# AADF – Stage-Storage vs. Constant Surface Area Error Analysis and CJ Strike Storage Calculation Analysis

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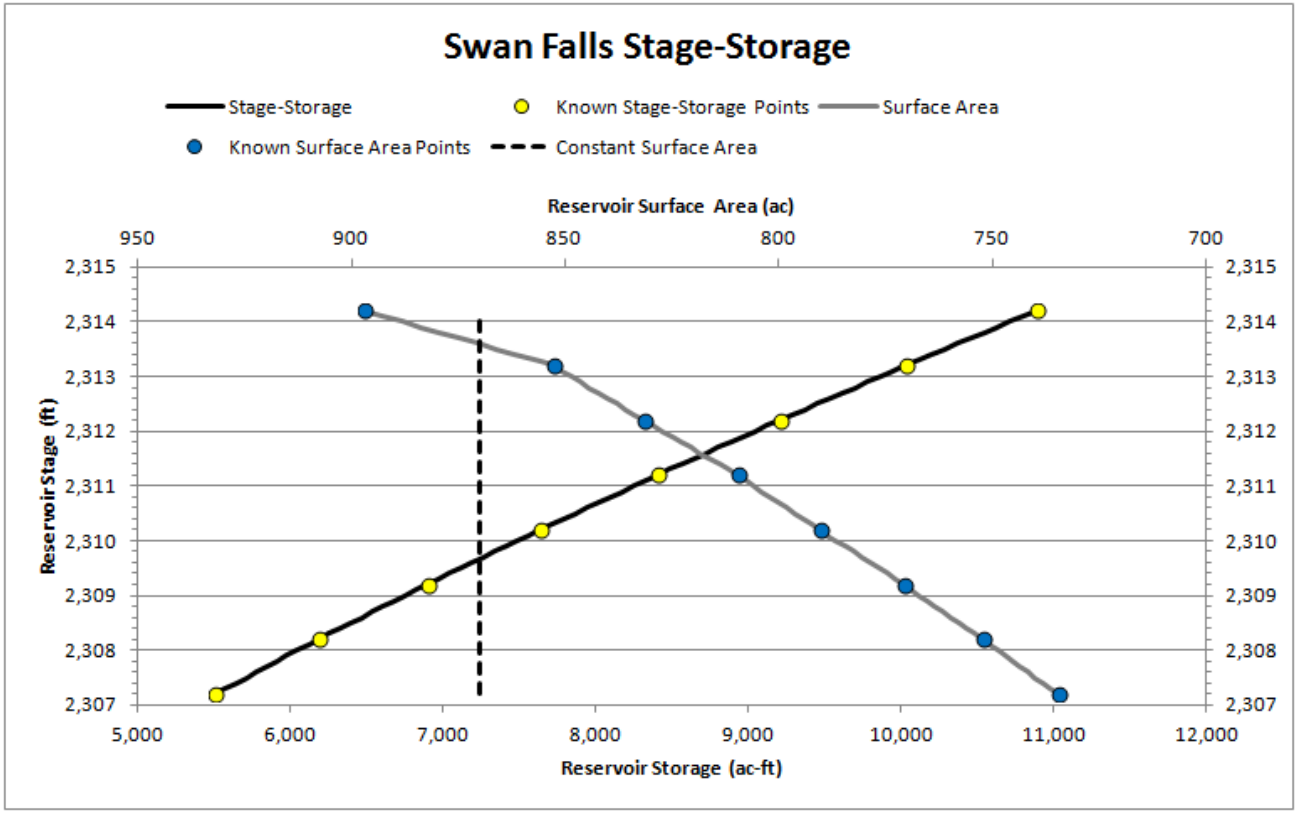
**Swan Falls Technical Working Group Meeting 10/20/2015**

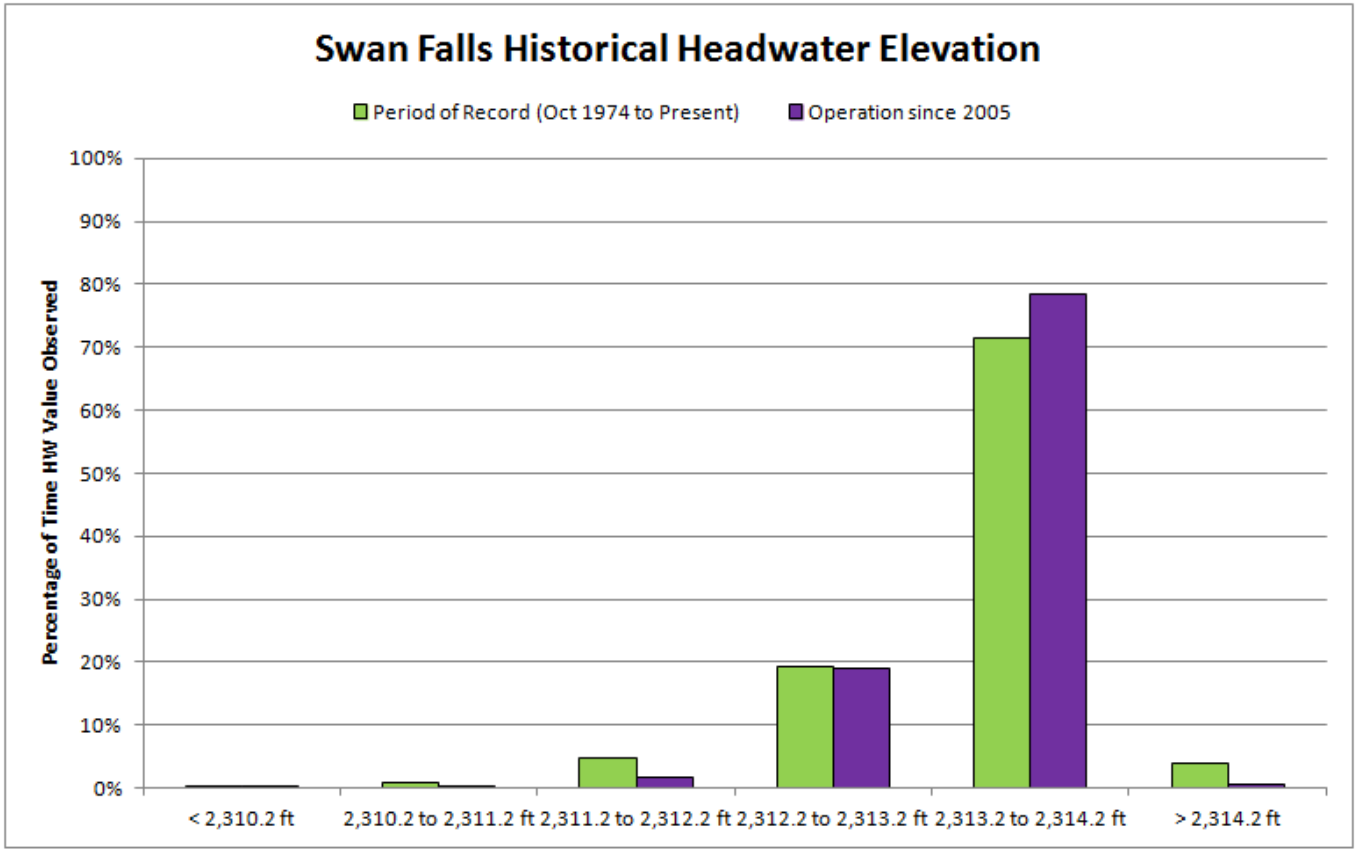
# Swan Falls Stage-Storage Curve

- 2012 red LiDAR and 2012/2014 multibeam bathymetry used to construct stage-storage curve
- Stage-storage curve from 2,307.2’ to 2,314.2’ (NGVD 29) in 1-ft increments; 2,314.2’ maximum stage
- Storage linearly interpolated at 0.1-ft increments



# Swan Falls

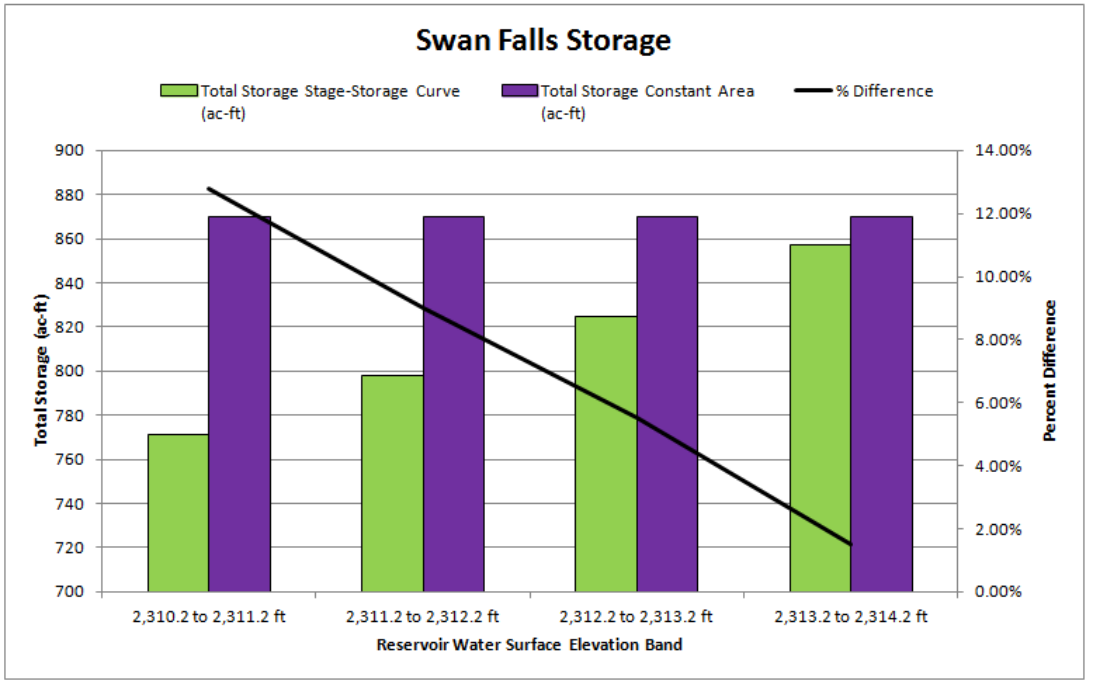
- Historically, Swan Falls has been operated in 2,313.2 to 2,314.2-ft range; since 2005 Swan Falls elevation has been between 2,313.2 to 2,314.2-ft approximately 78% of the time



# Swan Falls

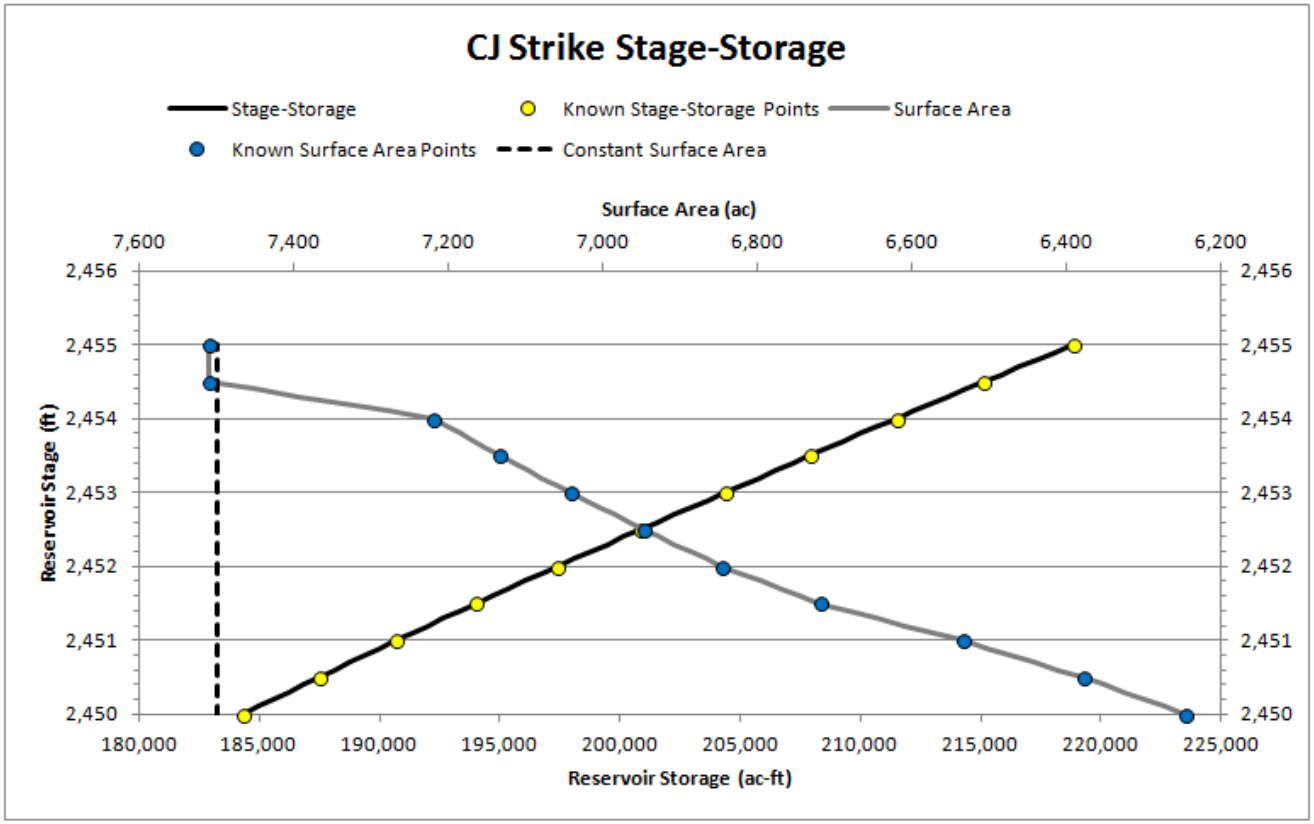
- Constant surface area of 870 acres assumed for AADF
- Error associated with constant surface area assumption is small in the top two feet of the reservoir (< ~5%); errors associated with the constant surface area assumption increases as headwater elevation decreases

| Stage Increment | Total Storage Stage-Storage Curve (ac-ft) | Total Storage Constant Area (ac-ft) | % Difference | Flow Rate Deviation for 0.1-ft change in 1 hour (cfs/hr) |
|---|---|---|---|---|
| 2307.2 to 2308.2 ft | 674.98 | 870 | 28.89% | 236 |
| 2308.2 to 2309.2 ft | 710.12 | 870 | 22.51% | 193 |
| 2309.2 to 2310.2 ft | 743.56 | 870 | 17.00% | 153 |
| 2,310.2 to 2,311.2 ft | 771.40 | 870 | 12.78% | 119 |
| 2,311.2 to 2,312.2 ft | 798.02 | 870 | 9.02% | 87 |
| 2,312.2 to 2,313.2 ft | 824.65 | 870 | 5.50% | 55 |
| 2,313.2 to 2,314.2 ft | 857.18 | 870 | 1.50% | 16 |



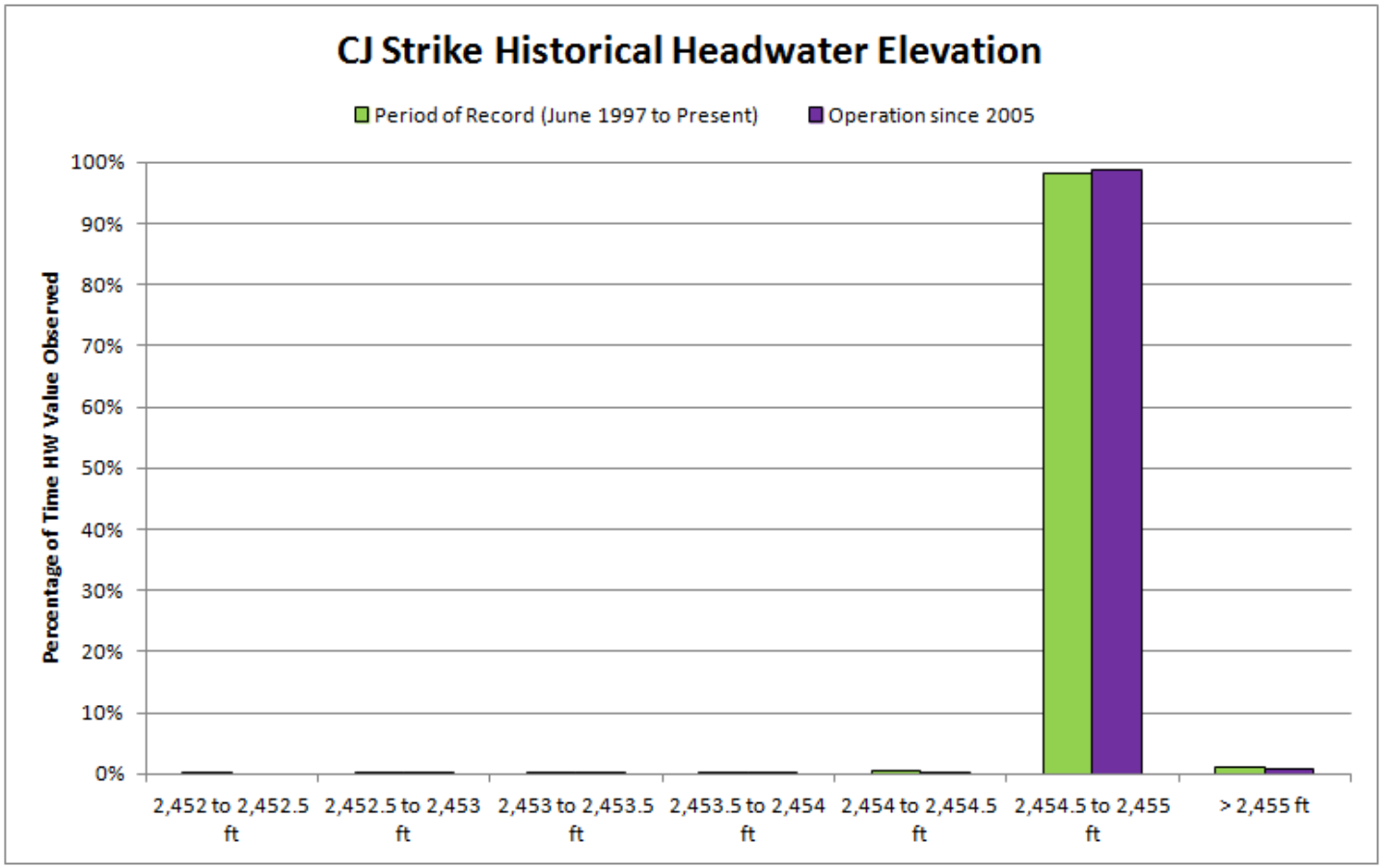
# CJ Strike Stage-Storage Curve

- 1995 single beam bathymetry cross sections used to construct stage-storage curve; shoreline elevation of 2,455’ assigned to the surface.
- Stage-storage curve from 2,445’ to 2,455’ (NGVD 29) in 0.5-ft increments; 2,455’ maximum stage
- Storage linearly interpolated at 0.1-ft increments



# CJ Strike

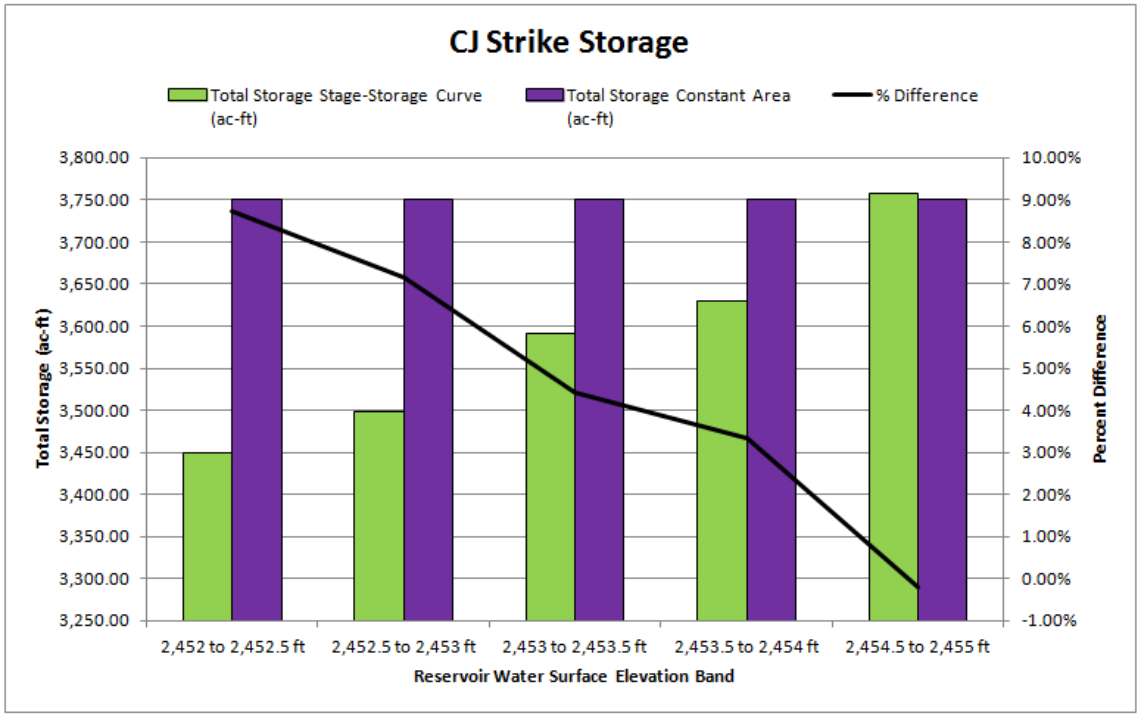
- Historically, CJ Strike has been operated in 2,454.5 to 2,455-ft range; over 95% of historical values fall within this range



# CJ Strike

- Constant surface area of 7,500 acres assumed for AADF
- Error associated with constant surface area assumption is small in the top 1.5 feet of the reservoir (< ~5%); errors associated with the constant surface area assumption increases as headwater elevation decreases

| Stage Increment | Total Storage Stage-Storage Curve (ac-ft) | Total Storage Constant Area (ac-ft) | % Difference | Flow Rate Deviation for 0.1-ft change in 1 hour (cfs/hr) |
|---|---|---|---|---|
| 2,450 to 2,450.5 ft | 3,157.00 | 3,750.00 | 18.78% | 1435.06 |
| 2,450.5 to 2,451 ft | 3,229.00 | 3,750.00 | 16.14% | 1260.82 |
| 2,451 to 2,451.5 ft | 3,315.00 | 3,750.00 | 13.12% | 1052.7 |
| 2,451.5 to 2,452 ft | 3,397.00 | 3,750.00 | 10.39% | 854.26 |
| 2,452 to 2,452.5 ft | 3,449.00 | 3,750.00 | 8.73% | 728.42 |
| 2,452.5 to 2,453 ft | 3,499.00 | 3,750.00 | 7.17% | 607.42 |
| 2,453 to 2,453.5 ft | 3,591.00 | 3,750.00 | 4.43% | 384.78 |
| 2,453.5 to 2,454 ft | 3,629.00 | 3,750.00 | 3.33% | 292.82 |
| 2,454.5 to 2,455 ft | 3,757.00 | 3,750.00 | -0.19% | -16.94 |



# Swan Falls and CJ Strike Recommendation

- Although potential flow change errors are relatively small (<100 cfs) within the normal operating headwater ranges at Swan Falls and CJ Strike, it is recommended that the stage-storage curves be used instead of the constant surface area method. Using the stage-storage curves should reduce the errors present in the normal operating range, and also avoid increased errors outside of the normal headwater operating range for each reservoir.

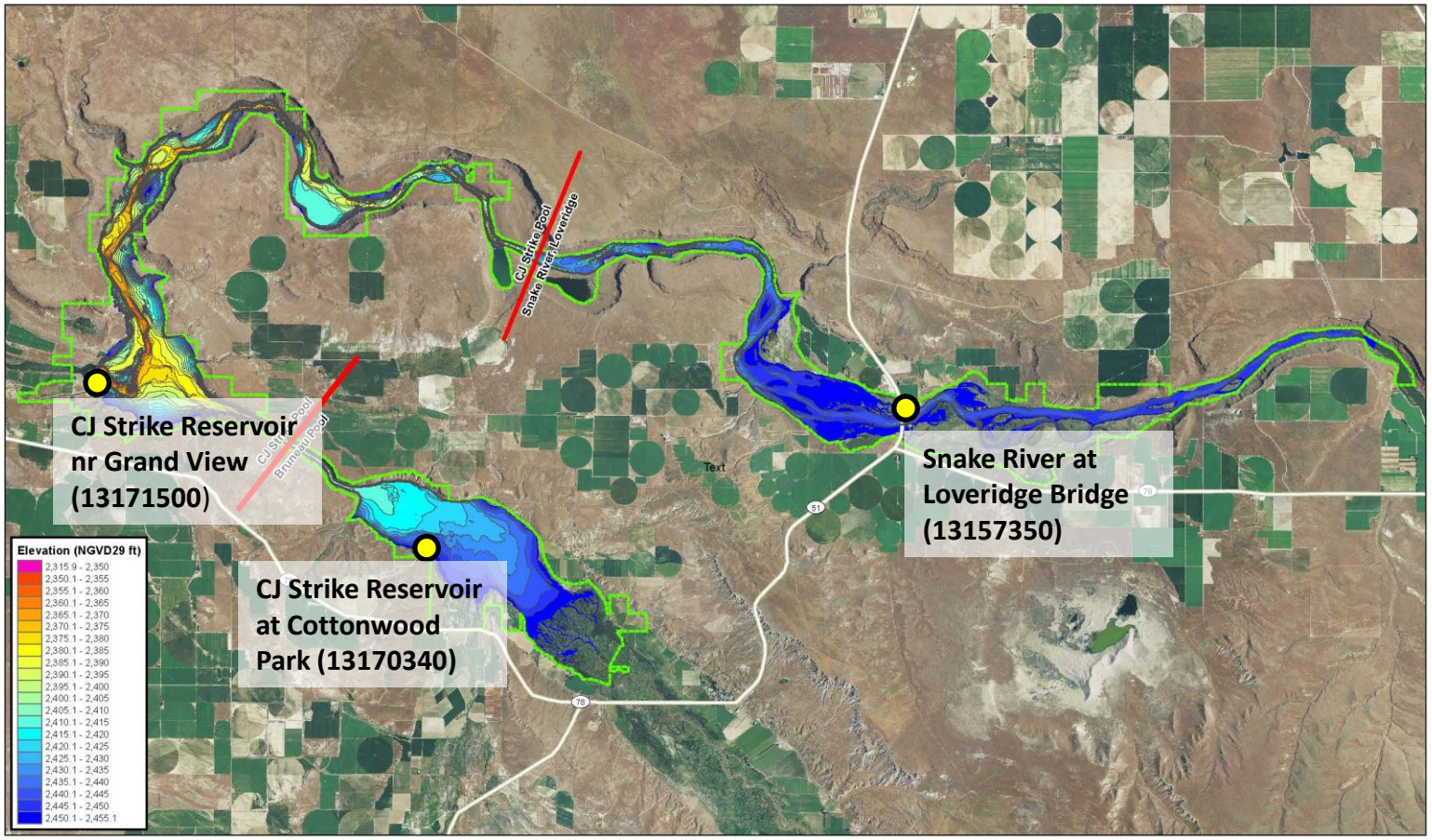
# Bliss and Lower Salmon Falls

- Detailed bathymetry for Bliss not available
- Recommend using surface area method for Bliss since storage in Bliss Reservoir is small. Surface area currently used in analysis is 255 acres.
- Recent green LiDAR obtained for Lower Salmon Falls area; stage-storage curves for Lower Salmon Falls will be updated with data obtained from the new survey
- Recommend using surface area method for Lower Salmon Falls until revised stage-storage curve is available.

# CJ Strike Storage Change Calculation Options

- Two options initially investigated:
  - Method 1: apply weights to CJ Strike headwater gages (Loveridge Bridge, Cottonwood Park, CJ Strike Dam). Optimize weights to reduce variation from inflow and outflow calculation using gaged flows.
  - Method 2: calculate storage in each "arm" of the reservoir using CJ Strike headwater gages (Loveridge Bridge, Cottonwood Park, CJ Strike Dam).
- Compare the results of each method to a baseline condition (Inflows – Outflows) and to the current reservoir stage method using CJ Strike Dam headwater only
- Initially, select February 2015 as analysis time period
  - Winter time period reduces uncertainty due to diversions
  - Month contains periods of calm and high wind
  - Complete hourly record for gaged flows at Loveridge Bridge, Bruneau River near Mouth, and Snake River below CJ Strike Dam

# CJ Strike Bathymetry and Headwater Gages

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Contours (5' Interval)

IPCo Project Boundary

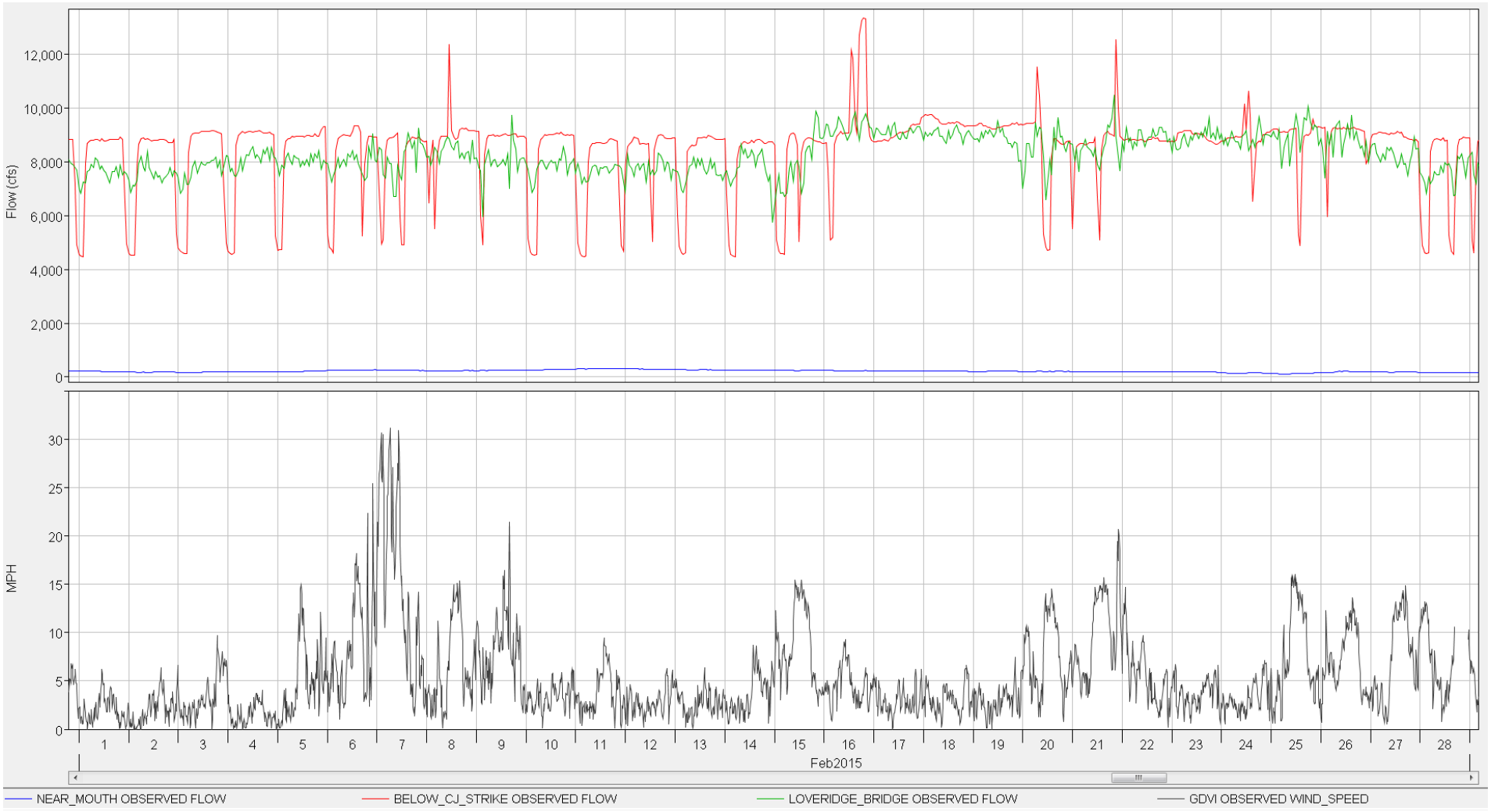
Headwater Gage

*CJ Strike Reservoir*
*1995 Singlebeam Transect Bathymetry*

N

0 0.75 1.5 3 4.5 6 Miles

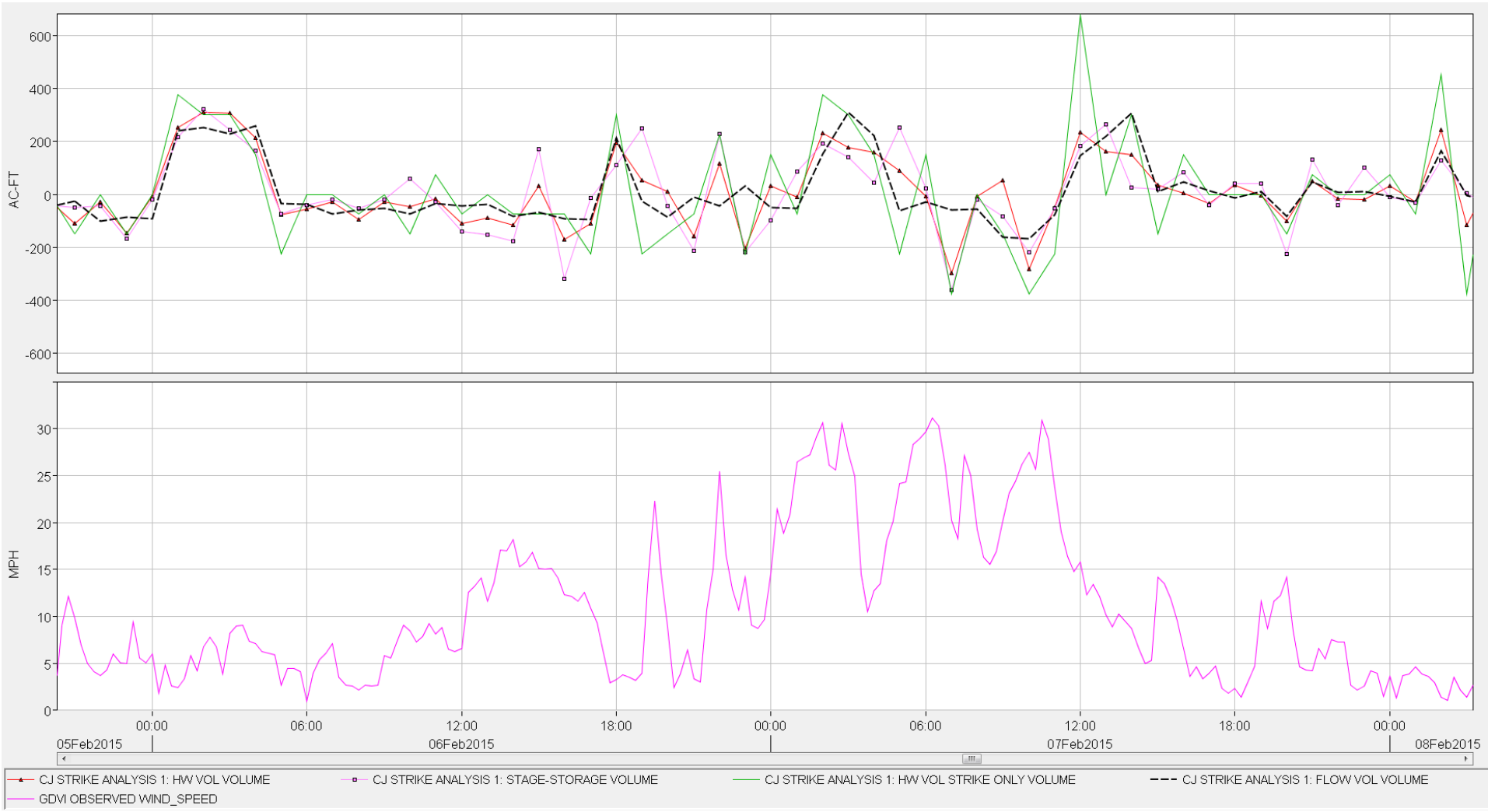
# February 2015



# Results

- Method 1: used global optimization routine for entire month of February
  - Loveridge weight = 0.26
  - Cottonwood Park weight = 0.11
  - CJ Strike Dam weight = 0.64
- Method 2: used stage-storage curve for each reservoir "arm" based on initial estimate of split
- Best fit to baseline volume change obtained with Method 1 (SSE 2.4 x $10^6$); Method 2 provided next best fit (SSE 3.7 x $10^6$); current method using CJ Strike headwater gage only had least best fit (SSE 7.3 x $10^6$)

# Results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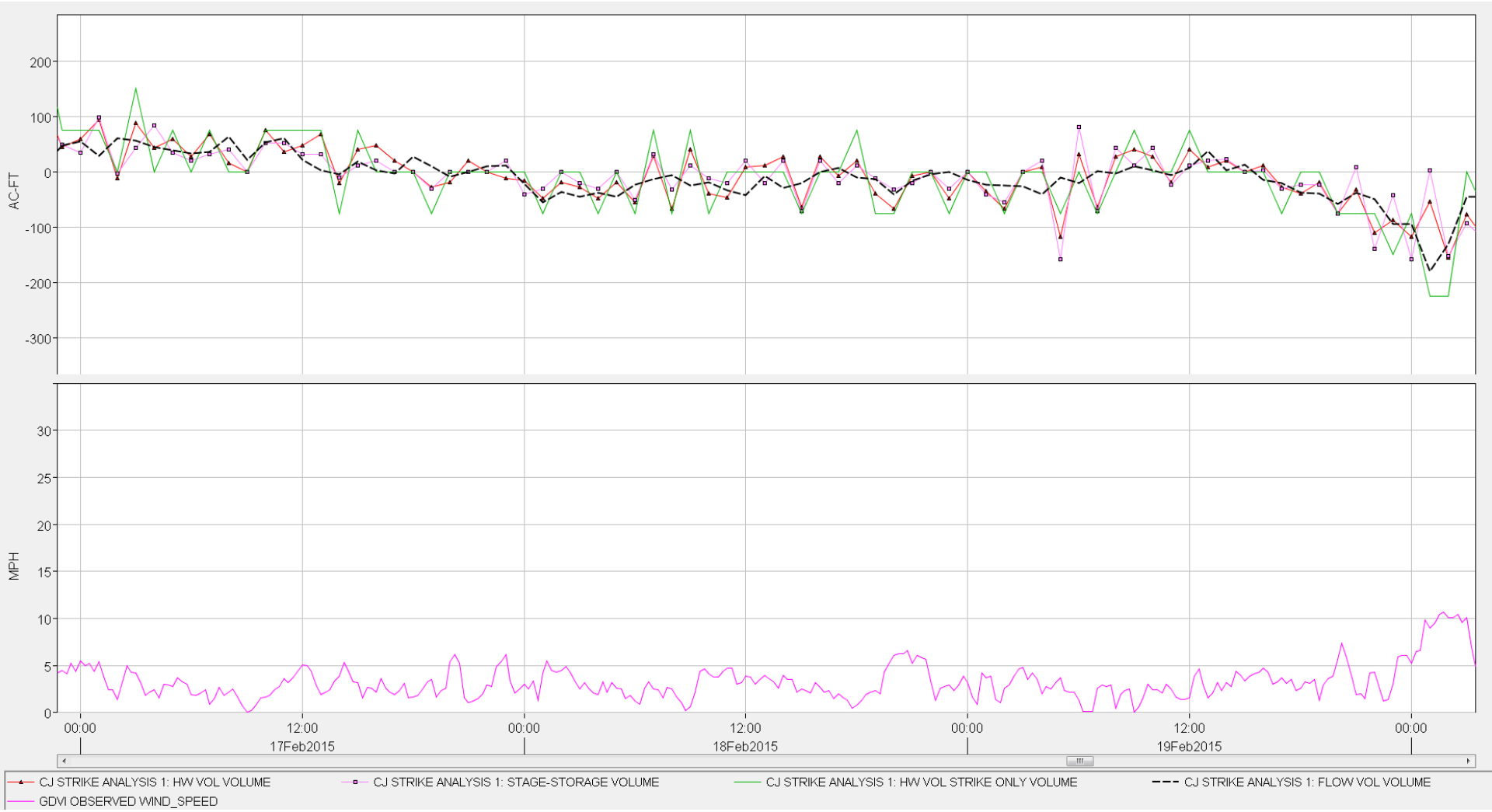
CJ STRIKE ANALYSIS 1: HW VOL VOLUME
CJ STRIKE ANALYSIS 1: STAGE-STORAGE VOLUME
CJ STRIKE ANALYSIS 1: HW VOL STRIKE ONLY VOLUME
CJ STRIKE ANALYSIS 1: FLOW VOL VOLUME
GDVI OBSERVED WIND_SPEED

# Results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CJ STRIKE ANALYSIS 1: HW VOL VOLUME
CJ STRIKE ANALYSIS 1: STAGE-STORAGE VOLUME
CJ STRIKE ANALYSIS 1: HW VOL STRIKE ONLY VOLUME
CJ STRIKE ANALYSIS 1: FLOW VOL VOLUME
GDVI OBSERVED WIND_SPEED

# Next Steps

- Investigate additional analyses for Method 1 (HW weighting)
  - Different time steps (weekly, daily, hourly) for optimization
  - Different weighting factors for wind vs. non-wind events
  - Compare storage changes to observed outflow for validation of optimal weighting (target winter months)
- Investigate additional analyses for Method 2 (storage by arm)
  - Use temporary headwater gages (between Loveridge and main reservoir) to refine breakpoint between gages
  - Select several breakpoint locations and compare performance to identify optimal assignment of influence area for each gage