prevents excessive usage early in the season when the EWA_River volume may be overestimated.
Will50Vol	NRCS 50th Forecasted March – September Williamson Net Inflow.
Williamson River Flow in cfs	Inflow at Williamson River given by the data on the WillR Inflow sheet. If selecting a day before the entered date, historical data is used. If after, the projected value is used (based on climate scenarios).
Will_prop_cum	The previous day's Williamson River flow volume as a portion of the total predicted Williamson River volume left from today through Sep 30.
Cum_Willdv	The cumulative amount of inflow that has gone through the Williamson River from Febuary 23 through the selected date.
UKL_inflow_daily	Inflow at Upper Klamath Lake given by the data on the UKL Inflow sheet. If analyzing a day before the entered date, historical data is used. If after, the projected value is used (based on climate scenarios).
S1yestelev – UKL elev	Pool elevation at Upper Klamath Lake given by data on the UKL Inflow sheet. If analyzing a day before the entered date, historical data is used. If after, the projected value is used (based on climate scenarios).
S1maxlvl	The maximum pool elevation attained for the season at Upper Klamath Lake. Uses a simple max function of the current and previous day.
pastmaxUKLlvl	If the selected day is before the month of June, check to see if the selected days elevation is greater than the average elevation between the previous 5 days. If it passes 0 is assigned, else a 1 is assigned. Used for the Spring fill rate ratio.
Fill_rate_ratio_spring	The spring fill rate ratio used in the Link River for IGD calculation. If the selected day is before the month of June and the pastmaxUKLlvl is less than 1, the ratio is the minimum of (UKL elev – 4136/ Target Level – 4136) or 1, otherwise 1.
Net_LK_accrete	The net accretions in the Lower Klamath area. It is the difference between diversions (North & Ady Canal), return flows (LRDC & F/FF), and upstream accretions (Keno Net Accretions) on the Klamath River.
Keno Net Accretions	A determinant equation to assign the Keno Net Accretions for the selected cell. Based on if this a projection or a historically measure amount, the function utilizes information from the sheets 'USBR Daily' & 'Accrete_adj'. If projecting a week out from the input date, an average of the past week is used to smooth transition from current values to projections.
Link River for IGD	The amount of flow in the Link River assigned to the Iron Gate Damn.
Link for IG min and Ramping	The amount of water released from the Link River Dam to meet minimum flow requirement or ramping rates at the Iron Gate Dam. Will be 0 unless a flow deficit is shown for the day.
Flood Control Release	The amount of water released from the Link River Dam with purpose of staying at/below the flood control threshold.
Link for lgmin_prj	The amount of water released from the Link River Dam for the project minimum flow at Iron Gate Dam. This is an altered amount from the BiOp due to realized difference in needed water for accounts.
Override_Correction to Link	The override correction flow assigned to the Link River Dam if the operator determines excess water is needed at the Iron Gate Dam.
MAX LINK RELEASE	The maximum release allowable for Link River Dam.

Row	Description
Calculated Link Release for River Excluding Flood	The amount of water released into the Klamath River from the Link River Dam excluding what is released for flood control.
C1 Override	The override flow released at the Link River Dam which has been Input by the Operator. Only rarely used in certain circumstances
C1 Override Correction	If an override flow has been assigned to the Link River Dam this column takes the difference between it and the other diversions to give the correction portion of flow used for IGD release.
Calculated Link Release for River	The Link River Dam Release for the Klamath River adjusted by adding together requests as well as the Override Correction flow.
Actual Link Release for River	The actual flow for that day shown by referencing the historical record or projection given by the USBR Daily sheet.
C1_EXC_cum	The cumulative releases to meet the IG Min, Flood Control Release, or Override Correction over the year.
Cumulative C1_EXC from Link for Igmin_prj	The cumulative releases from the Link River Dam to meet the Iron Gate minimum flow for the project.
Igmax bound on Link release	The maximum release allowed from the Link River Dam based on the accretions from the Reaches separating the two objects. If flows are brought into the Klamath River, this value decreases. If flows are diverted from the Klamath River, this value increases.
LRDC flow to Klamath River	The flow into the Klamath River from the LRDC. Reference historical data if available or make a projection dependent on assigned exceedance and date. Will use a running week average if within two weeks out of the input date to smooth transition to projections.
Flow into Klamath River from F/FF	The return flow into the Klamath River from the F/FF pump. The flow into the Klamath River from the LRDC. Reference historical data minus refuge borrow if the data is available or make a projection dependent on assigned exceedance and date. Will use a running week average if within two weeks out of the input date to smooth transition to projections.
Refuge Borrow	The amount of water borrowed from the Refuge to meet flow demands in the Klamath Basin. Cell is refenced from LKNWR_PC_Borrow sheet which is controlled by user input. This flow is routed through the F/FF pump.
F/FF Reduction due to Refuge Borrow	For historical data, it the minimum of the F/FF flow or Refuge Borrow that determine the flow reduction. Else, it is the projected Refuge Borrow. Is this the flow in the river which has been reduced or is this the amount the flow in the river has been reduced from its original value.
Pacificorp Borrow	The amount of water borrowed from Pacificorp to meet flow demands in the Klamath Basin. Cell is refenced from LKNWR_PC_Borrow sheet which is controlled by user input.
LRDC flow from LRDC to North Canal	The portion of return flow from the LRDC to the Klamath River that is pumped to diversion objects by the North Canal. Always assigns the minimum of the USBR Daily reference cell or the LRDC to Klamath cell. Logic – it can only send back as much as it is given.
LRDC flow from LRDC to Ady Canal	The portion of return flow from the LRDC to the Klamath River that is pumped to diversion objects by the Ady Canal. Has the same operation parameters as the North Canal, but it has second priority since it is located farther downstream.
EWAuseddv	The cumulative usage of the Environmental Water Account for the season up to a selected date.
EWAremainmin	If the selected date is before June, after September, or has a C1_EXC_cum less than 22% of the EWA, the minimum remaining EWA volume can be 0. Else, it will multiply the selected date's EWA by a value assigned by the EWARemain sheet. This is reserve

Row	Description
	enough EWA volume for the later months of the season in case of excess rampings, overrides, or flood control.
EWARemain	If the selected date is the first of the month between of March through September, the remaing EWA volume is maximum of either the minimum value set by EWAremainmin or the difference between the EWA and the EWA usage to date.
EWA_remain_JulSep	If the selected date falls between July and September, the remaining EWA volume is multiplied by a percentage assigned by the EWARemain sheet that will represent the adjusted remaining EWA volume.
UKL_Oct1_level	The projected pool elevation level in Upper Klamath Lake at the beginning of October. This is set at the beginning of the season by projections and can be altered as new data is input throughout the year.
Fill_level_target	The target pool elevation level in Upper Klamath Lake for October 1st is determined by the BiOp
Igmin	The minimum flow out of the Iron Gate Dam that was determined the BiOp.
Max of Igmin and Ramping	The max of either the Minimum IGD flow or yesterday's IGD flow minus the Rampdown limit.
Igmin_prj	The project minimum flow required at the Iron Gate Dam. Was determined after the BiOp due to realized excess needs.
Max or Igmin_prj and Ramping	The maximum of the projected IGD min flow or the previous day's IGD flow minus the Rampdown limit.
IG_max	The maximum flow out of the Iron Gate Dam, seems to be constrained for the months of July through September. Is left at around 100,000 cfs before this timeframe just to serve as a place holder.
Keno to IGD accretions	The accretions for the Iron Gate Dam in the reach between it and the Keno Dam. Reference historical data if available or make a projection dependent on assigned exceedance and date. Will use a running week average if within 8 days out of the input date to smooth transition to projections.
IGD-Prelim Calculated	The IGD flow calculated from the Link River flow released for IGD plus the accretions into the IGD.
C15 Override	The override flow assigned by the operator for the Iron Gate Dam in circumstances not controllable by in sheet equations.
C15 Override Correction	If the Override flow is 0, the correction flow is also zero for IGD. Else, it is the difference between the Override flow assigned by the operator and the current IGD release.
C15 flow (with Igmin and C15 override)	Checks the calculated flow to make sure it doesn't violate the minimum flow or ramping rules. If not, it is the calculated flow plus the override correction flow. Else, it is the max of the min or ramping corrected flow plus the override correction flow.
C15 flow final	The final flow out of the Iron Gate Dam which has been adjusted by the override correction flow from the Link River Dam.
Corrected C15 flow	The IGD flow plus the Override Correction flow for the IGD.
Actual LtoR – Calculated LtoR	The actual flow from the Link River Dam to the Klamath River minus the calculated amount. This rows tracks the accuracy of the sheet's projections.
Rampdown limit	The rampdown flow allowed at the Link River Dam for a set tier of flows. The flow tiers are separated into • IGD > 3000 • 3000 > IGD > 1750 • 1750 > IGD
C15 flow above minimum	Gives the amount of flow out of the Iron Gate Dam that is above the set minimum flow. Seems to only be calculated from July-16 through September-17.
EWA spent above minimums	The volume of water sent to the EWA from IGD that exceeds the minimum requirement. Calculated on a Daily Basis.

Row	Description
Sukraw Wells Pumping	Volume of water pumped from the Sukraw Wells into the blank river/lake/other? Seems to contribute to the EWA usage.
Boat Dance Flows Upper and Bottom Basin Calendar	Scheduled flow assigned for the Tribe's Boat Dance Ceremony, will not be counted against the EWA for that period.
Link total (C1_MiF + Flood release)	The release at the Link River Dam to meet the release at IGD on week later plus the LRD release for flood control at the selected date.
Maximum Flood Release	The maximum flow that was released to meet flood control targets.
Accretion Sum	The sum of total accretions occurring on the selected day throughout the entire basin.

Winter Calculator

The Winter Calculator allows the operator to track and assign the filling of the Upper Klamath Lake, usage of Supplemental Water Accounts, and release at Iron Gate Dam (IGD) from the beginning of October through the end of February. These accounts will utilize referenced or on sheet calculations of basin data to assign their daily values as well as form projections for the remainder of the season. For KBAO, this is the sheet used to track compliance with the BiOp on a day to day basis.

Where Summer Calculator is used to track EWA for to BiOp compliance, the Winter Calculator functions to maximize the Upper Klamath Lake volume for the next season's available water. This begins by tracking the current (UKL_elev) and CNRFC projected (UKL_elev guidelines) elevations through the course of the Fall/Winter Season. Taking the difference between the current value and the target elevation (4142.8 ft), the necessary fill rate (Needed_fill_rate) to meet the targets by the end of the season can be found. To incorporate this into a Link Release (Link_release_FW) that will satisfy these conditions, the difference (Fill_rate_diff) in the recent (Recent_fill_rate) and needed (Needed_fill_rate) fill rate is incorporated with UKL cumulative inflow index (UKL_cum_inf_index) to give an adjustment factor (Fill_rate_adjust). Other variables altering the Link Release (Link_release_FW) are the Williamson flow (Williamson flow, will_prop), accretions (Accrete_adj), and monthly augments (OctNov_Augment). To ensure this value satisfies flow requirements, a target release (Link_WF_target) is provided which considers the ramping rules (Link target with Rampdown) and minimum flows at Link (Link_min) and IGD (Link releases for IGD min). In addition to the filling rates, rows were added to demonstrate the flow quantities (Fill_flow) needed to meet the difference in max Upper Klamath Lake volume (Fill_vol) before the season ended.

In the bottom section of the calculator is the flow calculations and conditions for the Iron Gate Dam Release. The dates for these rows are shifted a week ahead, reflecting the 7-day travel time of corresponding upstream conditions. Here the calculations are relatively straight forward as most variables were figured in the upper portion. The final release at IGD is given a preliminary calculated value based on the flow target (Link_WF_target), accretions (Net Accrete), and flood control release (Max Flood Control Release). Before this represents the assigned final flow, it is checked to meet the minimum flow (without rampdown) and the rampdown requirement correlated to the previous day's actual (rampdown from actual) and scheduled (rampdown from scheduled) flow. The assigned final flow can then be found in the "Actual or Projected IGD release". For historical dates it will be a reference from the USBR Daily sheet. For current to future days it will be the checked value discussed.

Other information or accounts that can be found in the bottom portion of the calculator are such as the specific rampdown rate (Rampdown Rates) or increment of release (Release due to Rampdown) for a given flow and the theoretical releases at IGD if the minimum (IDG flow with "Link min") or calculated

(IGD flow with "Link_release_FW") flow were assigned at Link. Some importance seems to also be given the cumulative amount that the IGD release was greater than the Igmin due to rampdown regulation (Cumulative Fall Flow Banking).

The last important part of the calculator is a blocked section in the center of the sheet which tracks supplemental accounts referring to the Klamath Diversion District or Refuge. Here is where volume from the project supply (KDD FWAvail Account, Refuge Remaining Project Supply) and distribution (KDD Diversion, Refuge Diversion) is tracked. Since each has an allotted volume for the season, the main concern seems to be tracking the overuse of those accounts. Each does this in similar ways by tracking the daily and cumulative diversion ((KDD or Refuge) FW Diversion, FW Cumulative Diversion) after exceedance. From these values, the debt ((KDD or Refuge) Debt) to those accounts can be figured to assign payback for the current or following season. In addition, if there is excess available water from these accounts ((KDD or Refuge) FWavail Account), that volume is tracked and able to be utilized to meet other release throughout the Klamath. This tends to be a much rarer occurrence than a water deficit.

General Questions

4. Why does tracking/calculation of the fill rate variable start on November 9th? Is this chosen due to conditions by the operator or is it a schedule start? If set by an operator, what factors into choosing this date?

Table 9. Descriptions of Rows in the Winter Calculator

Row	Description
UKL_elev guidelines projected from CNRFC & Hist Ag	Pool elevation guidelines for the Upper Klamath Lake set by the UKL Inflow sheet. Uses the CNRFC & Historical Aggregates to assign a projection for this category.
UKL_elev, projected or actual	Either a projected or measured pool elevation for the Upper Klamath Lake for the selected day. If a projection, it is just set to the previous day's elevation guideline value.
EWA_reserve	Volume of water to be reserved for the Environmental Water Account over the Winer Season. This was set by the October 1 value for EWA Reserve in the Summer Calculator sheet.
Link_min	The minimum allowable flow out of the Link River Dam for the Winter Season as determined by the 2013 BiOp.
Needed_fill_rate	The fill rate needed to meet to meet the difference in yesterday's elevation and the 4142.8 ft target over the amount of days left in the Winter Season.
Recent_fill_rate	The difference between the UKL elevations on the selected date vs that from a week ago, which is taken over the past seven days to give the recent fill rate.
Fill_rate_diff	The difference between the Recent Fill Rate and Needed Fill Rate for the selected date. Positive values indicate the recent fill rates exceed the average rate needed to reach the target elevation whereas negative values indicate fill rates are less than that needed to reach the target elevation.
Fill_rate_adjust	The adjustment factor for the filling rate of the Upper Klamath River based on whether it is a dry or wet year. Can be determined by referencing the UKL cumulative inflow rate to the Fill rate adjust sheet. If it is less than 0.3, dry, else it is average or wet for > 0.3.
UKL_cum_inf_index	The difference between the realized and minimum cumulative inflow for the Winter Season over the difference between the set max and min cumulative inflows. All values are a function of the selected date.
UKL_inflow_daily	The inflow into the Upper Klamath Lake on the selected date, value is referenced from the UKL_Inflow sheet.
UKL_inflow_cumulative	Cumulative inflow for the Winter Season up to the selected date. The initial value for October 1 is set as the cumulative inflow for the month of September (referenced from Summer Calc.).

Row	Description
Hist_UKL_inflow_min_cumulative	The period of record minimum cumulative inflow for the selected date. Value referenced from the UKL_inflow_cum sheet.
Hist_UKL_inflow_max_cumulative	The period of record maximum cumulative inflow for the selected date. Value referenced from the UKL_inflow_cum sheet.
Williamson flow	Inflow at Williamson River given by the data on the WillR Inflow sheet. If selecting a day before the entered date, historical data is used. If after, the projected value is used (based on climate scenarios).
Will_prop	The proportion of yesterday's flow through the Williamson River that is targeted for Release at the Link River Dam. Utilizes an iteration equation that references the Will_prop sheet, this calculation depends on the magnitude of flow and the current month.
Net_accrete	Net accretions into the Klamath River which is determined by flow from Lake Ewauna accretions and LRDC for specific objects. (North Canal, Ady Canal, F/FF)
Accrete_adj	Accretion adjustment factor determined by the volume of flow from the accretion objects calculated in the Net_accrete row. Utilizes an iteration equation that references the Accrete_adj sheet, calculation depends on magnitude of accretions and the month. • Value is applied to the Link River Dam release target. • When there are low accretions, this initiates a greater release of water from the LRD. When there are high accretions, this initiates a lower release of water from the LRD. • Accretion adjustment applied after Nov 15 is only for relatively dry conditions. (UKL cum inf index < 0.3)
LRDC flow to Klamath River	The flow into the Klamath River from the LRDC. Reference historical data if available or make a projection dependent on assigned exceedance and date. Will use a running week average if within two weeks out of the input date to smooth transition to projections.
Flow into Klamath River from F/FF	The return flow into the Klamath River from the F/FF pump. The flow into the Klamath River from the LRDC. Reference historical data minus refuge borrow if the data is available or make a projection dependent on assigned exceedance and date. Will use a running week average if within two weeks out of the input date to smooth transition to projections.
LRDC flow from LRDC to North Canal	The portion of return flow from the LRDC to the Klamath River that is pumped to diversion objects by the North Canal. Always assigns the minimum of the USBR Daily reference cell or the LRDC to Klamath cell. Logic – it can only send back as much as it is given.
LRDC flow from LRDC to Ady Canal	The portion of return flow from the LRDC to the Klamath River that is pumped to diversion objects by the Ady Canal. Has the same operation parameters as the North Canal, but it has second priority since it is located farther downstream.
I10 Keno Net Accretions	A determinant equation to assign the Keno Net Accretions for the selected cell. Based on if this a projection or a historically measure amount, the function utilizes information from the sheets 'USBR Daily' & 'Accrete_adj' while also using a 7-day average of past values for a 2 week out event to smooth the transition from recorded to projection based assingments.
EWAcarryover	The quantity of EWA to be carried over from the previous year's Spring/Summer season to the following one. This value has been historically been zero since excess EWA volume is available and is commonly overdrawn.
OctNov_Augment	Augmentation flow for the Link River Dam release if the selected date falls in October or November. Based on the volume of EWA carried over from the previous spring/summer season.
Link_release_FW	• For October through November 15: The release at the Link River Dam as determined by the Williamson River flow (d_{-1}), flow & accretion adjustments, and flow augmentations.

Row	Description
	• For November 16 through 30: The release at the Link River Dam as determined by the Williamson River flow (d_{-1}), flow adjust, accretion adjust, fill rate adjust, and flow augmentations. (Just for Dry Season) • For December through February: The release at the Link River Dam as determined by the Williamson River flow (d_{-1}), flow and fill rate adjustments.
Link_WF_target	The target release desired for the Link River Dam which is dependent maximum of the Link minimum allowable release, calculated release, or Link release to meet the IGD minimum allowable release.
Link target with Rampdown	The above release target with the adjusted to consider the rampdown requirements at the LRD. Simply the sum of the Link_WF_target and increment of release due to rampdown.
Fill_vol	Volume of water needed to be added to the Upper Klamath Lake to completely fill the lake as well as recharge the refuge and KDD if volume was used from these accounts. Max volume is set at the pool elevation of 4142.8 ft.
Adj_fill_vol	Volume of water needed to completely fill the UKL, neglecting the additional water available to partially fulfill the demand.
Fill_flow	Daily flow of water needed over the remainder of the Season to completely fill the Upper Klamath Lake as well as refuge and KDD (only if volume was used). Equation adjusted in January to prevent excessive filling.
Or in Jan-Feb if NRCS 50% UKL net inflow+UKL elev-EOSep 4139 elev>900TAF, Fill_Flow=0	Triggers the fill flow to 0 for the month of January through February if the combination of 50% NRCS forecast inflow and current UKL Volume minus the volume at 4139 ft pool elevation is greater than 900 thousand-acre feet.
FWavail	The selected date's water volume available to be contributed to the Upper Klamath Lake to meet its maximum volume. A function of the three-day running average minus the target and fill flow. Will only occur when that value is greater than zero.
KDD Diversion	The agriculture diversion satisfied by pumping Klamath Diversion District flow through the Ady and North Canal. This row is a sum of those two flows for the selected day.
KDD Cumulative Diversion	Tracks the total ag diversions through the Ady and North Canal over the course of the Fall/Winter Season.
KDD SR Cumulative Diversion (capped at 19,234 AF)	Same as the cumulative diversion but sets a cap for the season at 19,234 AF as to not overdraw or pull water from other accounts.
KDD FW Cumulative Diversion (starts after completion of SR)	Tracks the cumulative diversion overdraw for the season. Once the cumulative diversion exceeds 19,234 AF this row will have a value.
KDD FW Diversion (starts after completion of SR)	Once the diversion account use has exceeded its allotted volume (19,234 AF), this row tracks the daily diversion/overdraw for the remainder of the season.
KDD FWavail Account	The account which tracks the Fall/Winter water available to the KDD. If the cumulative diversion from the KDD is less than the cap (19,234 AF) and the selected date falls within the first 80 days of the season, this equals 0. Else, it is the sum of the season and daily allowable cap. This is a cumulative equation, so the value could theoretically grow by the daily allowable cap each day. Relies on FWavail being non-zero.
KDD FWavail Debt	Tracks the seasonal debt or water owed due to the overuse of the Fall/Winter available water account. It is a cumulative function which sums the previous days debt and the daily diversion after overdraw minus the sum of yesterday's available water and the daily available cap.
Refuge Diversion	Miscellaneous flows diverted out of the refuge into the Klamath River/Lake. Data referenced from the Misc In_Out sheet.
Refuge Cumulative Diversion	Tracks the total miscellaneous diversions from the Refuge over the course of the Fall/Winter Season.

Row	Description
Refuge Remaining Project Supply	The remaining water from the project supply to be utilized by the Refuge minus its diversions to the Klamath. The value for this account is reset on the first of every month from Oct to Dec to keep tracking accurate.
Refuge Project Supply Cumulative Diversion	Same as the cumulative diversion but sets a cap for the season at the initial Project Supply to prevent overdraw or pulling water from other accounts.
Refuge FW Cumulative Diversion	Tracks the cumulative diversion overdraw for the season. Once the cumulative diversion exceeds the initial project supply this row will have a value.
Refuge FW Diversion	Once the diversion account use has exceeded its initial project supply, this row tracks the daily diversion/overdraw for the remainder of the season.
Refuge FWavail Account	The account which tracks the Fall/Winter water available from the Refuge. It is the sum of the previous day's available water and daily available cap minus the daily diversions once the project supply is overdrawn. Else, it is zero.
Refuge Fwavail Debt	Tracks the seasonal debt or water owed due to the overuse of the Fall/Winter available project supply. It is a cumulative function which sums the previous days debt and the daily diversion after overdraw minus the sum of yesterday's available water and the daily available cap.
I15 Keno to IGD accretions	The accretions to the Iron Gate Dam in the reach between it and the Keno Dam. Typically determined by the Pacificorp accretions, else references values from Accrete_adj sheet or is a 7 day running average of the past values.
IGD flow with "Link_min" release at Link River Dam	The release from IGD if the minimum release is executed at LRD and net accretions are the inflows.
IGD flow with "Link_release_FW" release at Link River Dam	The release from IGD if the calculated release is executed at LRD and net accretions are the inflows.
Igmin	The minimum flow out of the Iron Gate Dam that was determined the BiOp.
Link release for IGD min	The amount of water released from the Link River Dam to meet minimum flow requirement at the Iron Gate Dam. It is the difference between the Igmin and Net Accretions.
C15 flow (IGD – Final Calculated in cfs)	This is the final calculated flow release from the Iron Gate Dam, it is either the larger of the Link release for IGD or the Flood Release. The accretions are then added to this amount.
C15 flow (Final Calculated in cfs) without rampdown	This row is checking to make sure that the flow is not below the minimum required flow for the Iron Gate Dam, if it is the flow is set the min.
C15 flow (Final Calculated in cfs) with rampdown from schedule	This row is checking to make sure that the daily change in flow does not violate the rampdown rate for the Iron Gate Dam. If it does, set the flow to the previous day's calculated flow minus the rampdown rate.
C15 flow (Final Calculated in cfs) with rampdown from actual	This row is checking to make sure that the daily change in flow does not violate the rampdown rate for the Iron Gate Dam. If it does, set the flow to the previous day's actual flow minus the rampdown rate.
Actual or Projected IGD releases	A check of the historical record to see if an IGD release value has been measured for this day. If not, the value is set to the calculated or rampdown flow.
Increment of Release Due to Rampdown	Tracks the amount (cfs) the calculated flow was altered by when considering the rampdown rate.
Cumulative FWavail	Tracks the cumulative amount of additional water available for use up to the selected date. Function of the previous days cumulative available water plus the difference between the water available and the amount used for that day.

Row	Description
FWused	The amount of additional water available that has been used for the IGD release on the selected date.
Rampdown Rates	Sets the rampdown flow for the Iron Gate Dam depending on the release for the selected Date. If less than 1900 cfs, 150 cfs. If less than 3300 cfs, 300 cfs. Else, it is the difference between the actual or projected IDG release minus 3000 cfs.
Rampdown Adjusted Flow	Checks the flow for the selected date so it does not exceed the rampdown limit. If it does, it sets the previous days flow minus the allowable rampdown flow.
Rampdown vs Calculated	A comparison of calculated flow at IGD and Rampdown Flow. First it checks if the selected date has passed, if it has it will assign the historical data. Else, it will assign the max of either the rampdown adjusted flow or IGD final calculated flow.
EWA for rampdown	Assigns the release at IGD to be taken from the EWA if the rampdown adjusted flow is greater than the calculated flow.
Cumulative Fall Flow Banking	For the Fall/Winter Season, this is the cumulative amount that the IGD release was greater than the Igmin due to rampdown regulation.
Max Flood Control Release	Release from the Iron Gate Dam to prevent exceedance of the flood control volume at the Upper Klamath Lake.

Thresholds

If the Dashboard is the controller of the calculator, the Thresholds is the visualizer. Here, a compilation of elevation, flow, and usage data is gathered and plotted to show if the management of the objects is complying or will comply with the BiOp. A few calculations for thresholds are present, otherwise most data have been copied over. Representation of conditions on these plots is relatively changeable and can be altered to meet the operator's needs.

As far as management goes, there is very little needed to do on this sheet. The two most important objectives are to copy and paste over the elevation values from either the shadow or regular operational scenario and the Act&Proj inflows into their appropriate cells. Henceforth, the setup takes the monthly average of inflow and ending monthly volume to create the variable of Inflow & Storage. That variable is what's used as the dependent variable to assign the corresponding monthly threshold. That equation has a few different forms, whether it be a polynomial, logarithmic, or linear equation depending on the month and curve/formula it falls under. Now that the threshold have been assigned, all the data necessary is available for the first two graphs.

These graphs are simple representations of Elevations vs the BiOp Thresholds. The first is observed for the year under consideration, in this case, it is for 2018. The thresholds found earlier are marked for each month and the values from the elevation table are tracked in relation. Since the elevation cell is formulated to transfer between measured and projected when appropriate, the two are separated by different lines. The black line is the measured data while the dotted line is projected. If the operator wishes to visualize other data, such as the min and max thresholds for the month, options are included in the setting to add this to the plot. Not much changes with the second graph except the timeframe considered and inclusion of minimum thresholds. Here, the current elevation is represented with 6 months of historical and projected on each respective side. This way, the operator has a better understanding of the recent observed trends and the extended outlook which will be necessary to schedule appropriate releases/borrowing for compliance. In both graphs, a table which outlines the conditions input on the dashboard (exceedances) is shown for reference.

The next graph available is for the IGD releases. In this scenario, all the data has been either drawn over from the summer calculator (projected) and USBR Daily (measured) sheets. These releases are plotted,

historical until the date of switched to projected until the end of the timeframe. In addition, this plot seems to include an ideal/set ceiling (6030) and floor (Igmin) for the flows. These are likely available to make sure the operator keeps the release within this range. An option is available in the settings to lower the ceiling to 3000 ft. Although, these are not hard limits since the flow is shown to violate both lines.

The last graph is for the Environmental Water Account. Perhaps the most simplistic, it only accounts for two variables. These variables are the Used EWA up until that date and the remaining EWA for the remainder of the year. The total EWA for the year is drawn over from the supply calculator. The difference between this value and the used EWA up to that day (tracked on the Summer Calculator) is taken to give the remaining EWA. These are taken to create a pi-chart with used in Blue and remaining in Red. It should be noted that EWA usage can exceed the available volume for the year, in which case the negative remaining EWA will be represented on the plot. No additional variables are available for plotting in the settings for this chart.

Questions

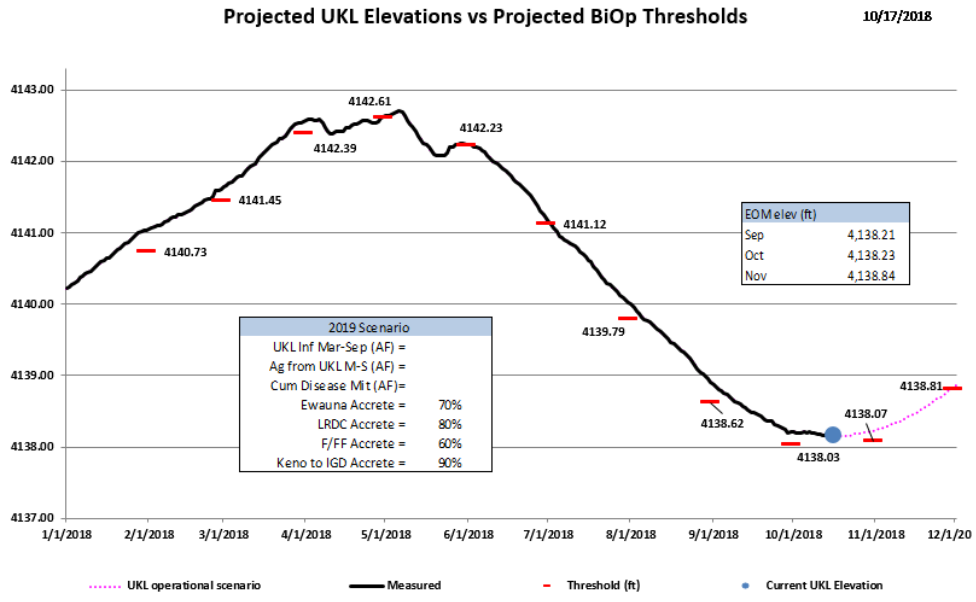
5. The Graph for Projected UKL Elevations vs Projected BiOp Thresholds references the EOM elev in a table, what is this and what does EOM stand for?

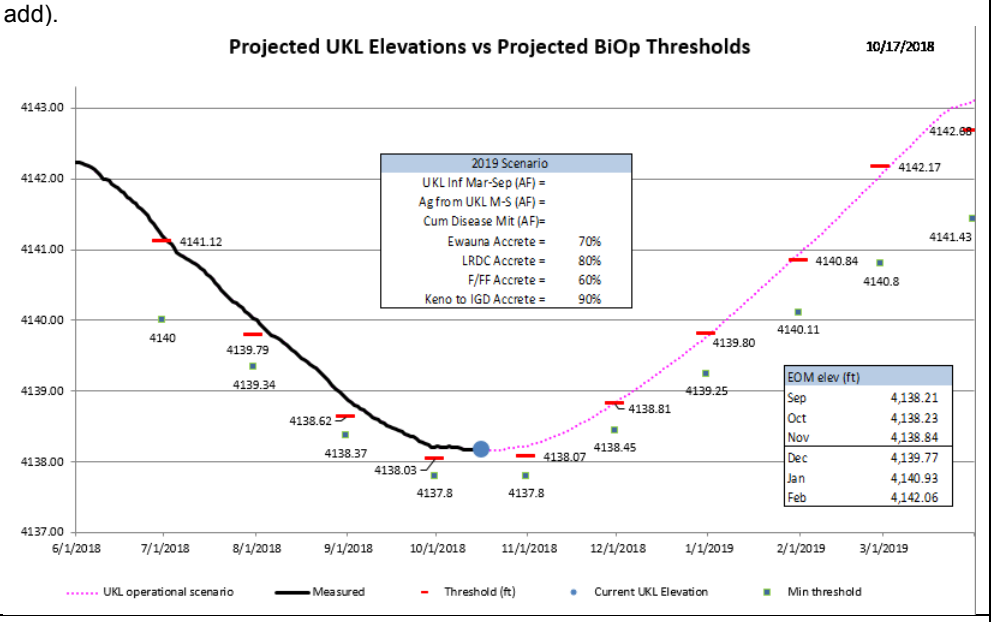
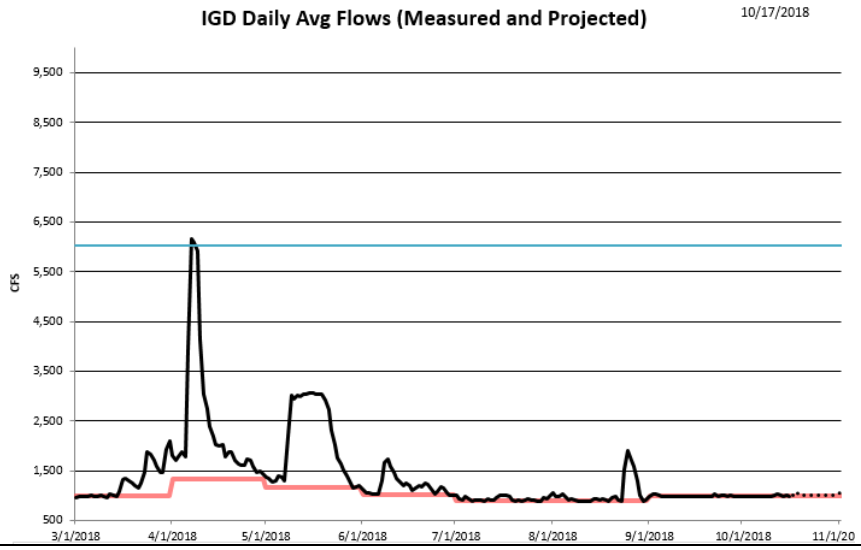
Table 10. Description of columns on the Thresholds sheet

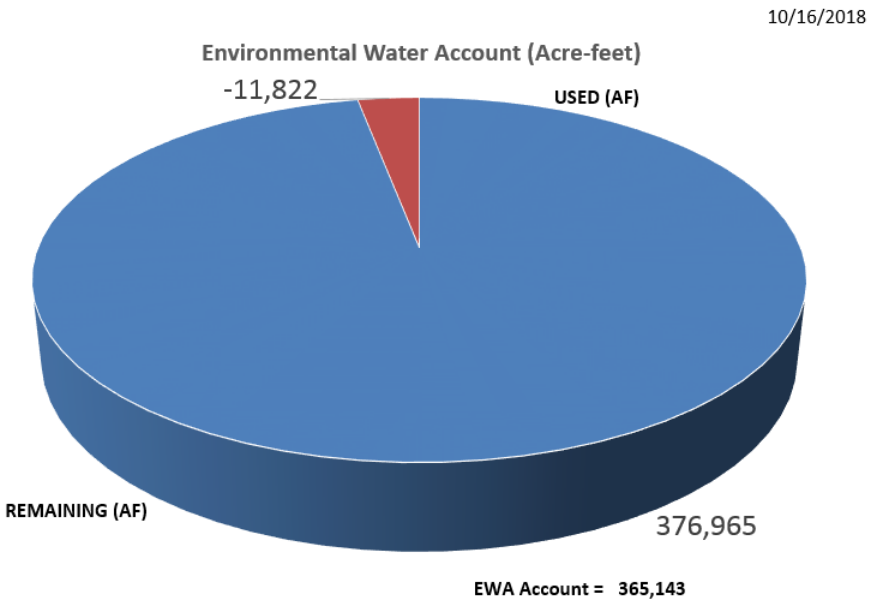
Column	Description
Projected Net Inflow	The sum of actual or projected UKL inflow for the month, referenced from the Monthly Inflow cell below.
Inflow & Storage	The sum of the cumulative inflow and end volume for the month, referenced from the Projected Net Inflow and Likely Vol column. Equation is adjusted to account for cumulative shadow operation flows when available.
Shadow Cumulative	The cumulative shadow operation flow for the period (Jan 2018 – Sep 2019), references its value from the dashboard column “Total Deliveries”. Used for the Winter Months.
Op Sc	The Operation Scenario UKL elevation at the end of the month. This value can be historical or a projection depending where the date falls in relevance to the day input to the Dashboard. Referenced from the UKL Operational Scenario column below.
Shadow	The Shadow Operation UKL elevation at the end of the month. This value can be historical or a projection depending where the date falls in relevance to the day input to the Dashboard. Referenced from the UKL current scenario (Shadow) column below.
Threshold	The takes the corresponding Inflow & Storage cell value and uses a provided equation to find the Threshold elevation for the month. This equation may differ from month to month as either Dunsmoor Curve Data or Sep+Inflow Formula Data is used. Within those two categories, the equation may have a linear, polynomial, or logarithmic relation.
UKL operational scenario	A historical or projected value of the elevation at UKL for that day. If historical, it will used the measured elevation from a few columns over. In either case, each of these values were referenced from the UKL Inflow sheet.
UKL current scenario (shadow)	The historical or projected value of the elevation at UKL under the shadow operation. This value will reference the Shadow UKL evel column on the UKL Inflow sheet.
Most Likely Elev	In this case, it is just the UKL elevation in the UKL operation scenario column copied over to this column.
Likely Volume	The volume in the UKL found for the last day of the month. Utilizes an area-capacity table to find this value, references the mostly likely elevation for this day.
Measured	The measured UKL elevation, referenced from the UKL Inflow - Measured elev column.
Projected	The projected UKL elevation, referenced from the Most Likely Elev column when the day fall after the date input on the Dashboard.
Inflow (Actual & Proj) TAF (Shadow)	The Actual or Projected inflow at UKL for that day, referenced from the Inflow (Actual and Proj) column on the UKL Inflow sheet.

Column	Description
	6. If this column has the label Shadow, why does it not reference a shadow operation inflow from the UKL Inflow sheet?
Combined inflow	In this case and detailed in the instructions, it is just the values from the Inflow (Actual & Proj) TAF (Shadow) copied over to this column.
Monthly Inflow	The total UKL inflow for the month. This is done by summing of the values in the Combined Inflow column over that month.
BiOp Min	The minimum allowable elevation at the UKL as determined by the BiOp.
Threshold	Gives the elevation calculated in the threshold column above along with the min and max value it could be for that month.
Sep+Inflow Formula Data	Here is the information needed to calculate the Threshold elevation given the Inflow and Storage for the month. Basically, it represents a graph that where the elevation is the y axis and the Inflow and Storage is the x axis. This will be used for the months of march through September (Spring/Summer).
Dunsmoor Curve Data	Here is the other info that is used to calculate the Threshold elevation for the months of October through February (Fall/Winter). Same format as the Sep+Inflow Formula Data.

Table 11. Graphs shows on the Threshold sheet

Graph	Description
Projected UKL Elevations vs Projected BiOp Thresholds - 2018	Tracks the measured/projected elevation vs the thresholds calculated for the UKL. The measured data is plotted up to the current date, at that point the flows from the UKL operational scenario are used as projections for the remainder of the year. Current elevation is marked, and the thresholds are shown for each month. Options exist to plot shadow operation flows, projection flows, min & max thresholds, and customized scenarios. Also included is a table which show the conditions set for the scenario (exceedances), referenced from the Dashboard. 
Projected UKL Elevations vs Projected BiOp Thresholds - Extended	Exactly the same as the previous graph except for the projected outlook length. Here, the elevation vs thresholds are tracked at 6 months ahead and behind the assigned date. In this version, minimum thresholds have been chosen to shown. In addition, most of the additional data options exist for plotting except for the custom scenarios (may be able to

Graph	Description
	add). 
IGD Daily Avg Daily Flows (Measured and Projected)	Tracks the releases at IGD min over a period decided by the user selection. The measured flow at IGD is plotted up to the current date, at which point the projected flows referenced from the Summer/Winter Calculator (depends on timing) are used as projections for the remainder of the period. The minimum allowable release is represented on the graph along with the marker of 6030 cfs (perhaps the ceiling), these perhaps show the range in which the releases should be kept. Most of the data referenced here is transferred over from the Summer/Winter Calculator and USBR Daily sheet. In addition, the availability to mark the 3000 cfs line is selectable in the plotting options. 
Environmental Water Account (Acre-feet)	Tracks the Environmental Water Account remaining and used volume for the year. The available volume from the EWA Account is referenced from the Supply Calculator Sheet and the usage from the Summer Calculator (no EWA usage in the Winter). The remaining is the difference between those two values. This is all represented in the form of a Pi-chart, which can show negative values if the Account is overdrawn. No extra data options are

Graph	Description
	available unless specifically created by the operator. Blue is used and Red is remaining. 

Supply Calculator

While most of the sheets in the IGD calculator track releases and account usages, the supply calculator concerns itself with assigning the availability of water. Two supplies are set here, the Project Supply and EWA River. Each account is determined by aggregating forecasts of seasonal inflows and target elevations. These values will be referenced to a corresponding percentage of the total volume the accounts will possess. Periodically, these accounts will be updated once observed inflows are available, thus adjusting the available volume for the remainder of the year. In addition, conditions have been listed to adjust the values when a wet season scenario occurs.

Before setting the EWA River and Project Supply volumes, a few projections and possibly observed values are needed. Starting from left to right, the first cell requiring entry is the UKL elevation at the end of February. Since the both EWA and Project accounts will be set before February has ended, this cell will at first be a NRCS projection (reference website). Once past and the season analysis initiated, this value can be taken from the UKL inflow sheet (found in the Shadow Op elev column - measured). The storage, which will be used as a variable for the account volume calculation, is found from the elevation referenced to an area-capacity table. The second entry is the March through September Inflow into UKL. Here, the NRCS forecasts and observed flows are aggregated to provide the total flow throughout the season. The NRCS forecasts are updated from the months of March through May for both Williamson and UKL Inflows. The top column references these values until that month has ended and the observed flow can serve as the replacement. Once these forecasts have been entered, the only available input left is the volume for increased minimum flows. In this cell, the operator can transfer over the value found in the Summer Calculator.

Now that the inputs have been set, the rest of the preliminary variables will be set by their cell's equations. The UKL EOS target elevation will take the march thru September inflow and reference it to a target interpretation sheet to assign its value. The target storage will execute the same process as end of February storage, except using the target elevation instead. With volumes all set, the total supply is set by taking the difference between the sum of end of Feb storage and Mar-Sept Inflow minus the target storage for the end of the season. Based on the total supply, a corresponding multiplication factor is assigned

which represents the percent of the total supply should go to the EWA River account. If the value found from the product of the total volume and multiplication factor is less than 320 TAF, the EWA River will automatically be set to 320 AF. This will likely only occur in extreme drought years; otherwise, it will simply be that product. The project supply is therefore the difference between the Total Supply and the sum of EWA River and Flow for Min Volume. If this value exceeds 390 TAF, the excess portion will be assigned to the EWA River account. These two previous calculations are redone once April 1 has past, in which case the actual flow from March will be incorporated.

The same procedure can be repeated for a year out with projected values will be available to set account values. There is some uncertainty about the operation of this page, the first being the incompleteness of values entered for NRCS forecast for April and May. Second, how actual values are set before the date has past. Some clarification from KBAO may be necessary to decipher these issues.

Table 12. Description of columns on the Supply Calculator

Column	Description
UKL end of February elev	The elevation of the UKL at the end of February. This will be a measured value if prior to the date, otherwise it is a projected elevation based on the NRCS forecast.
End of February storage	Simply takes the elevation at the end of February and uses an area-capacity table to look up the corresponding volume.
March-Sept inflow vol	The cumulative Inflow at the UKL over the months of March to September. In 2018, this utilizes the actual flow for march thru may and the NRCS estimate for Jun-Sep. In 2019, this uses the Mar – Sept actuals and the NRCS estimate for May. 7. Why does the data for the same projection change? Also, why does the 2019 projection add the May projection on top of the already found Apr-Sep inflows, wouldn't this be double counting?
UKL EOS target elev	The target elevation at UKl for the end of Season/Summer. Utilizes a look up function to reference the March-Sept inflow to an elevation located on the EOS target interpret sheet.
UKL EOS target storage	Simply takes the target elevation and uses an area-capacity table to look up the corresponding volume.
UKL Supply	The difference between the End of February and Target Storage, with the addition of the March-September inflow. This is how much water is available to use for all the accounts in the Klamath for the year.
%UKL Supply to EWA River	A look up function to reference the UKL Supply to a corresponding factor that will decide what percent of volume will be allocated for the EWA.
EWA River	The volume of EWA allocated for river flows. This will be the UKL supply multiplied by the factor found above if this amount greater than 320 TAF. Else, it will be 320 TAF.
Volume for Increased Minimum Flows	If the operator decides there needs to be an greater flow in the rivers, this cell will be assigned a volume to satisfy the necessary increase.
Project Supply	The difference between the UKL Supply and the EWA River plus Volume for Min Flows. If this value is greater than 390, it will be reduced to 390 and the remaining volume will go to the EWA River.
Project Supply set after Apr 1	Same formula and result for the EWA River and Project Supply as before. 8. Why does this not change? Shouldn't the April project/observed flow factor into this cell's output?
USGS daily avg "Month" flow	Williamson River: The months forecast for the cumulative Williamson River Inflow for the months of $Month_{+1}$ thru September. Provides the forecast from the NRCS and the CNRFC, different cells/values. **UKL Inflow: The NRCS forecast for cumulative UKL Inflow in the months of $Month_{+1}$ thru September. Also provides that value divided into uniform daily inflows. 9. Why is only the March forecasted flow filled out? Also, why is the Daily flows left blank?

Williamson actual & NRCS est.	The in-calculator Williamson projected flows for the timeframes of March, Apr, May, and June-Sep. NRCS forecasts for the same months are provided in the column over.
UKL actual & NRCS est.	The in-calculator UKL projected inflows for the timeframes of March, Apr, May, and June-Sep. NRCS forecasts for the same months are provided in the column over.

ShadowOp_In_Out

The ShadowOp_In_Out sheet is a background operation category as it provides values for the main calculators and dashboard. Here, the flow deduction for the shadow accounts managed on the dashboard are executed on a daily flow schedule. These values are used to find the shadow operation flows that are calculated on the UKL Inflow sheet.

The ShadowOp_In_Out sheet can be divided into approximately 3 sections.

- Triggers
- Deductions
- Daily Balance

Triggers

The rules/description of the two types of triggers are laid out in Table 13. These are the basic mechanisms used to initiate and categorize deduction for a selected account. Initiation is simply a yes or no function, either this action does not affect the shadow op (0) or it does affect the shadow op (1). The categorization is coded to three options, UKL Inflow is unaffected (0), only the past UKL inflow is affected (1), and the past and projected UKL inflow is affected (2).

Table 13. Description of triggers and inflow treatment on the ShadowOp_In_Out sheet

Triggers	Description
Shadow Trigger	If this value is equal to 0, this action will not affect the shadow operation. If this value is equal to 1, this action will affect the shadow operation.
Inflow Treatment	If this value is equal to 0, there will be no affect to the UKL Inflow. If this value is equal to 1, the projected inflow will not be affected but the past inflow will be. If this value is equal to 2, the projected and past inflow will be affected.

Deductions

The second section is the daily execution of the flow/volume deductions referenced from the 11 shadow operation accounts shown on the Dashboard. Here, the function for the three categories will be the same except for the second trigger which is what will be used to differentiate where the flow is assigned (see above paragraph for description). The function checks each account on the dashboard in a similar method. There are three steps in most cases for this method, the first checks if the shadow trigger is less than 0.5, the second checks if it is greater than 0.5, and the third checks if the corresponding date falls outside the assignment timeframe (using no inflow deduction column for example). If any of these conditions are satisfied, the value assigned from that account is zero. Otherwise it the daily uniform quantity listed. This process is repeated until all accounts have been analyzed. As mentioned, a few of the checks for this method use an anomalous equation, such as the dilution flow which will reference to the Misc In_Out sheet if triggered. This process is now repeated for the other two columns.

Table 14. Description of columns on the Deductions section of the ShadowOp_In_Out sheet

Column	Description
No Inflow Deduction	Checks the triggers and start/end dates of the 11 Shadow Operation accounts on the dashboard. If the Shadow Switch is 1, the Inflow Treatment switch equal to 0, and the date between the start/end dates, the deduction flow assigned to this column will be the daily flow set for that operation account. Aggregates those account deductions together for one flow value.
Past Inflow Deduction	Checks the triggers and start/end dates of the 11 Shadow Operation accounts on the dashboard. If the Shadow Switch is 1, the Inflow Treatment switch equal to 1, and the date between the start/end dates, the deduction flow assigned to this column will be the daily flow set for that operation account. Aggregates those account deductions together for one flow value.
Past and Proj. Inf. Deduction	Checks the triggers and start/end dates of the 11 Shadow Operation accounts on the dashboard. If the Shadow Switch is 1, the Inflow Treatment switch equal to 2, and the date between the start/end dates, the deduction flow assigned to this column will be the daily flow set for that operation account. Aggregates those account deductions together for one flow value.

Balance

The last section covers the flow/volume balance of the UKL and certain shadow op accounts. Starting from left to right, the first value pulled is the Regular UKL Volume which referenced from the UKL inflow sheet. The difference between this column and the cumulative total shadow volume for that date will be taken to give the Shadow UKL volume. The Cumulative total shadow volume is the aggregation of the inflows and outflows from the shadow op accounts. The outflows being the Daily Additional Ag Supply, Surface Flushing, and Dilution Flows. Whereas, the inflows are the Daily Agency Pumping, LKNWR Borrow, and PacifiCorp Borrow. The outflows are represented with negative values and the inflow with positive. Thus, if the cumulative shadow flow is negative, there were more outflows and vice versa. Once again, this value is taken with the UKL Volume to show what it would be under shadow operation conditions. It is unclear why these Daily values are the only accounts considered of the out of the 11 possible. In addition, the UKL Volume under shadow operation can also be found on the UKL Inflow sheet, except this column considers all account deductions.

Table 15. Descrption of columns on the Balance portion of the ShadowOp_In_Out sheet

Column	Description
Regular UKL Vol	The measured or projected volume in the UKL, dependent on the day's position to the input date. No shadow operation considered, referenced from the UKL Inflow sheet.
Shadow UKL Vol	The measured or projected volume in the UKL plus the cumulative shadow operation volume. This shadow value may be positive or negative depending on which accounts are being utilized that day.
Cumul Total Shadow Volume	The difference between the inflow and outflow shadow accounts. If there are more outflows, this value is negative. Vice versa if there are more inflows.
Total Shadow Outflow	The sum of the Daily Ag Supply, Surface Flushing, and Dilution Flow. These values will reduce the UKL volume.
Total Shadow Inflow	The sum of the Daily Agency Pumping, LKNWR Borrow, and PacificCorp Borrow. These values will increase the UKL volume.
Daily Add Ag Supply	The additional volume of water supplied to ag requests. References the total Ag Deliveries column on the Dashboard and divides the corresponding months value to a uniform daily value.
Daily "Object"	The rest of the columns in this portion of the sheet are not filled out. Based off the Ag column, they likely reference their daily corresponding quantity shown on the Dashboard over the period listed.

Notes

The following bullets make notes about the deductions incorporated into this sheet:

- The effects of the flow deduction to UKL inflow or volume are not represented on this sheet. Instead, they are shown on the UKL inflow sheet.
- The No Inflow Deduction directly reduces the UKL volume whereas the other two directly reduce the UKL inflow. They will also be reflected in the volume reduction as well (a result of inflow reduction).
- When the deductions are negative, it's increasing the UKL inflow/volume. When deductions are positive, it's reducing the UKL inflow/volume.
- There are both accounts to track the withdrawal and payback of water volume. Deductions or Increases in flow occur to fulfill both these purposes when their specific conditions are met.

Questions

10. Why is the right-hand portion of the Daily columns not tracked?

Misc In_Out

For the operation of the main sheets of the IGD Calculator, it would be inefficient to include every minor input/output onto a single page. Instead, many values are tracked elsewhere and aggregated into a single variable such as accretions which could be substituted to capture the overall effect. The Misc In_Out page accomplishes that function. Here, all the minor, miscellaneous, and intermittent flows occurring throughout the Klamath are tracked. While some cells are simple observations, other require dedicated functions to initiate conditional flow releases on the Klamath. The page is therefore split into two section, one that controls the release activation and timeframes (Upper section) and another that assigns the flows through the year (Lower Section).

Questions

11. What does DG stand for? Is this used interchangeably to represent different lower column section with the number behind it coding for a particular one? Or does it just stand for Dam Gate #?
12. Why do the dilution/flushing flows only occur through the early portion of the year (Jan – June)? Is this because it is the driest season and this is when it's needed or is it a listed action in the BiOp?

Upper Section

The upper part of the Misc In_Out sheet is the control section. There are three main activation switches and a couple of cumulative flow amounts for that year. The switches control the dilution and surface/deep flushing flows as well as the accretion reference. For both flows, one cell is for the on/off toggle and another for the operation timeframe. Each differs slightly though, the Surface/Deep Flushing flow considers ramping whereas the Dilution flow has control over the activation term it uses for flow assignment (short/long/actual). Both track their yearly totals in cells adjacent to the activation switch. The Alt Accretion is only a 2-cell control, the first for on/off toggle and the second to set the alternate year which the accretions will be referenced. The following table describes these computations further.

Table 16. Misc In_Out Upper Section column descriptions

Column	Description
Sum Refuge	The total volume of water delivered to/from the refuge for that year. For some reason this cell has been entered as zero, perhaps by the manager.
DG1 Dates	The start date for the DG1 release is entered here and the end date is automatically set. The end date will always be 2 days after the input start date.
DG1 On/Off	This is part of a series of trigger system cells that initiate different actions depending on the value set here. For this cell, the DG1 Flushing flow will be initiated if 1 is input, and turned off if 0.
DG1 Ramp	Second part of trigger system series. Before this cell can act, the DG1 flushing flow must be turned on (1 in the cell). The value input here will determine the form of ramping for the DG1 Flushing Flows. A 0 signals no ramping, a 1 signals the ramping rates set in the BiOp, and a 2 signals a modified ramping rate set in Ramp Rate column below.
2018 DG1	The total DG1 Flushing Flows for the year, these flows are only active from the first of January through the end of April. See the Surface and/or Deep Flushing Flows for the daily values.
2018 DG4	The total DG4 Flushing Flows for the year, these flows seem to be active only for the first of April through the fifteenth of June. See the Cumulative Long Dilution column for the total flows throughout the period and the Dilution Flow column for the daily values.
Disease Trig	The first cell is used to initiate a flow release to prevent diseases forming in the Klamath River system. The short duration flow is activated by an input of 2, the long duration flow is activated is activated by an input of 1, the actual dilution flow is activated by an input of 3, and the no flow release is activated by any other number.**The second cell is used to set the year for which trigger window is used for dilution flow. This can be any year from 2005 to 2017 or 9999 which selects a custom trigger window.
Total 2018 from Barnes/Agency Pumping (First – Total 2018)	The total volume of water from/to the Barnes/Agency Pumping. Only occurs from the first of April through the end of September.
2018 Total from LKNWR allot	Sum of the daily flow volume from Area K (see below column) for 2018. In this case, no values or equations are in these cells.
Total 2018 No DF IDG flows	The Sum of the values in the No DF IGD Flows column below for the 2018 season. Only takes the values from the beginning of April to the end of September even though there are values throughout the whole year.
Alt Accretion On/Off	Trigger system to determine which years accretions should be used. If this value is 0, it will use the current years accretion. If the value is 1, it will use the year entered in the year below.
Alt Accretion Yr	The year whose accretions are desired to use for the relevant column on this sheet. Can be any year from 1982 thru 2016.

Lower Section

The lower part of the Misc In_Out sheet contatins the daily monitoring/assignment section. For the most part, the only column the rest of the calculator is concerned with is the Total Misc Flows. If this value is negative, water is being delivered to the Klamath. Whereas, a positive value means return flow are occurring. Most of the columns that the Total Misc flow accounts for are just observations. However, the three directly adjacent to it do have some functionality. The first, Water to Refuge, is connected to the Dashboard Shadow Op Accounts and the other two, Surface/Deep Flushing and Dilution flows, are set by the upper section.

Table 17. Misc In_Out Lower Section Description

Column	Description
Total Misc Flows	Sum of all the intermittent or miscellaneous flows for that date. Includes the objects from the next 14 column except for the cumulative dilution flows.
Water to Refuge	Checks the triggers and start/end dates of the Refuge accounts on the dashboard. If the Shadow Switch is 1, the Inflow Treatment switch equal to 2, and the date between the start/end dates, the flow assigned to this column will be the daily flow set for that operation account. Aggregates those account flows together for one flow value.
Surface and/or Deep Flushing Flow	This column executes a conditional function for finding the flushing flow from the beginning of January to the end of April. If the DG1 is on, the date within the DG1 timeframe + 7 days, and precedes the input date, the column will equal the previous week's projected flow minus the actual flow at Link. If the DG1 is on, the date within the DG1 timeframe, and the IGD flow with accrete less than 6030, the flushing flow is the IGD flow with accrete minus 6030 cfs. Else it is the difference between the DF IGD flow and IDG flow with accrete or zero, difference occurs when the previous day's DF IGD flow is greater.
Dilution Flow	This column uses a rather long and complicated equation which would be difficult to explain in whole. Basically, this cell has a term to consider ramping for dilution flows and another which chooses to take the difference of 3000 cfs and No DF IGD flows converted to AF and switched sign or the same equation except it is 4000 cfs instead. See column for equation, there are also considerations for the Disease Trigger, Dilution $flow_{d-1}$, Cumulative Long Dilution, and DF IGD Flows. In addition, there is a certain portion of time where this column equals the difference between the Actual and the previous week's Projected Link.
Short Duration Dilution	Same as the Dilution Flow column except the disease trigger must be set to 2 and the ramp rate/trigger is not considered.
Cumulative Long Dilution	Tracks the cumulative Dilution Flow throughout the period of consideration (April 1 – June 15).
Cumulative Short Dilution	Tracks the cumulative Short Duration Dilution throughout the period of consideration (May 5 – June 15).
Projected or Actual Dilution	Uses a shorter version of the conditional statement in the other dilution columns. Here, if the actual dilution trigger is active, the No DF IGD flow less than 4000 cfs, and the date precedes the input date, the value for this column will be 4000 cfs min the No DF IGD flow converted to AF and sign switched. Otherwise it is zero.
Regulatory Call	This cell references its value from the Call Effects sheet for that date. There only seems to be values available up to July 31, 2017. Seem to be related to the Williamson and Wood River Flows.
Barnes/Agency Pumping	The volume of water pumped from Barnes or Agency Lake. Seems to be a value input by the manger, perhaps from another excel document.
Wood River Wetland	The same setup as Barnes/Agency Pumping, tracks the volume from/to this object. A value which seems to be input by the manager referenced from another excel document.
Yurok Boat Dance	The flow diverted for Yurok Tribe's ceremonial boat dance, the specifics on this event is outlined briefly in the BiOp. Occurs around the end of July. The values seem to be flow reductions that occur after the ceremony was completed.
LKNWR Flow	The flow being delivered from or returned to the LKNWR. If there is delivery from, this value will be negative. If there is flow returned, this value will be positive. Value likely tracked on another spreadsheet and transferred over by the manager.
Ground Water Pumping	The volume of water delivered from the ground water source for that date.
Area K	The volume of water diverted from this area, seems to be related to the LKNWR allotment set in the upper section which is divided over 40 days somewhere in the year.
Actual IGD Flow	The recorded flow at IGD referenced from the USBR Daily sheet. Will only have a value if its date precedes the input date.

Column	Description
Actual Link Release	The recorded release at LRD referenced from the USBR Daily sheet. Will only have a value if its date precedes the input date.
Projected Link from 7 days ago	References the previous week's calculated Summer Link Release for the River Excluding Flood from the UKL Inflow sheet. As indicated, there will only be non-zero values for the Summer season.
DG1 Day Count	Tracks the number of days that Surface and/or Deep Flushing Flows are occurring.
No DF IGD flows	The flow at Iron Gate Dam not considering deep flushing flows. Obtains its values by referencing the Summer or Winter Calculator for the appropriate period.
DF IGD flows	The difference between the No DF IGD flow column and the min of either the Dilution or Short Duration Dilution Flow. Will make this column a greater value since the dilution flow have a negative sign.
Net Accretions	The accretions to IGD which has be transferred over from the Summer or Winter Calculator, depending on the time of year.
Link Flows – Net Accretion	The flow at Link if the accretion to the Klamath/IGD were not considered. Takes the difference of the No DF IGD flows and Net Accretions column.
IGD flows with Accretions for X yr.	If the Alt Accretion trigger is turned on (1), this row will reference the DailyAccretion_Lookup sheet to assign a value based on the alt year entered above and the day/month of that cell. This will be added to the value in the Link Flows – Net Accretion column to give the adjusted flow.
1 DF 3000 2 DF 4000	A check column that will be referenced for determining ramping rate/restrictions in the next 12 rows. If there is a DF flow at IGD, check to see if this value is greater or less than 3500. If less, a 1 will be assigned. If more, a 2 will be assigned. If there was no DF flow, a 0 will be assigned.
1 -12 (days)	When a dilution flow occurs, this will estimate the flow under ramp down limits for the following days until it goes back to zero. Seems to be calculated in AF.
Ramp Cost	The sum of the flows that were gradually decreased under ramp down limits (columns 1-12).
Ramp Day	Counts how many days it took the flows after deep flushing to return back to zero under ramp down limits.
DF Cost plus Ramp Cost	This is the sum of the Ramp Cost and Cumulative Long Dilution Column. Will be used to initiate a ramping trigger in the next column.
Ramping Trigger	A condition OR function. It will be activated if the DF Cost plus Ramp Cost is greater than a preset value, the trigger was initiate yesterday, or if the date is a week out/past the disease flow period.
Ramp Rate	Sets the ramping rate if the trigger is activated. Has two component, one for if ramp down has been occurring and another for if it this is the first day in the ramping cycle.

Miscellaneous Sheets

The IGD Calculator contains many other sheets. We reviewed the sheets and documented the miscellaneous sheets, Table 18. , and those that appear to be no longer used, Table 19.

Table 18. Miscellaneous Sheets

Sheet	Description
LKNWR_PC_Borrow	Tracks the water borrowed from Pacificorp and the LKNWR refuge. Primarily serves in tandem with the Summer and Winter Calculator. Columns include: • Refuge Discharge to Drain: The flow available to be borrowed from the Refuge on a given day

	• F/FF Refuge Return: This will return the full borrowed amount if the total F/FF flow is greater, otherwise it will be the total F/FF flow from the USBR Daily sheet. This column is linked to the Summer & Winter Calculator • PC Borrow: Flow borrowed from Pacificorp is tracked here, will be transferred over from another accounting document
Ramp Rates	This sheet is referenced by the Ag Demand to calculate the rampdown rates when deep/surface flushing is occurring in the river. The top row (1-17) is in days and the lower in flow (cfs).
Accrete_adj	This is the historical database referenced for exceedances set in the calculator. This data is averaged over the timeframe of 1981 to 2013. Four tables are available for the following objects: Lake Ewauna Accretions, Keno to Iron Gate Accretions, LRDC Accretions, and F/FF Accretions. Each of the objects also contains rows for items such as #%RFC scenarios, Historically Minimum Flows, and 2013 measured flow.
FWAvailParams	Parameters for the Fall/Winter Calculator concerning deliveries to the KDD and Refuge as these are the only object which have the right to withdraw water during this season. It has total daily caps and daily percentage limitations for both which are listed by month. In addition, description of reasoning and scenarios are presented below the tables.
Fill_rate_adjust	Dedicated sheet for assigning the fill-rate adjustment factor to be used for the Upper Klamath Lake. Will be used in both the Winter Calculator. Is dependent on the difference between the recent and needed fill rates. Provides values for both dry and wet scenarios.
UKL_inflow_cum	A table documenting the period of record maximum and minimum flows into the Upper Klamath Lake, only for the Fall/Winter Season. Period of record considers years from 1981 to 2013. Values are transposed to right-hand side and the difference of the Max and Min is given.
Will_prop	The table referenced for the iteration equation on Winter Calculator which determines what portion of yesterday's Williamson Inflow will be released at Link River Dam. To the right of the main columns is the difference in flow magnitude and adj factor. Below is a table used to interpolate values when they fall into a set range. Only the Fall/Winter month are considered here.
EWA_Reserve lookup	The table used to set the EWA Reserve values on the Summer Calculator Sheet. That row will reference the EWA_River volume to the lefthand column on this sheet. Based on that value, the corresponding volume in the right-hand column is selected and converted to acre-ft (*1000).
EOS target interp	The table used to set the EOS UKL target elevation on the Supply Calculator. Dependent on the value of NRCS Mar50vol forecast (left-hand column) which references a corresponding EOS UKL elevation (right-hand column).
EWA River interp	The table used to set the %UKL Supply to EWA River on the Supply Calculator. Dependent on the value of UKL Supply (left-hand column) which references a corresponding percentage (right-hand column).
UKL area-capacity table	The table used to set the volume (AF) from the elevation (ft) at UKL, or vice versa. The left-hand column is elevation and the right-hand column is volume.
IGmax	The table used to set the IG_max on the Summer Calculator for the months of July through September. Once the final forecasted EWA Volume has been assigned for June, the IG_max can be set by refencing this volume (left-hand Column) to a corresponding max flow (right-hand Column).
EWARemain	The table used to set the EWARemainMin and EWA_remain_JulSep on the Summer Calculator for the months of June through September. Based on the month, a corresponding percentage is assigned. That percentage will be multiplied with the EWA Volume to give these rows values.
UKL_flood	The table used to set the flood control threshold on the UKL Inflow sheet. Rather than one reference variable, this operation will use two. They are the date (month & day) and flood lookup. If the flood lookup is 2, the dry scenario is used. If the flood lookup is 4, the wet scenario is used. Both flood threshold elevation and volumes are

	presented here for each day. Also, flood levels for each month are on the left-hand side which will be used in the Thresholds2019 sheet.
ULKElev_LinkQ	A table which assigns the Max release at Link River Dam depending on the elevation of the Upper Klamath Lake. Does not seem to be linked to any of the other sheets in the calculator. Provides these releases in cfs and TAF. In addition, these releases were revised due to physical system conditions in the downstream river. These values are listed on the right-hand side.

Table 19. Miscellaneous sheets that appear to be outdated or irrelevant.

Sheet	Description
Trigger_Data	A table which assigns triggers for spores, 13C thresholds, 20% POI, 80% outmigration, and etc. Dependencies seem to be date, duration, Cl max, and Cl min. The individual tables listed here only have operation conditions up until the year 2017. In addition, if it is linked to any of the other sheets in the calculator, it is unclear.
Call_Effects	A table which seems to assign flow adjustments to the Williamson and Wood River. Operational values are only listed to the 2017. In addition, it is unclear if it is linked to any of the other sheets in the calculator,
Retrieved TS	Seems to be data from the WRIMS Model. It is unclear what values it is contains other than Williamson River Inflow. Does not seem to be linked to the other sheets in the IGD calculator.
GroupSpecsRetrieved TS	Provides the period of record and pathnames for the data transferred over from the WRIMS Model.
Daily Accretion Lookup	Table of historical accretions for year 1996 through 2016. It is unclear where this table is linked to and if it is still relevant since the previous two years accretions have not been added.
Obsolete Thresholds 2018	Same setup and format as the Thresholds2019 sheet, except for the previous year. Thus, it is not in use since this period is now all measured data.