VWP CIA Summary (TEMPLATE)

JK

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This is an R Markdown document. This will serve as the template for VWP Project Model Summaries moving forward. For related GitHub issue see <https://github.com/HARPgroup/vahydro/issues/317>.

# VAHydro Model Boilerplate:

## VAHydro

The comprehensive VAHydro hydrologic model is used to evaluate instream and off-stream beneficial uses for surface water withdrawals throughout Virginia. The VAHydro model simulates streamflow with inputs such as precipitation, climate, land use, and topography, as well as local data collected through DEQ water supply planning and reporting programs including all known withdrawals and discharges, as well as operational rules of VWP permits and major hydrologic features such as reservoirs.

The VAHydro model is built on rainfall-evaporation-runoff (RER) time-series from the Chesapeake Bay Model Phase 6 which runs from 1984-2014 in the Chesapeake Bay watershed drainage, and 1984-2005 in the rivers flowing outside of the Chesapeake Bay watershed, aka the “southern rivers.” The VAHydro model features high-resolution hydrologic subsections called “river segments” (over 600 river segments in total), roughly the size of HUC 10 hydrologic units, with additional high-resolution segments added for VWP modeling projects as needed.

## CIA

DEQ assesses water supply sustainability through Cumulative Impact Analysis (CIA) modeling. CIA is a modeling and analysis approach that takes into account the varied hydrologic process occurring throughout a river network (including meteorology and human water use). By simulating a daily water balance for every individual river segment within a watershed, DEQ is able to evaluate the potential “cumulative impact” of all streamflow changes occurring upstream of any location within the river network, as well as the downstream impact of individual permitted withdrawal operations.

The goal of the folloing analysis was to estimate the cumulative impacts of all existing water users in addition to the requested water withdrawal upon existing beneficial uses, including both in-stream and off-stream uses.

# Project Introduction (To be provided by permit writer)

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## Location Map

*No location map available for this facility model*

# Model Overview and Scenario Descriptions

**River Model Description** This segment of the James River model stretches from just downstream of Cartersville to the Huguenot Bridge. It has a total drainage area of approximately 6,769 square miles.

**Facility & Intake Model Description** The James River Correctional Center intake from the James River is located near the confluence with Beaverdam Creek. The facility returns process water flows to Beaverdam creek, and transfers water to Goochland County.

The following model scenarios were simulated in order to determine the most effective means of meeting the project need and all other in-stream beneficial uses:

* **Current permit, 2.0 mgd and 90% Flow-By** (Current Permit) - The current permit scenario uses a maximum annual demand of 730.0 million gallons, and a maximum withdrawal rate of 2.0 MGD. Allowable withdrawal at this intake is based on a 90% flowby, as calculated from the previous days flow at the James River Cartersville gage, USGS 02035000. Although the maximum daily withdrawal in this scenario is equal to 2.0 mgd, the daily withdrawal rate is modeled as a function of historical monthly use patterns, and winter withdrawals range from 1.8-1.9 mgd. Therefore, the average rate of withdrawal simulated is approximately 1.95 MGD.
* **Descriptive name for titles, ex: Proposed permit conditions with 90% flowby** (3.0 MGD, 90% Flow-by) - The proposed permit scenario evaluated the cumulative impacts of a maximum annual demand of 1,08.0 million gallons, and a maximum withdrawal rate of 3.0 MGD. Allowable withdrawal at this intake is based on a 90% flowby, as calculated from the previous days flow at the James River Cartersville gage, USGS 02035000. Although the maximum daily withdrawal in this scenario is equal to 3.0 mgd, the daily withdrawal rate is modeled as a function of historical monthly use patterns, and winter withdrawals range from 2.7 to 2.8 mgd. Therefore, the average rate of withdrawal simulated is approximately 2.9 MGD.

# Intake Site Description & Current Estimated Stream Flows

**Table 1:** Modeled monthly current flow statistics for James River intake in cubic feet per second (cfs). Columns show the minimum (Min) and average (Mean) modeled flow, and a range of non-exceedence flow percentiles, that is, the column header indicates the percent of flows that do *not* exceed the given value. For example, the “10%” states that only 10% of flows in the given month are expected to be less than the indicated value, and therefore, 90% of the flows in that month are expected to be greater than the given value. For example, in the table below the 10% column states that 10% of flows within the month of January would be less than 3076.2cfs.

| **Month** | **Min** | **5%** | **10%** | **25%** | **30%** | **50%** | **Mean** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Jan | 1,748.9 | 2,595.3 | 3,076.2 | 4,781.0 | 5,519.9 | 7,524.5 | 9,810.4 |
| Feb | 1,754.7 | 3,318.8 | 4,080.5 | 5,555.4 | 5,990.2 | 7,877.2 | 10,173.3 |
| Mar | 1,641.0 | 3,716.6 | 4,353.2 | 6,459.7 | 7,217.1 | 9,663.1 | 12,246.1 |
| Apr | 2,396.4 | 3,305.6 | 3,693.3 | 5,389.6 | 5,815.5 | 7,951.5 | 11,167.1 |
| May | 1,930.4 | 2,835.2 | 3,242.3 | 4,399.3 | 4,921.6 | 6,663.3 | 8,435.9 |
| Jun | 1,248.8 | 1,728.2 | 2,205.2 | 2,974.3 | 3,256.8 | 4,282.9 | 6,118.3 |
| Jul | 1,022.5 | 1,244.7 | 1,488.9 | 1,879.6 | 1,995.3 | 2,584.9 | 4,063.3 |
| Aug | 735.7 | 959.0 | 1,170.2 | 1,514.6 | 1,619.7 | 2,282.0 | 2,993.2 |
| Sep | 655.9 | 988.7 | 1,136.1 | 1,405.6 | 1,529.2 | 2,135.7 | 4,904.1 |
| Oct | 567.1 | 901.1 | 1,096.3 | 1,630.8 | 1,875.1 | 2,678.0 | 5,184.8 |
| Nov | 513.5 | 820.2 | 1,140.9 | 1,993.4 | 2,211.8 | 3,828.5 | 6,595.0 |
| Dec | 569.5 | 1,048.2 | 1,861.2 | 4,013.2 | 4,593.7 | 6,706.4 | 8,636.5 |

# Model Summary Results - Conclusion/Recommendation

* **Current permit, 2.0 mgd and 90% Flow-By** - Due to the size of the demand in the existing permit relative to flows in the James River, the full demand of 2.0 mgd can be met at all times in the simulated period.
* **Descriptive name for titles, ex: Proposed permit conditions with 90% flowby** - The model analysis from of flow conditions from 1984-2014 show that the full proposed withdrawal can be met during all simulated conditions. The net consumptive loss is estimated to be approximately 0.3 MGD after considering wastewater treatment return flows, and so individually this project has a very low impact on the flow in the James River. Taken collectively with all other permits in the watershed run at their permitted maximum, the cumulative flow changes in the James River are estimated to be less than -2% in average daily flow. However, during low flows, consumptive losses in this stream can be significant, amounting to approximately 7% during drought watch (10% non-exceedance flow), and 8% during drought emergencies (when flow is less than 5% non-exceedence flow). This part of the James River has a previously completed IFIM habitat study, which shows that the majority of species/life-stages considered maintain habitat losses below 10%, although adult redhorse and BJA do see losses over 10% for 1-3 months of drought warning conditions.

## CIA

This table summarizes the cumulative impacts to flows, aquatic life, and off-stream demand for the project. The section entitled “River Segment Model Statistics” contains mean flows (Flow Out), and drought flows (30 and 90 Day Low Flow), as well as an estimated percent total consumptive use as a resutl of all withdrawals (Cumulative Withdrawal) and discharges (Cumulative Point Source) in the watershed. The section entitled “Facility Model Statistics” shows the withdrawals, return flows (Point Source), and the model estimate for potential unmet demand due to demands exceeding the allowable withdrawal at the intake based on the cumulative conditions in the watershed and the flow-by rules in effect. There will be one or more columns in this table representing each scenario considered for this analysis.

# Stats Comparison Table:

| **Description** | **Current Permit** | **3.0 MGD, 90% Flow-by** |
| --- | --- | --- |
| runid | 400 | 600 |
| River Segment Model Statistics: |  |  |
| Flow Out (cfs) | 7401.99 | 7400.70 |
| Flow Baseline (cfs) | 7520.91 | 7520.88 |
| Minimum Days of Storage Remaining |  |  |
| 30 Day Low Flow (cfs) | 595.11 | 593.86 |
| 90 Day Low Flow (cfs) | 1016.93 | 1015.49 |
| Consumptive Use Fraction | 0.02 | 0.02 |
| Cumulative Withdrawal (mgd) | 245.90 | 246.05 |
| Cumulative Point Source (mgd) | 169.03 | 168.37 |
| Richness Change (abs) | -0.07 | -0.07 |
| Richness Change (%) | -0.14 | -0.15 |
| Facility Model Statistics: |  |  |
| Withdrawal (mgd) | 1.95 | 2.90 |
| Point Source (mgd) | 1.75 | 2.61 |
| Maximum 30 day potential unmet demand (mgd) | 0 | 0 |

# Reservoir Storage Plots:

## This property does not exist

[1] “No riverseg impoundment for run id 400”

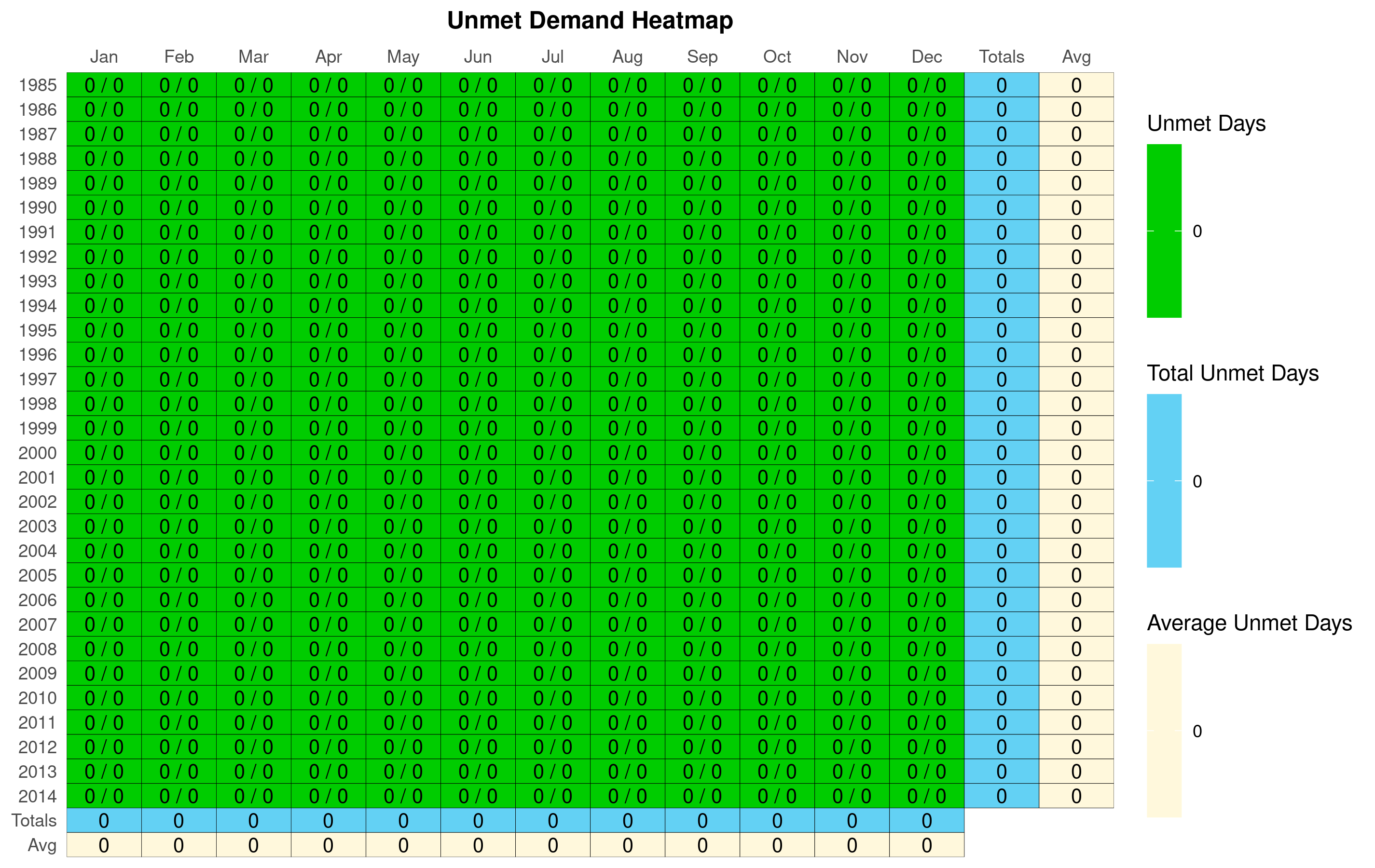
## This property does not exist

[1] “No riverseg impoundment for run id 600”

# Unmet Demand Heatmaps:

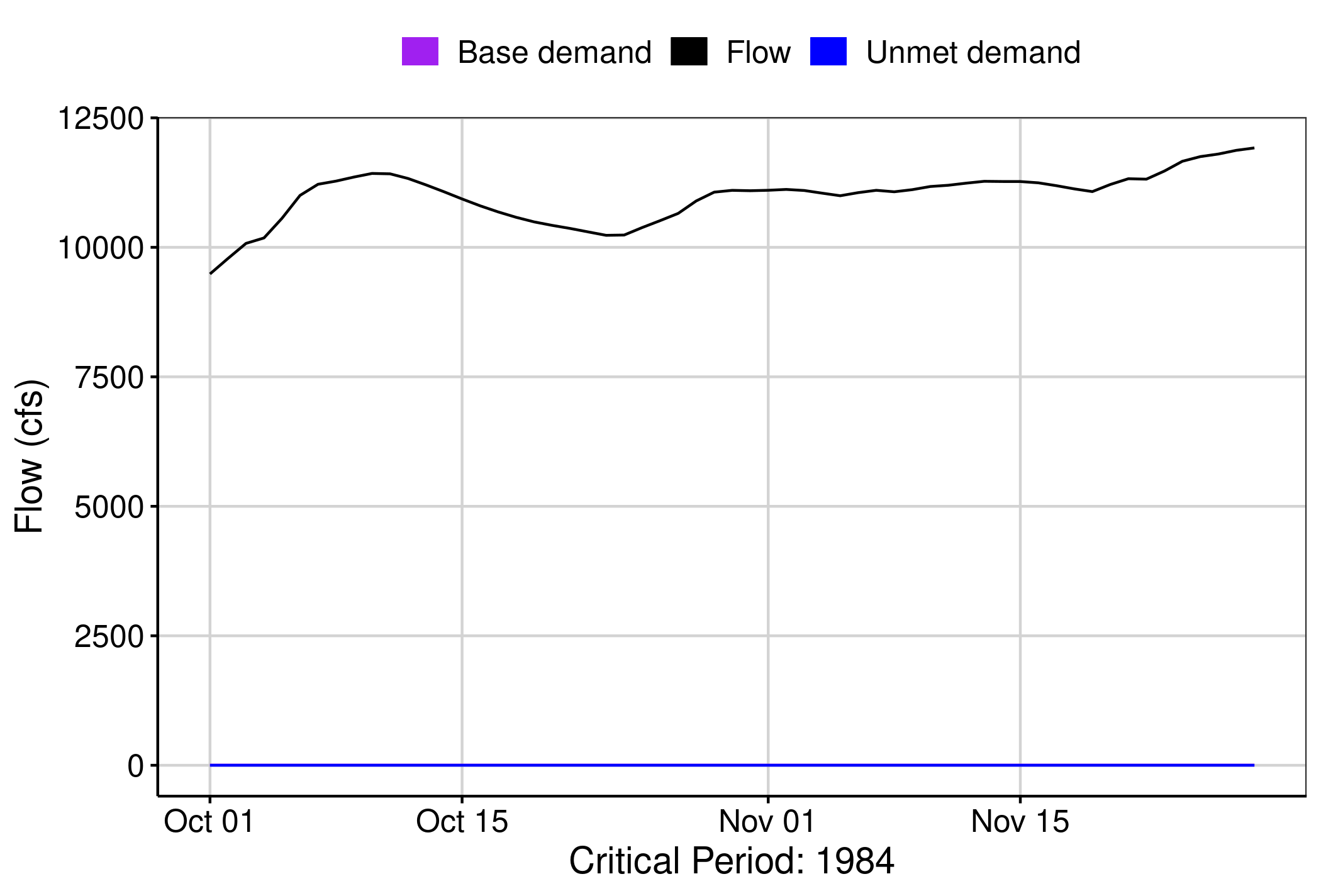
## Number of properties found: 1

## Reservoir Storage: Current Permit



## Number of properties found: 1

## Unmet Demand: Current Permit

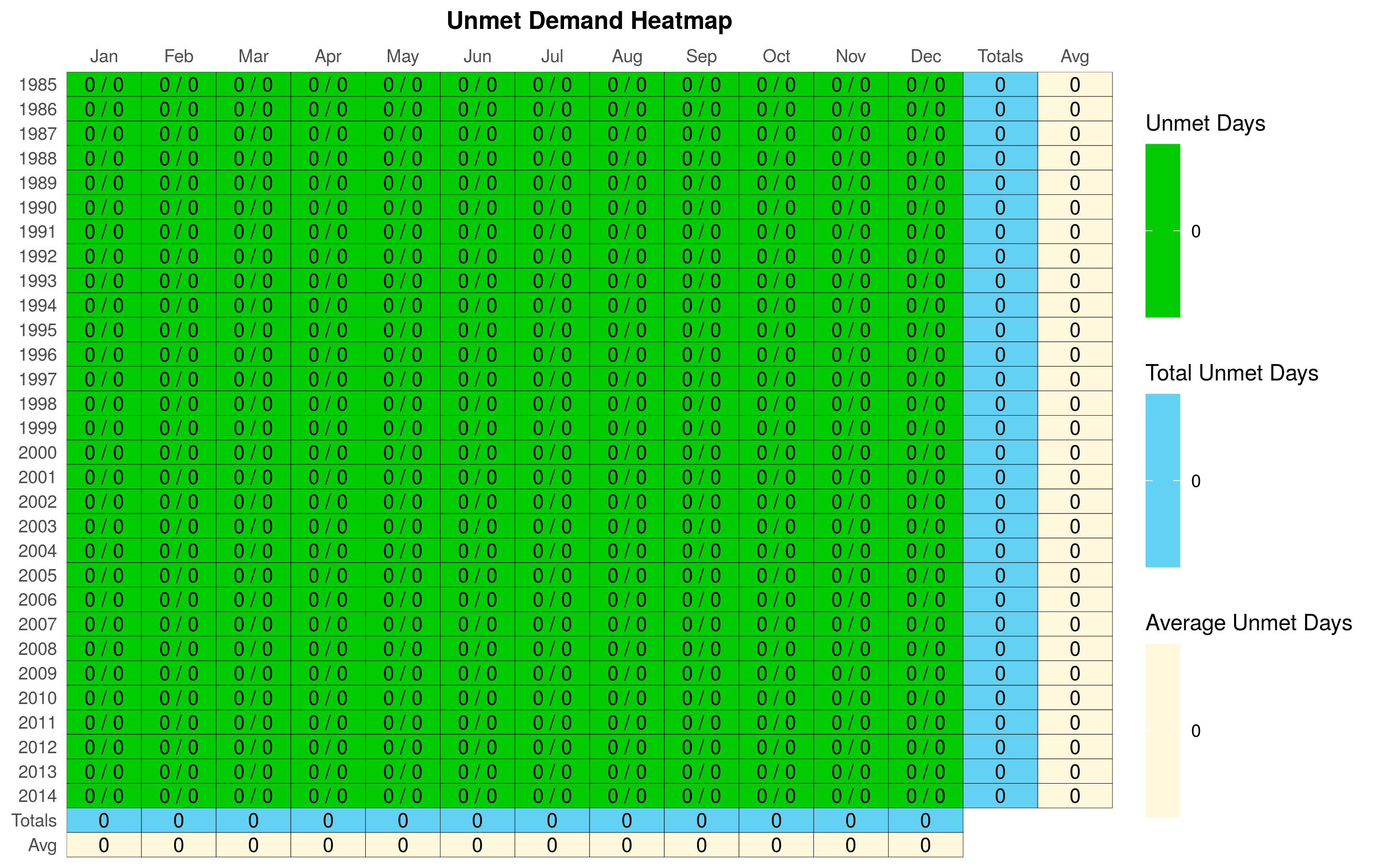


## This property does not exist

[1] “No local facility impoundment for Current Permit”

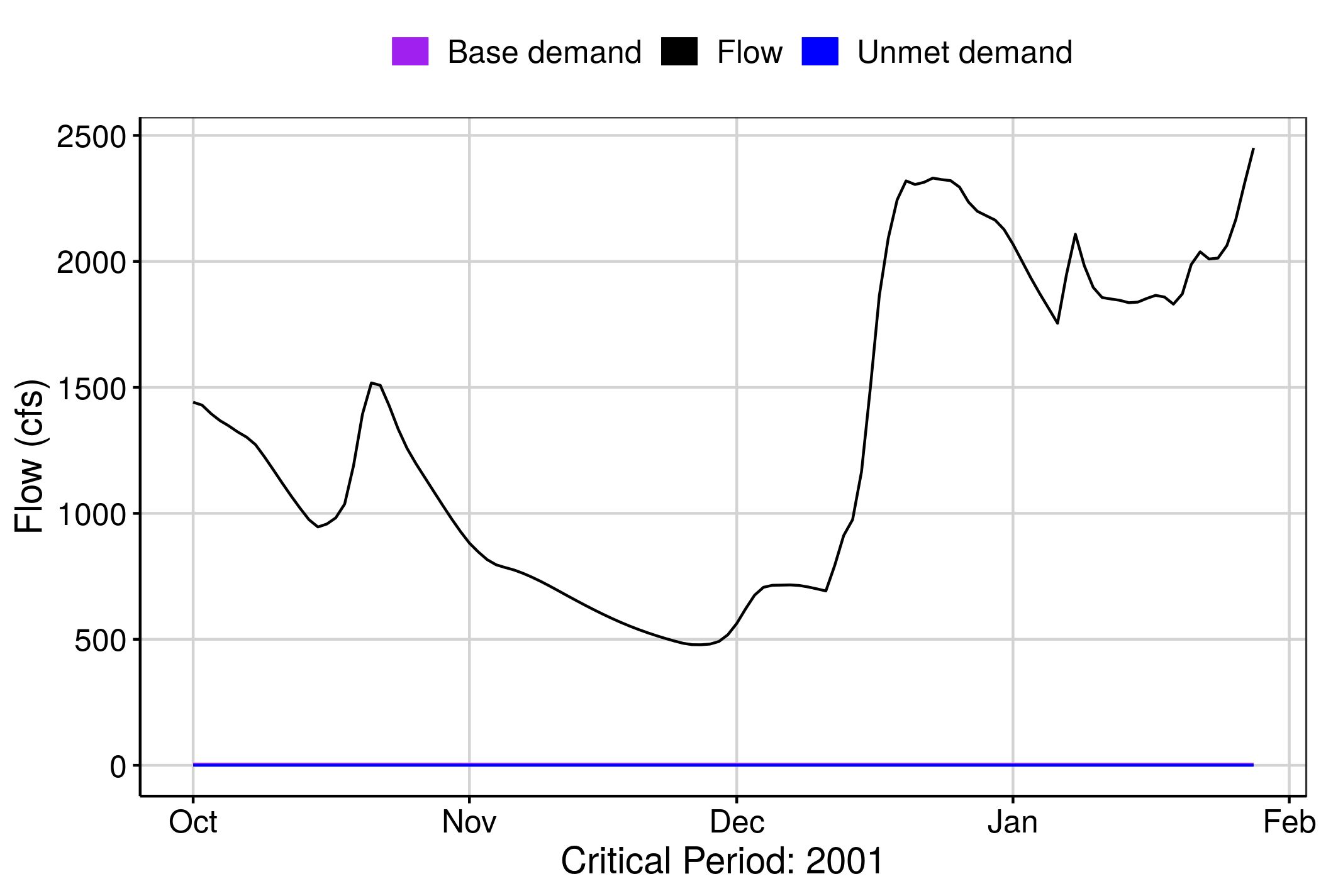
## Number of properties found: 1

## Reservoir Storage: 3.0 MGD, 90% Flow-by



## Number of properties found: 1

## Unmet Demand: 3.0 MGD, 90% Flow-by

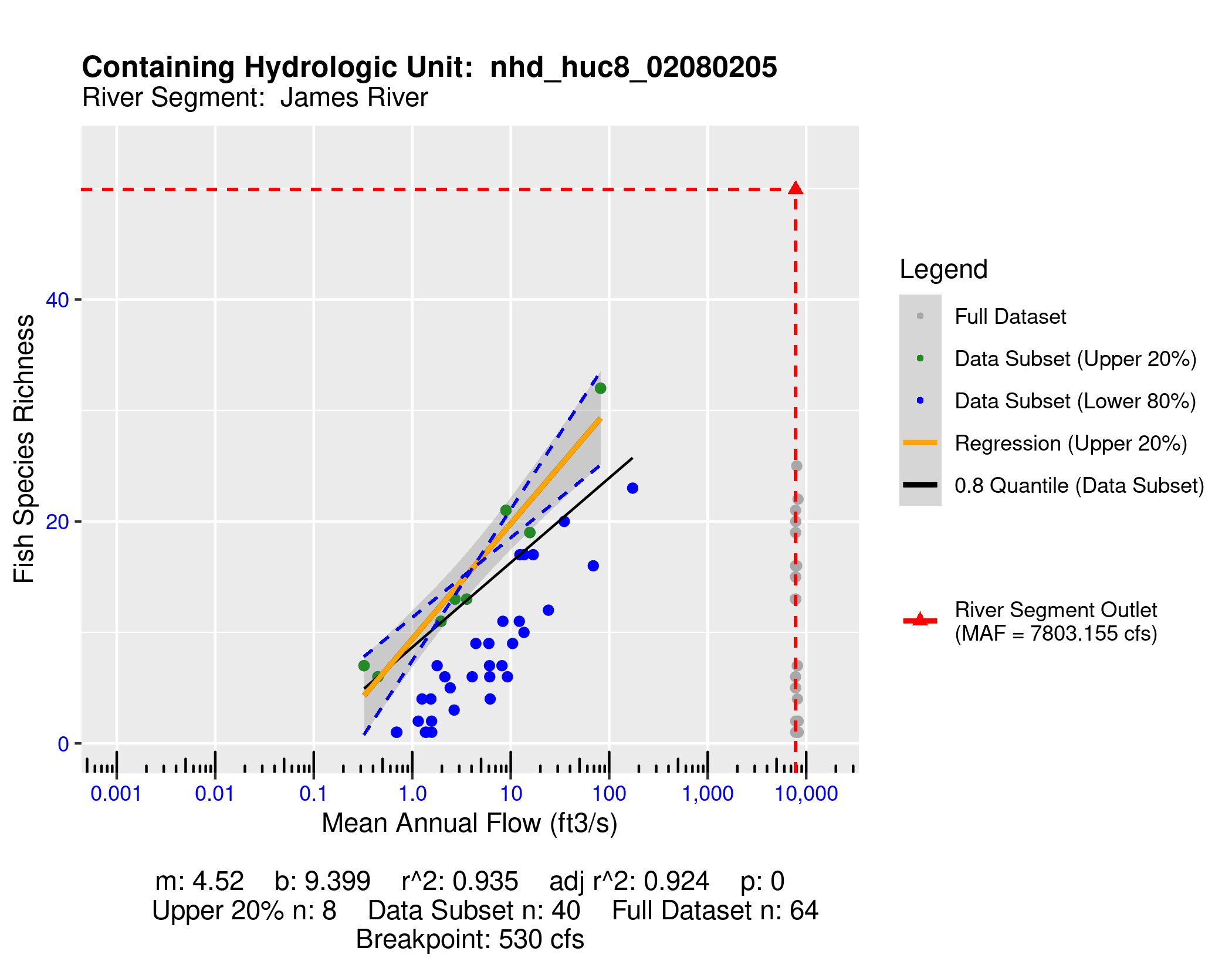


## This property does not exist

[1] “No local facility impoundment for 3.0 MGD, 90% Flow-by”

# Ecological Impacts Assessment:

## Elfgen:



## Habitat (If Applicable):

# Additional Sections

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