

## **Calculations Performed on USGS Data for Great Lakes to Gulf Project**

Outline:

1. Calculation of nitrate load and cumulative load from discharge and nitrate level
2. Gap filling of missing discharge and nitrate level values

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### **Calculation of Nitrate Load and Cumulative Load from Discharge and Nitrate Level**

USGS data from <http://waterservices.usgs.gov/nwis/iv/> is updated in 15 minute intervals and contains measurements for discharge( $ft^3/s$ ) and nitrate plus nitrite level( $mg/L$ ). The loading rate( $mg/s$ ) is calculated by multiplying the discharge and nitrate+nitrite levels using unit conversion

$$LoadingRate = Discharge \cdot NitrateLevel \cdot \left(28.3168 \frac{L}{ft^3}\right)$$

The total load is calculated for each 15min period by multiplying the loading rate by 15min (900s).

$$Load = LoadingRate \cdot 900s$$

This value for load is included with each datapoint.

The cumulative load since water new year is calculated for each datapoint. At 00:00 local time of Oct 1 of each year, the cumulative load is set to 0 after storing the final value. Starting at the first datapoint of the water new year, which occurs 00:15 Oct 1, the load for the datapoint is added to the cumulative load of the previous datapoint to calculate the current cumulative load.

$$CumulativeLoad(t_{final}) = \sum_{t=1}^{t_{final}} Load(t)$$

Here,  $t=1$  is the first datapoint of the water year and  $t_{final}$  is any other datapoint within the water year. The datapoint at 00:00 Oct 1 is, therefore, the total load for the previous water year.

### **Gap filling**

The USGS data from <http://waterservices.usgs.gov/nwis/iv/> has gaps in the measurement data for discharge and nitrate levels. Discharge and nitrate level are used to calculate the nitrate load and cumulative nitrate load. Missing values disallow the calculation of the yearly cumulative load and therefore necessitate gap filling.

A linear gap fill was used. Regardless of the length of the gap (ranging from 1 missing measurement to months without measurements) a slope was calculated using the last and next available datapoints.

$$Slope = \frac{Value_{end} - Value_{start}}{Index_{end} - Index_{start}}$$

Each empty value is then calculated by multiplying the number of time increments since the last actual measured value,  $Index_n$ , times the slope.

$$FilledValue_n = Index_n * Slope$$

The calculation is performed in the same manner for discharge and nitrate level.