DESCRIPTION OF BUREAU OF INDIAN AFFAIRS' SPREADSHEET ACCOUNTING SYSTEM

The Bureau of Indian Affairs' spreadsheet accounting system accounts for all of the water in the Lower Walker River, broken down into the following four reaches:

1. From the Yerington Weir to the Wabuska Gage,
2. From the Wabuska Gage to Weber Reservoir,
3. Within Weber Reservoir, and
4. From Weber Dam to Little Dam.

The logic path for the pass-through accounting involves accounting for Program Water at the following five locations:

1. The Yerington Weir
2. The Wabuska Gage
3. The inflow to Weber Reservoir
4. The outflow from Weber Reservoir
5. The outflow downstream of Little Dam

The accounting system is designed to be implemented on a daily time step using online data from USGS gages to the extent possible and the best available sources for any other information needed. All gage flow data used in the accounting system reflects the average flow for the previous day (midnight to midnight), conforming to standard USGS reporting procedures. All other measured and estimated data used in the accounting system similarly reflects average values for the previous day (midnight to midnight). Weber Reservoir daily storage data reflects measurements at midnight, conforming to standard USGS reporting procedures. The accounting system specified below assume that flow units from gages (Q values in the equations below, which represent the total daily quantity of water passing a particular gage or location, or? the total quantity of water in Weber Reservoir) may be input in any common unit of flow as long as they are consistent within the equation. For example, units of flow in daily average cubic feet per second (cfs) are the default unit of measure for the USGS gages. However, in some cases, such as with Weber Reservoir, relevant measures will be in acre-feet per day. In this case acre-feet per day units are carried through the PW computations until it is appropriate to convert these into units of flow (at a conversion factor of 1 cfs equal to 1.9835 AF/day. Time factors for movement of water through the system are not incorporated into the accounting by river reach, but may be added in the future to improve accounting accuracy.

Program Water at the Yerington Weir

The accounting system begins with the daily amount of Program Water at the Yerington Weir, obtained from the Federal Watermaster or other appropriate authority.

Flows downstream from the Yerington Weir are currently measured by the USGS at the Miller Lane Gage. Absent the availability of direct flow measurements, the accounting system estimates the flow at the Yerington Weir. In the event a gage is installed at or near the Yerington Weir, the accounting system would use direct measurements from that gage.

Program Water at the Wabuska Gage

The amount of Program Water at the Yerington Weir as described above is checked against the total flow at the Yerington Weir and adjusted if needed using Equation (1):

$$PW_{yw} = MIN(Q_{yw}, PWI_{yw}) \qquad \text{Eqn. (1)}$$

where,

PW_{yw} = Program Water in unit flow rate arriving at the Yerington Weir Gage;

Q_{yw} = Daily average total flow at the Yerington Weir;

PWI_{yw} = Program Water as initially specified in unit flow rate arriving at the Yerington Weir Gage.

The initial calculation of the amount of Program Water at the Wabuska Gage is equal to the Program Water at the Yerington Weir multiplied by an appropriate factor for losses and/or gains, as expressed below:

$$PWI_{wab} = PW_{yw} \text{ x } LGF \qquad \text{Eqn. (2)}$$

where,

PWI_{wab} = Initial calculation of Program Water in unit flow rate arriving at the Wabuska Gage;

LGF = Flow conveyance loss or gain resulting from infiltration, seepage, evaporation and riparian vegetation uses, but not the result of physical returns or withdrawals from the river by irrigation practices and structures (note: bank seepage may be returned back to flow in the river under some circumstances resulting in a gain in flow between the gages).

Between the Yerington Weir and the Wabuska gage there are currently known to be three primary sources of physical returns to or withdrawals from the river:

1. Stanley Ranch irrigation diversions (direct pumping from the river).
2. the Perk/Joggles Drain return flows (East-side Drain); and
3. the Wabuska Drain return flows (West-side Drain).

If gaged return flow data are available, the LGF variable in Equation (2) is determined using daily gaged flow values as expressed in Equation (3) below:

$$LGF = (1 - (Q_{yw} – (Q_{wab} - DR_{wab} - DR_{jog} + ID_{stan})) / Q_{yw}) \qquad \text{Eqn. (3)}$$

where:

Q_{wab} = Daily average total flow at the Wabuska Gage;

DR_{wab} = Daily average Wabuska Drain return flow or diversion;

DR_{jog} = Daily average Perk/Joggles Slough return flow or diversion;

ID_{stan} = Stanley Ranch irrigation diversion.

The DR variables in Equation (3) are either positive, representing return flows to the river, or negative, representing diversions from the river. This is consistent with field observation that flow in these drains may be in either direction depending on river stage.

In the event that flows are not measured at the Yerington Weir, the daily flow at the Yerington Weir shall be calculated based on flow data from the Miller Lane and Wabuska gages and an estimate of losses or gains between the Yerington Weir and Wabuska. The calculated flow at the Yerington Weir, Q'_{yw}, would be used in the place of Q_{yw} in Equations (1) and (3) and would be calculated as follows in Equation (4):

$$Q'_{yw} = Q_{wab} + (Q_{ml} - (Q_{wab} - DR_{wab} - DR_{jog} + ID_{stan}))*(L_{yw\text{-}wab}/L_{ml\text{-}wab}) \qquad \text{Eqn. (4)}$$

where:

Q'_{yw} = Calculated daily average flow at the Yerington Weir;

Q_{ml} = Daily average total flow at the Miller Lane gage;

$L_{yw\text{-}wab}$ = River distance between the Yerington Weir and the Wabuska gage;

$L_{ml\text{-}wab}$ = River distance between the Miller Lane gage and the Wabuska gage.

In the event that gage flow at the Yerington Weir is available but gaged irrigation return flow data are unavailable, the LGF variable in Equation (2) is assigned a value or set of values using the following guidelines in Equations (5a) and (5b):

For $Q_{wab} < (Q_{yw} - ID_{stan})$, then:

$$LGF_{est} = (1 - (Q_{yw} - ID_{stan} - Q_{wab}) / (Q_{yw})) \qquad \text{Eqn. (5a)}$$

and for $Q_{wab} \geq (Q_{yw} - ID_{stan})$ then:

$$LGF_{est} = 0.95 \qquad \text{Eqn. (5b)}$$

In the event that both gage flow at the Yerington Weir and return flow data are unavailable, Q'_{yw} is calculated by Equation (6a) or (6b) below and substituted for Q_{yw} in Equations (1) and (3).

For $Q_{wab} < (Q_{ml} - ID_{stan})$, then:

$$Q'_{yw} = Q_{wab} + (Q_{ml} - Q_{wab})*(L_{yw\text{-}wab}/L_{ml\text{-}wab}) \qquad \text{Eqn. (6a)}$$

and for $Q_{wab} \geq (Q_{ml} - ID_{stan})$ then:

$$Q'_{yw} = Q_{wab}/0.95 \qquad \text{Eqn. (6b)}$$

When water use records the Stanley Ranch irrigation diversion (ID_{stan}) are available, ID_{stan} is based on these records. In the absence of water use records, ID_{stan} in the above equations is assumed to be zero when the river is operating under full priority, and is assumed to be diverting at the decreed and permitted (Permit 58707) diversion rate of 0.8782 cfs (rounded to 0.9 cfs) when the river is not operating under full priority.

Additional stream flow accounting variables may be added to Equations (3) and (4), including variables that represent additional return flows, additional diversions, and an additional Program Water component of subdrain flows from the Mason Valley Wildlife Management Area, or other sources, subject to securing necessary approvals.

Program Water may experience gains in flow only under the physical condition of bank storage return back to the river, up to but not exceeding, cumulative net Program Water infiltration losses during prior days in the irrigation season. The bank storage return flow would be allocated on a proportional basis with total flow in river, under the same procedure as allocation of infiltration losses.

The daily loss or gain of Program Water between the Yerington Weir Gage and the Wabuska Gage, PW_{lg}, is calculated as follows in Equation (7):

$$PW_{lg} = \text{MIN}\left(PWI_{wab} - PW_{yw},\ \text{MAX}\left(-\sum_{d=1}^{d=t} PW_{lg}^{d}, 0\right)\right) \qquad \text{Eqn. (7)}$$

where:

$\sum_{d=1}^{d=t} PW_{lg}^{d}$ = Cumulative net Program Water loss from the beginning of the Program Water Season up through the current day (t).

A negative value of PW_{lg} reflects a Program Water loss and a positive value reflects a Program Water gain.

The accounting system presumes that the Walker River Paiute Tribe's 26.25 cfs Decreed Water Right has priority, in accordance with the Walker River Decree, over all Program Water at the Wabuska Gage. Therefore, whenever the Tribe's 26.25 cfs Water Right is in priority, the final Program Water at the Wabuska Gage, or PW_{wab}, is equal to the lesser of the initial calculated amount of Program Water ($PW_{yw} + PW_{lg}$) and the measured flow at the Wabuska Gage (Q_{wab}) less the amount of the Tribe's 26.25 cfs water right ($TR_{26.25}$), but not less than zero, as expressed in Equation (8):

$$PW_{wab} = \text{MAX}(\text{MIN}(PW_{yw} + PW_{lg}, Q_{wab} - TR_{26.25}), 0) \qquad \text{Eqn. (8)}$$

Flows at the downstream end of this reach are measured by the USGS at the Wabuska Gage.

Program Water at the Inflow to Weber Reservoir

Program Water losses and gains between the Wabuska Gage and Weber Reservoir are determined by the difference in flows between the Wabuska Gage and the Cow Camp Gage, adjusted for:

(a) ungaged flow at Cow Camp, and

(b) additional unit loss downstream from the Cow Camp gage to the upstream edge of Weber Reservoir.

The Cow Camp gage has been shown by USGS to provide unreliable readings at high river stages due to flow bypassing the gaged main channel of the river. The first step in assessing losses and gains in this reach is to adjust the daily average flow measured at Cow Camp (Q_{cc}) to a corrected flow (Q^*_{cc}). This can be accomplished by the USGS, using standard correction techniques, as the operator of Cow Camp Gage.

The Cow Camp gage is situated approximately 1.5 to 2.5 miles upstream of Weber Reservoir, the distance being dependent on the reservoir water level. A river length adjustment factor is therefore required to estimate the flow at the inflow to Weber Reservoir. The unit rate of natural flow loss measured between the Wabuska and Cow Camp Gage is assigned to the ungaged reach below the Cow Camp gage. The natural flow loss determined over this reach of the Walker River is applied equally to both Program Water and non-Program water based on the volume of each type of water measured at the Wabuska gage. Measured gains in this reach shall also be shared on the same basis.

The computations of Program Water inflow to Weber Reservoir, using the corrected Cow Camp Gage flow and river length adjustment, are set forth in Equation (9).

$$PW_{webin} = PW_{wab} (1 - (((Q_{wab} - Q^*_{cc}) / Q_{wab}) L_{wab\text{-}web} / L_{wab\text{-}cc}) \qquad \text{Eqn. (9)}$$

where:

PW_{webin} = Daily Program Water inflow to Weber Reservoir;

$L_{wab\text{-}web}$ = River distance from Wabuska Gage to upstream edge of Weber Reservoir;

$L_{wab\text{-}cc}$ = River distance from Wabuska Gage to Cow Camp Gage.

The computations of total inflow to Weber Reservoir, using the corrected Cow Camp Gage flow and river length adjustment, are set forth in Equation (10):

$$Q_{webin} = Q_{wab} (1 - (((Q_{wab} - Q^*_{CC}) / Q_{wab}) L_{wab\text{-}web} / L_{wab\text{-}cc}) \qquad \text{Eqn. (10)}$$

where:

Q_{webin} = Daily total inflow to Weber Reservoir.

Flows near the downstream end of this reach are measured by the USGS at the Cow Camp Gage.

Program Water Passed Through Weber Reservoir

Program Water entering Weber Reservoir:

(a) is lost (largely to evaporation) from the Reservoir,

(b) is briefly held within the Reservoir,

(c) is released from the Reservoir, or

(d) undergoes some combination of (a), (b), and (c).

The accounting system assumes that all Program Water entering the Reservoir passes through the Reservoir over a 24-hour period. Program water held in the reservoir in this manner for one day is subsequently lost, held to the next day, or released.

There is currently no measurement of outflows from Weber Reservoir. This accounting system assumes the installation of a new gage immediately downstream of Weber Reservoir to measure outflow. The daily amount of Program Water leaving Weber Reservoir reflects three categories of discharge:

(a) Tribal Irrigation Water,

(b) Program Water,

(c) Other Natural Flow and/or Flood Storage Releases.

The sum of these three equals the Weber Reservoir outflow, as rearranged to express Program Water total in Equation (11) below.

$$PW_{webout} = Q_{webout} - IW - NR \qquad \text{Eqn. (11)}$$

where:

Q_{webout} = Total outflow from Weber Reservoir;

PW_{webout} = Program Water total outflow from Weber Reservoir;

IW = Irrigation Water total outflow from Weber Reservoir;

NR = Other natural flow, including flood control and reservoir maintenance releases, apart from the Irrigation Water and Program Water designated releases.

Program Water available in the reservoir at the end of each day shall be computed as follows in Equation (12):

$$PW_{web} = PW_{web\ t\text{-}1} - PW_{webout} - PW_{loss} + PW_{webin} \qquad \text{Eqn. (12)}$$

where:

$PW_{web\ t-1}$ = end of prior day PW_{web};

PW_{loss} = Program Water net Weber Reservoir storage loss for the current day ;

PW_{webout} = Program Water outflow from Weber Reservoir for the current day;

PW_{webin} = Program Water inflows to Weber Reservoir for the current day.

Daily losses to Program Water in Weber Reservoir are determined by allocating the daily loss in Weber Reservoir proportionately by volume between Program Water and all other water in Weber Reservoir. The daily reservoir storage loss charged to Program Water is calculated based on Equation (13):

$$PW_{loss} = (PW_{web\ t-1} \ / \backslash WEB_{t-1}) \ LOSS \qquad \text{Eqn. (13)}$$

where:

WEB_{t-1} = End of prior day total storage in Weber Reservoir;

LOSS = Quantity of Weber Reservoir net loss for the current day based on volumetric accounting.

The volumetric accounting of Weber Reservoir losses are calculated as follows. If precipitation is recorded at Weber Reservoir in any given day, the volume of water gained by direct precipitation falling on the water surface is determined based on daily recorded depth of precipitation multiplied by the daily average Weber Reservoir surface area. The volume gained by direct precipitation shall then be applied as follows in Equation (14):

$$LOSS = WEB_{t-1} - WEB_t + P - (Q_{webout} - Q_{webin}) \qquad \text{Eqn. (14)}$$

where:

WEB_t = End of current day total storage in Weber Reservoir;

P = Daily volume of precipitation falling on Weber Reservoir.

Targets for Program Water amounts leaving Weber Reservoir can be set in advance and may need to be reconciled after the fact with the actual amounts of Program Water and Tribal Irrigation water released. These adjustments are not yet included in the spreadsheet accounting system but can be added.

A gage immediately downstream of Weber Reservoir, along with the gages at Little Dam, would enable direct measurement of releases from Weber Dam and their apportionment into Program Water and other categories of water. Evaluation of gage data in this reach can be undertaken to determine if losses and gains in this reach can be assumed to be negligible or can be estimated reliably using an appropriate method based on the empirical data and or computer modeling based on the data.

Weber Dam to Little Dam

Program Water natural flow loss in the reach of the Walker River downstream from Weber Reservoir to Little Dam is determined by the gaged difference in flow between a new gage directly downstream of Weber Reservoir and the gaged flow at Little Dam. The accounting system applies the natural flow loss rate equally to both Program Water and non-Program water in proportion to the volume of each type of water. Measured gains in this reach shall also be shared on the same basis. Program Water reaching Little Dam will mark the control point for the end of conveyance accounting, and natural river losses downstream from Little Dam are not considered at this time due to the absence of Tribal diversions downstream from Little Dam.

Program Water at Little Dam is determined as follows:

$$PW_{ld} = PW_{webout} (1 - ((Q_{webout} - (Q_{canal1} + Q_{canal2} + Q_{ld})) / Q_{webout})) \qquad \text{Eqn. (15)}$$

where:

PW_{ld} = Daily quantity of Program Water passing by Little Dam.

Q_{webout} = Daily average flow at new gage located downstream from Weber Reservoir.

Q_{canal1} = Daily average flow at WRIID Canal 1.

Q_{canal2} = Daily average flow at WRIID Canal 2.

Q_{ld} = Daily total quantity of water passing by Little Dam.

Flows at the downstream end of this reach are measured by the USGS at the Little Dam Gage.