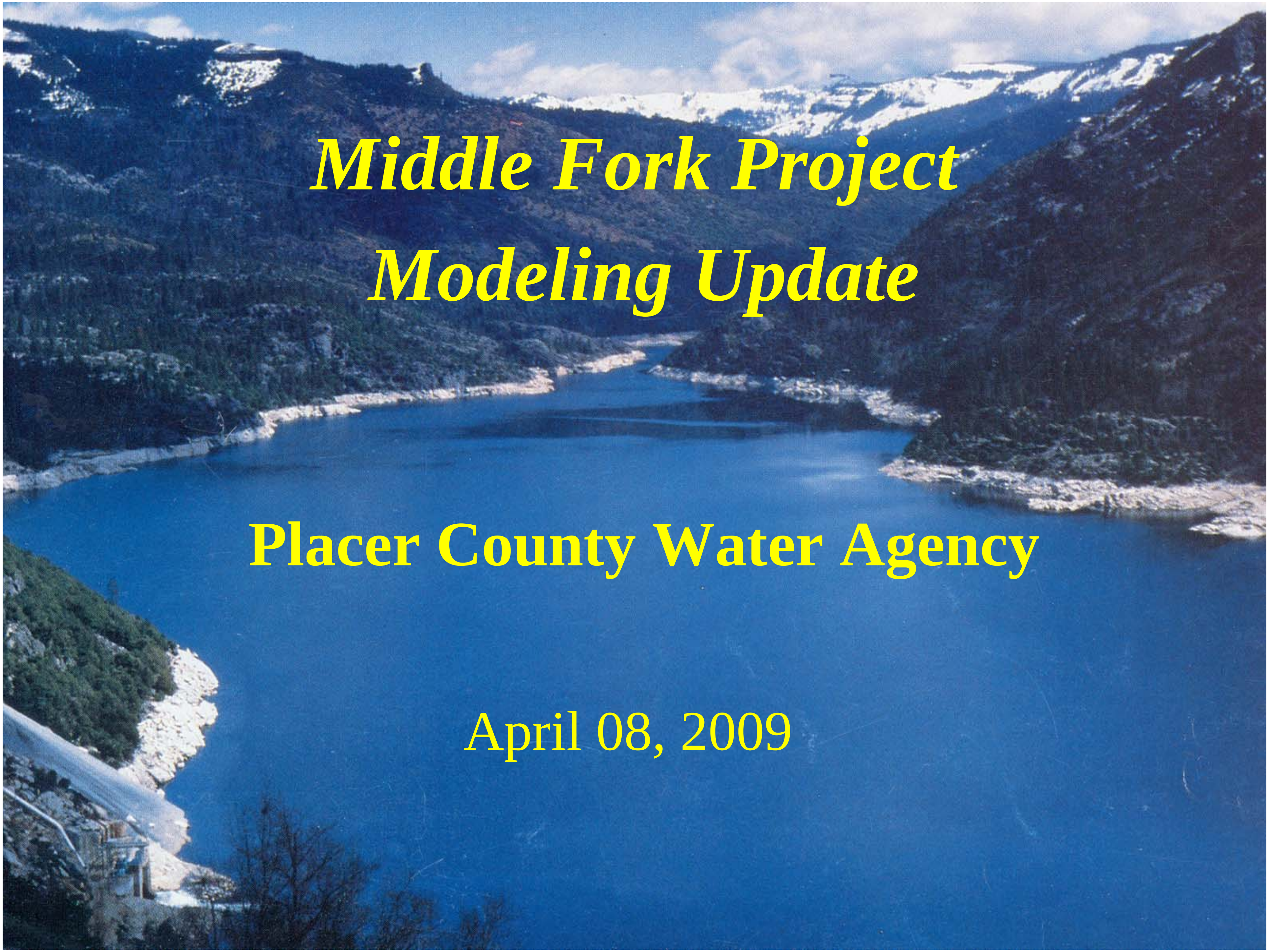

Middle Fork Project Modeling Update

Placer County Water Agency

April 08, 2009

Modeling Update

- What’s New
- Betterments Logic
- Hourly Model

What's new - Overview

- Updated Hydrology Set
- Updated Powerhouse Efficiency Curves
- Instream Flow Requirements Now Located in Pattern Tables
- Supplemental Flow Requirement Tables
- New Consumptive Demands Structure
- Updated SAE Curves
- Peak Hours Designation

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Updated Hydrology

- Reservoir inflows not gaged, computed from available data
- Additional analysis yielded better smoothing technique
- Previous technique smoothed months individually, new technique connects months
- Hydrology through water year 2007, previously through 2006

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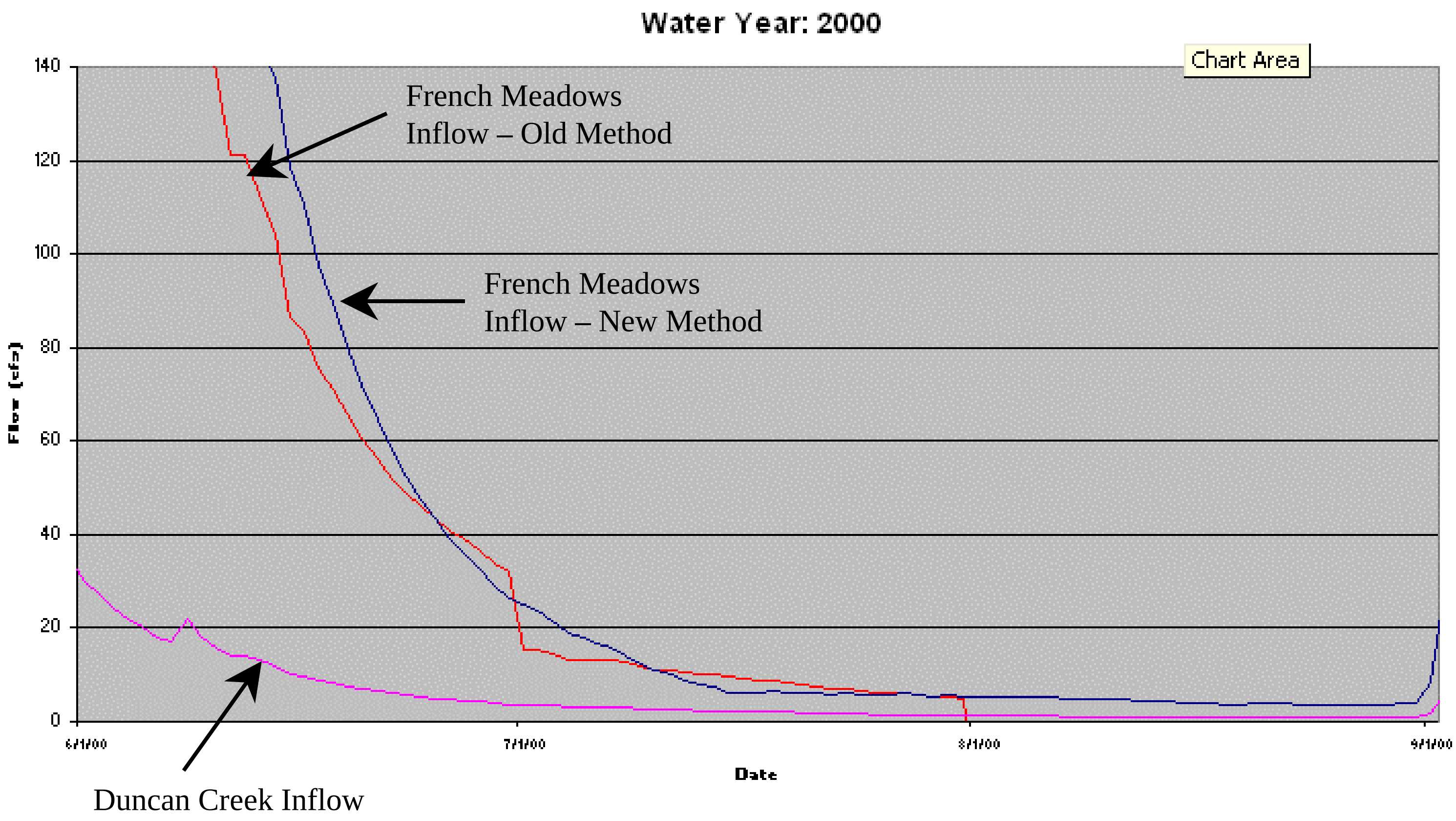
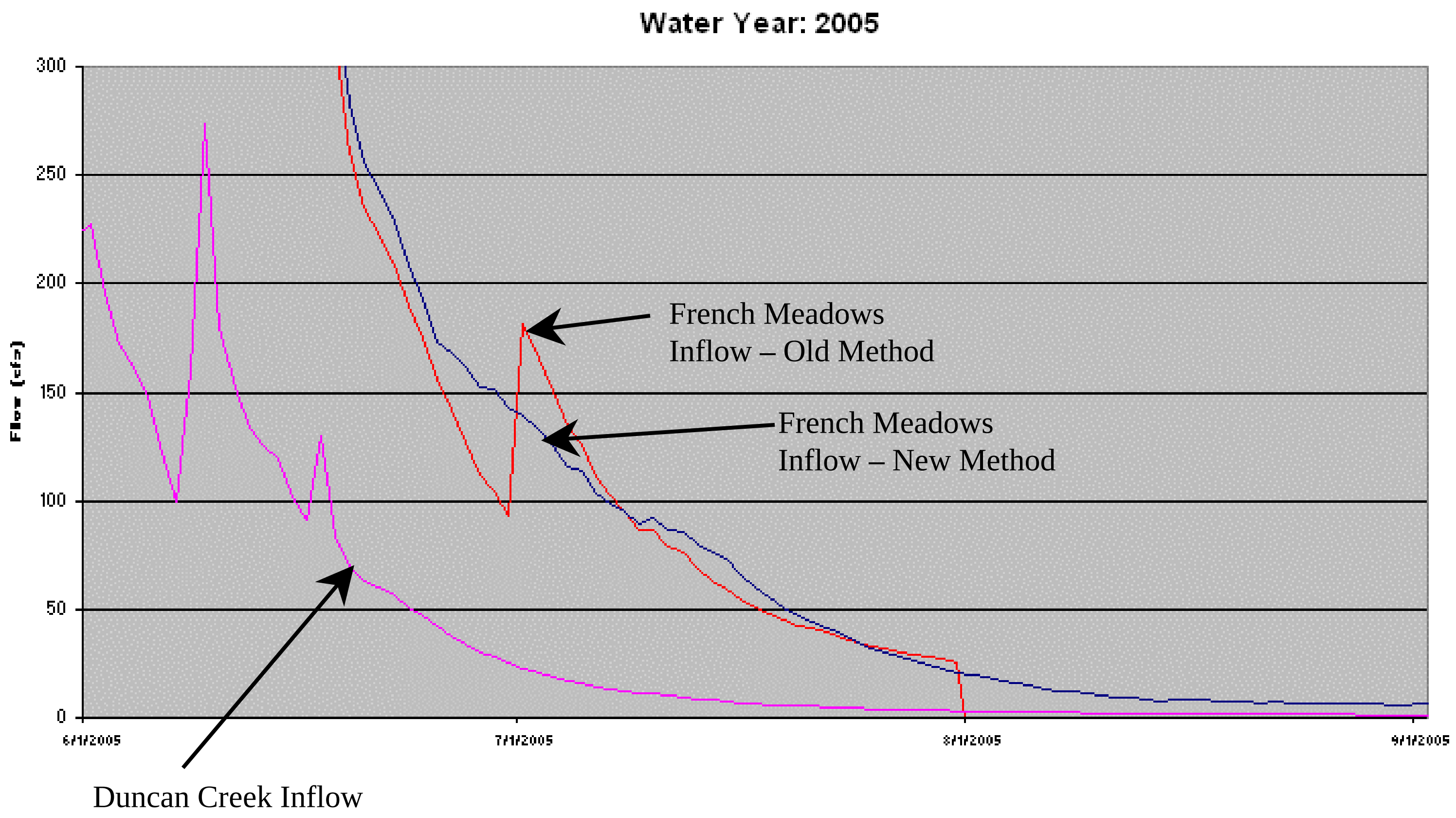
Updated Hydrology

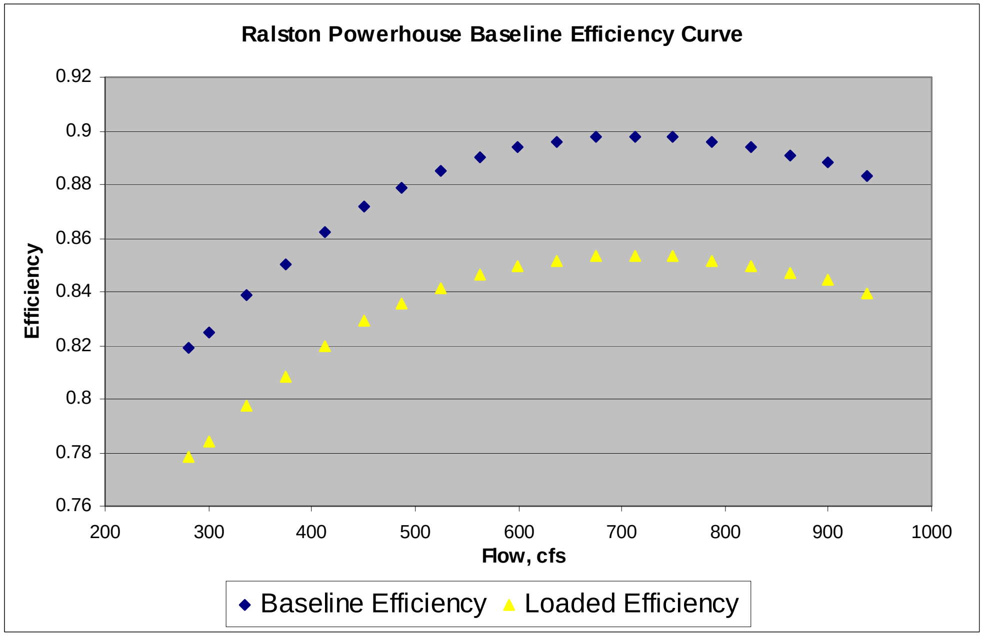


Updated Hydrology



Powerhouse Efficiency Curves

- Previous curves represented turbine efficiency, not total station efficiency
- Composite station efficiency includes:
  - 98% generator efficiency
  - 97% transformer efficiency



Instream Flow Requirements

- All flow requirements in pattern tables, previously in OCL code

```
Set duncan_creek_min : min_flow800.804
{
 Condition Wet : aui_ar >= [Year_type_wet]
     value : MIN { cfs_to_af{ 8 }*1.05 , timesers(800/inflow) }
 Condition AN : aui_ar >=  [Year_type_AN]
     value : MIN { cfs_to_af{ 8 }*1.05 , timesers(800/inflow) }
 Condition BN : aui_ar >=  [Year_type_BN]
     value : MIN { cfs_to_af{ 8 }*1.05 , timesers(800/inflow) }
 Condition Dry : aui_ar >= [Year_type_Dry]
     value : MIN { cfs_to_af{ 8 }*1.05 , timesers(800/inflow) }
 Condition CD : aui_ar >=  [Year_type_CD]
     value : MIN { cfs_to_af{ 4 }*1.05 , timesers(800/inflow) }
}
```

OCL Pattern

Name	EOP	Flow to Vol	Rate	Factor	Month	Day	Value
Duncan_AN_minflow	0	1	0	1.0	1	1	8.0
Duncan_AN_minflow					9	30	8.0
Duncan_AN_minflow	0	1	0	1.0	10	1	8.0
Duncan_AN_minflow					12	31	8.0
Duncan_BN_minflow	0	1	0	1.0	1	1	8.0
Duncan_BN_minflow					9	30	8.0
Duncan_BN_minflow	0	1	0	1.0	10	1	8.0
Duncan_BN_minflow					12	31	8.0
Duncan_CD_minflow	0	1	0	1.0	1	1	4.0
Duncan_CD_minflow					9	30	4.0
Duncan_CD_minflow	0	1	0	1.0	10	1	4.0
Duncan_CD_minflow					12	31	4.0
Duncan_Dry_minflow	0	1	0	1.0	1	1	8.0
Duncan_Dry_minflow					9	30	8.0
Duncan_Dry_minflow	0	1	0	1.0	10	1	8.0
Duncan_Dry_minflow					12	31	8.0

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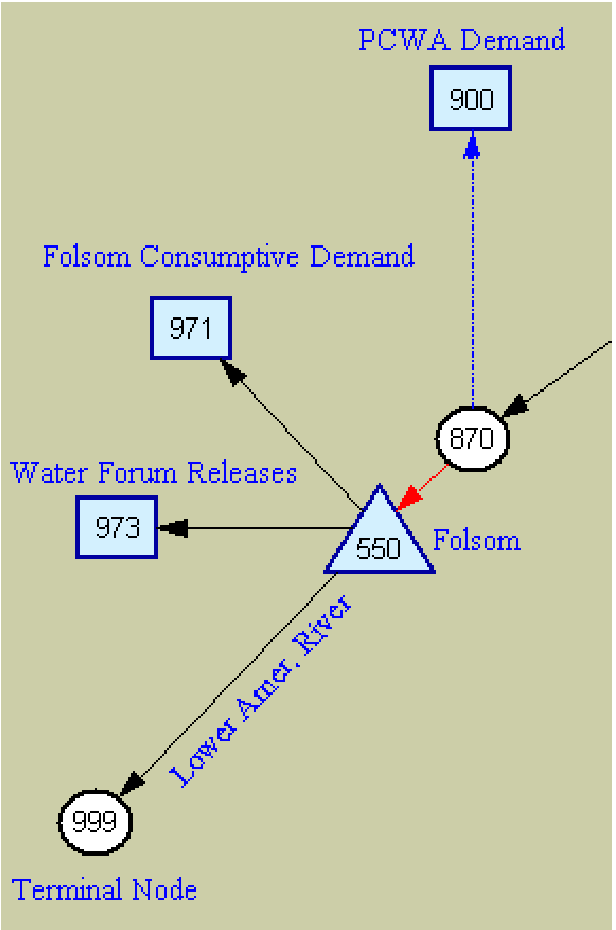
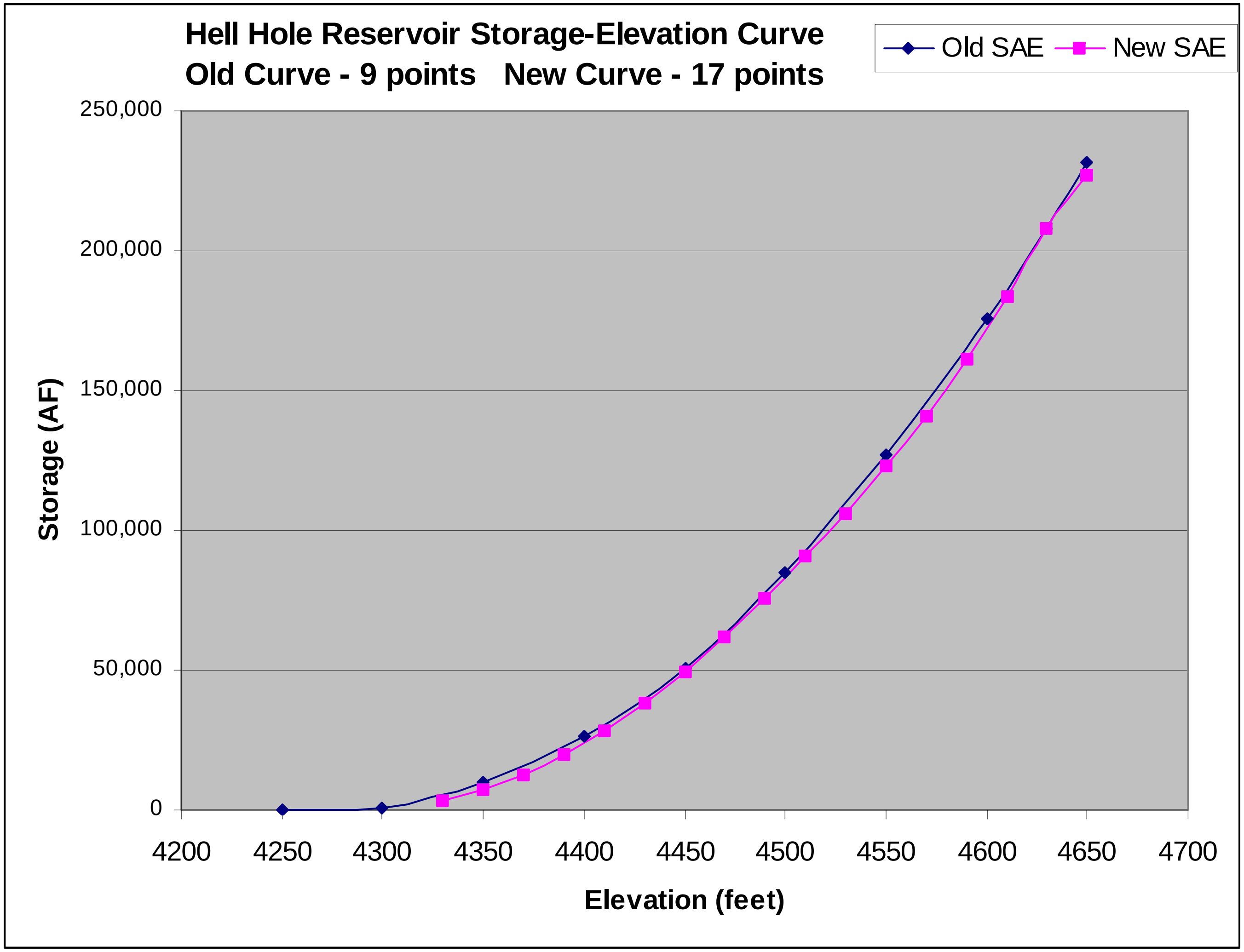
Consumptive Demands Structure

- Folsom demands were partitioned more than necessary, complicated demand tables



New SAE Curves



Peak Hours Designation

- Prioritize hours of day in terms of generation value

<table>
<tr><th>Hour of day</th><th>Weekdays Jul - Aug</th><th>Weekdays Jun, Sep</th><th>Weekdays Nov - Feb</th><th>Weekends Jun - Sep</th><th>Weekdays Mar - May & Oct</th><th>Weekends Oct - May</th></tr>
<tr><td>0</td><td>Off Peak</td><td>Off Peak</td><td>Off Peak</td><td>Off Peak</td><td>Off Peak</td><td>Off Peak</td></tr>
<tr><td>1</td><td rowspan="4">Super Off Peak</td><td rowspan="4">Super Off Peak</td><td rowspan="4">Super Off Peak</td><td rowspan="4">Super Off Peak</td><td rowspan="4">Super Off Peak</td><td rowspan="4">Super Off Peak</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td><td rowspan="3">Off Peak</td><td rowspan="3">Off Peak</td><td rowspan="3">Off Peak</td><td rowspan="3">Off Peak</td><td rowspan="3">Off Peak</td><td rowspan="19">Off Peak</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="2">Low Partial Peak</td><td rowspan="2">Low Partial Peak</td><td rowspan="4">Low Partial Peak</td><td rowspan="4">Low Partial Peak</td><td rowspan="14">Low Partial Peak</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td><td rowspan="2">High Partial Peak</td><td rowspan="2">High Partial Peak</td></tr>
<tr><td>11</td></tr>
<tr><td>12</td><td rowspan="2">Peak</td><td rowspan="6">Peak</td><td rowspan="9">High Partial Peak</td><td rowspan="8">High Partial Peak</td></tr>
<tr><td>13</td></tr>
<tr><td>14</td><td rowspan="4">Crit Peak</td></tr>
<tr><td>15</td></tr>
<tr><td>16</td></tr>
<tr><td>17</td></tr>
<tr><td>18</td><td rowspan="2">Peak</td><td rowspan="2">High Partial Peak</td></tr>
<tr><td>19</td></tr>
<tr><td>20</td><td rowspan="2">High Partial Peak</td><td rowspan="2">Low Partial Peak</td><td rowspan="2">Low Partial Peak</td></tr>
<tr><td>21</td><td>Low Part Pk</td></tr>
<tr><td>22</td><td rowspan="2">Off Peak</td><td rowspan="2">Off Peak</td><td rowspan="2">Off Peak</td><td rowspan="2">Off Peak</td><td rowspan="2">Off Peak</td></tr>
<tr><td>23</td></tr>
</table>

Hours in 2006	
Critical Peak	176
Peak	434
High Partial Peak	1393
Low Partial Peak	2127
Off Peak	3170
Super Off Peak	1460
Total	8760

Betterments

Betterments

- Ralston Powerhouse Capacity Upgrade
- French Meadows Powerhouse Capacity Upgrade
- Hell Hole Seasonal Storage Increase

Ralston PH Upgrade

- Increased capacity – 924 cfs to 1024 cfs.
- Betterment has improved efficiency curve
- Can take advantage of additional accretion flows

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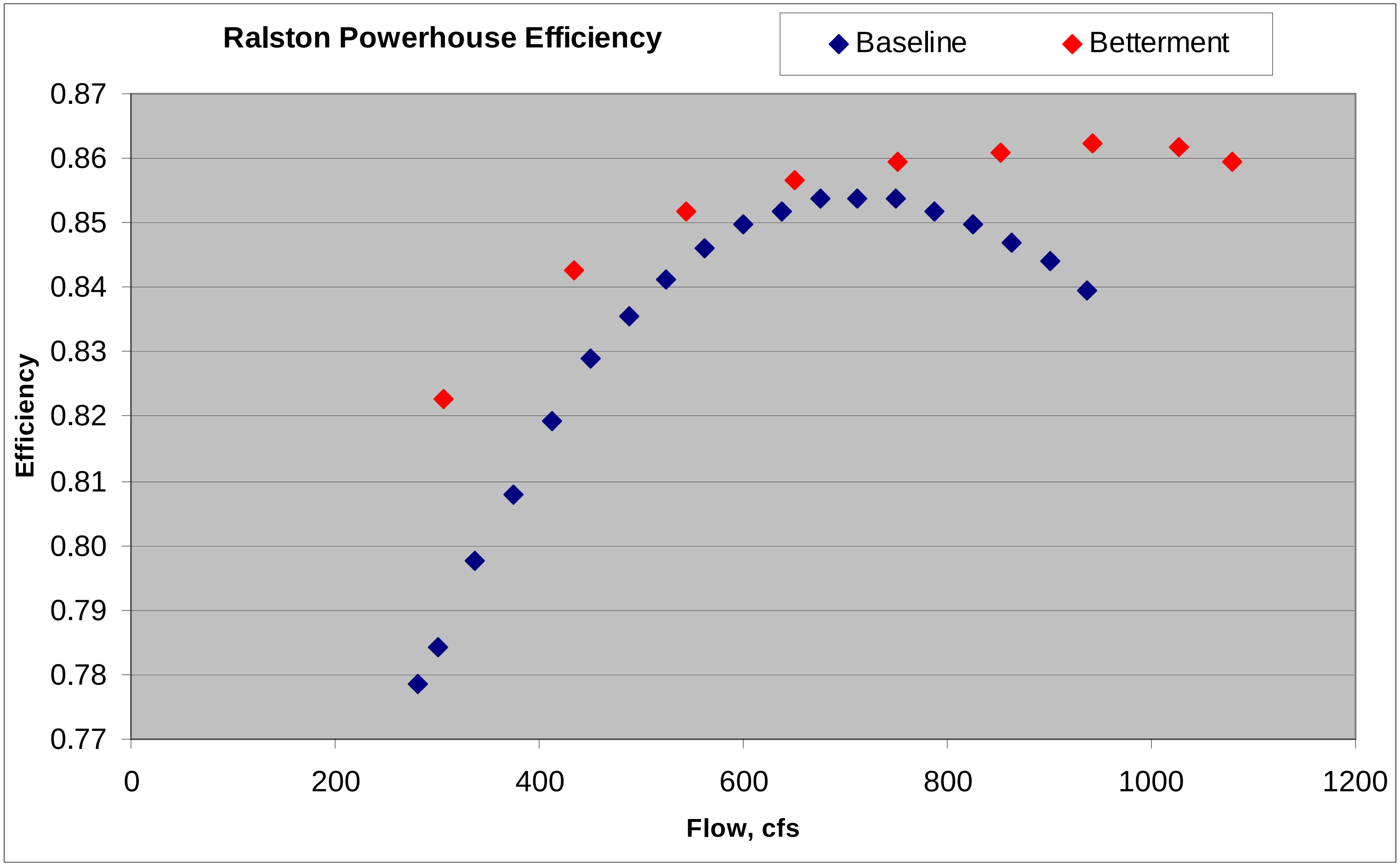
Ralston PH Upgrade



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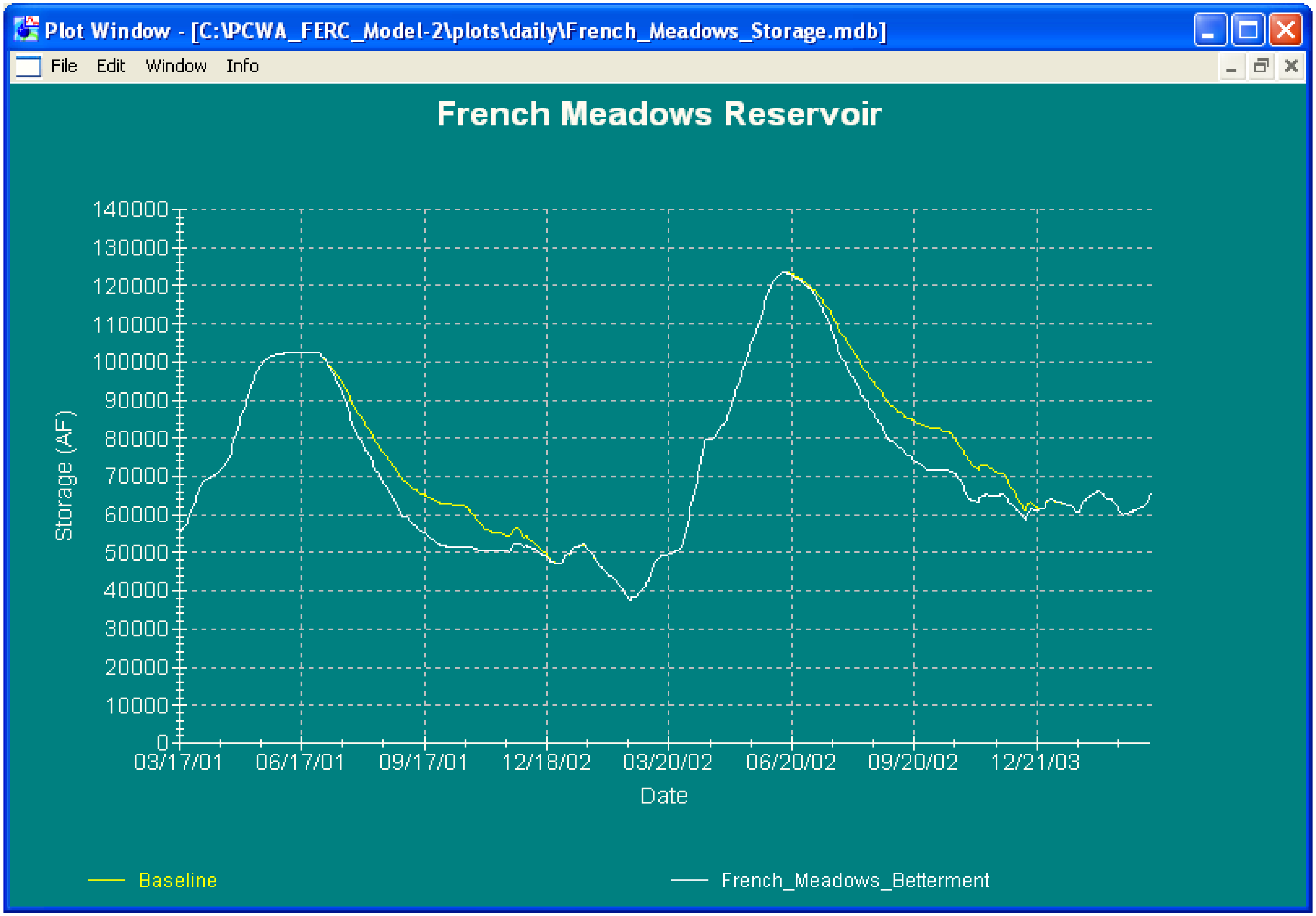
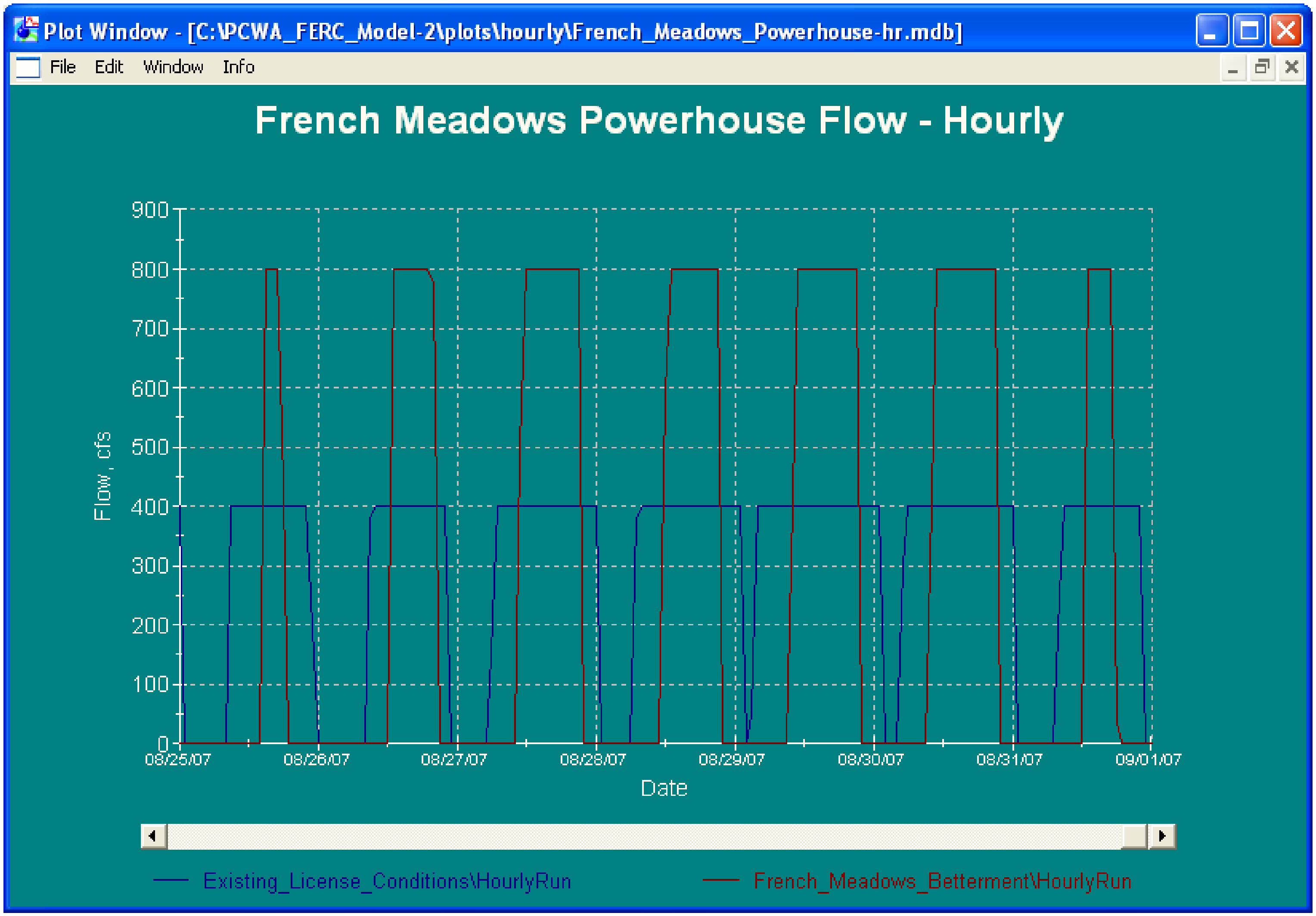
French Meadows PH Upgrade

- Increased capacity – 400 cfs to 800 cfs
- Possibility of new penstock alignment – different head loss relationship
- Slightly decreased KW per AF ratio, can put more generation in peak hours
- Potential for ancillary services
- Can move generation within season to more valuable periods

French Meadows PH Upgrade



French Meadows PH Upgrade



Hell Hole Seasonal Storage Increase

- Seasonal increase in storage capacity
- 6 foot raise – 7,600 AF
- Modeled with gates in place April through October (Assumption, need to verify)
- Increased active storage results in more generation in wetter years

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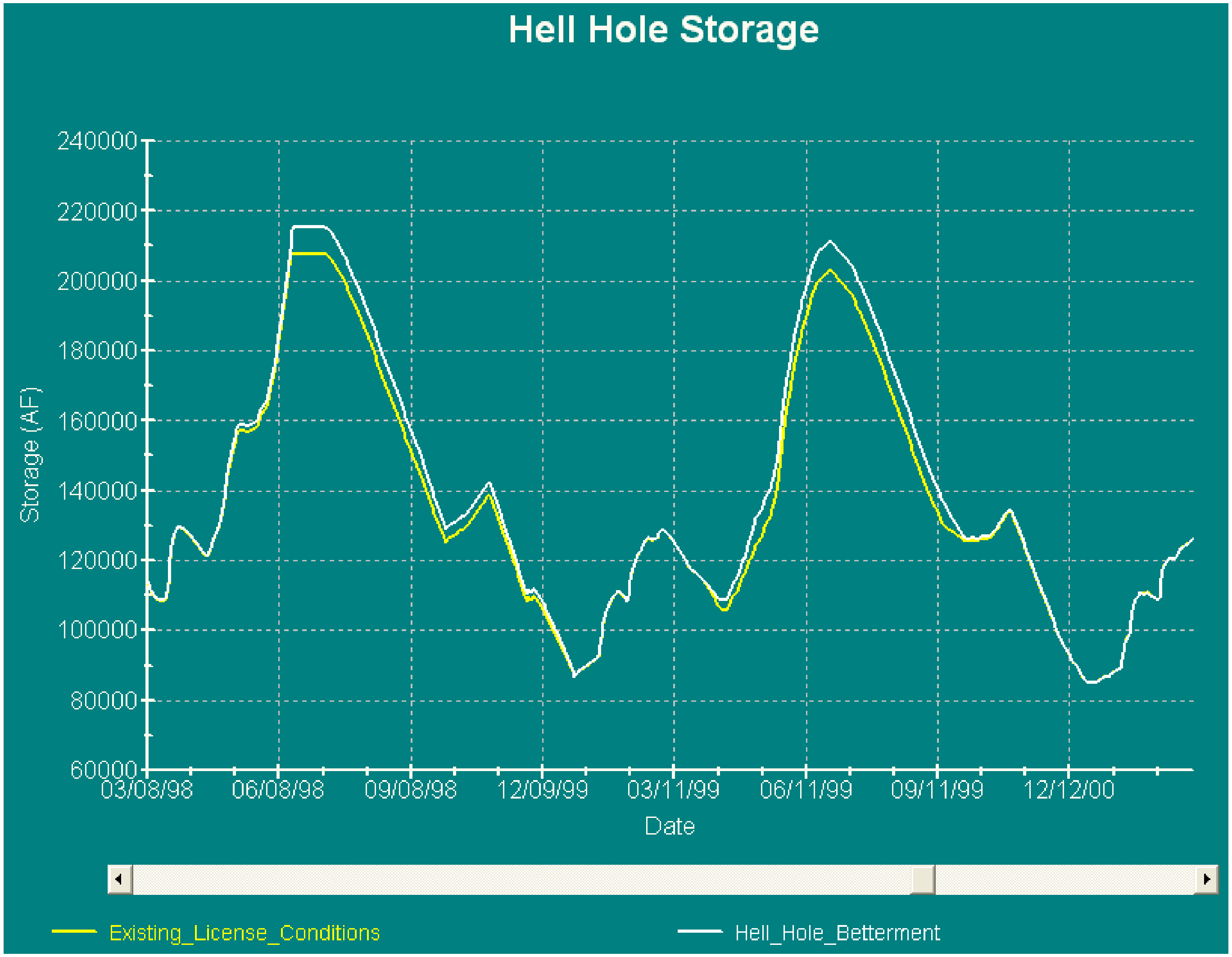
Hell Hole Seasonal Storage Increase



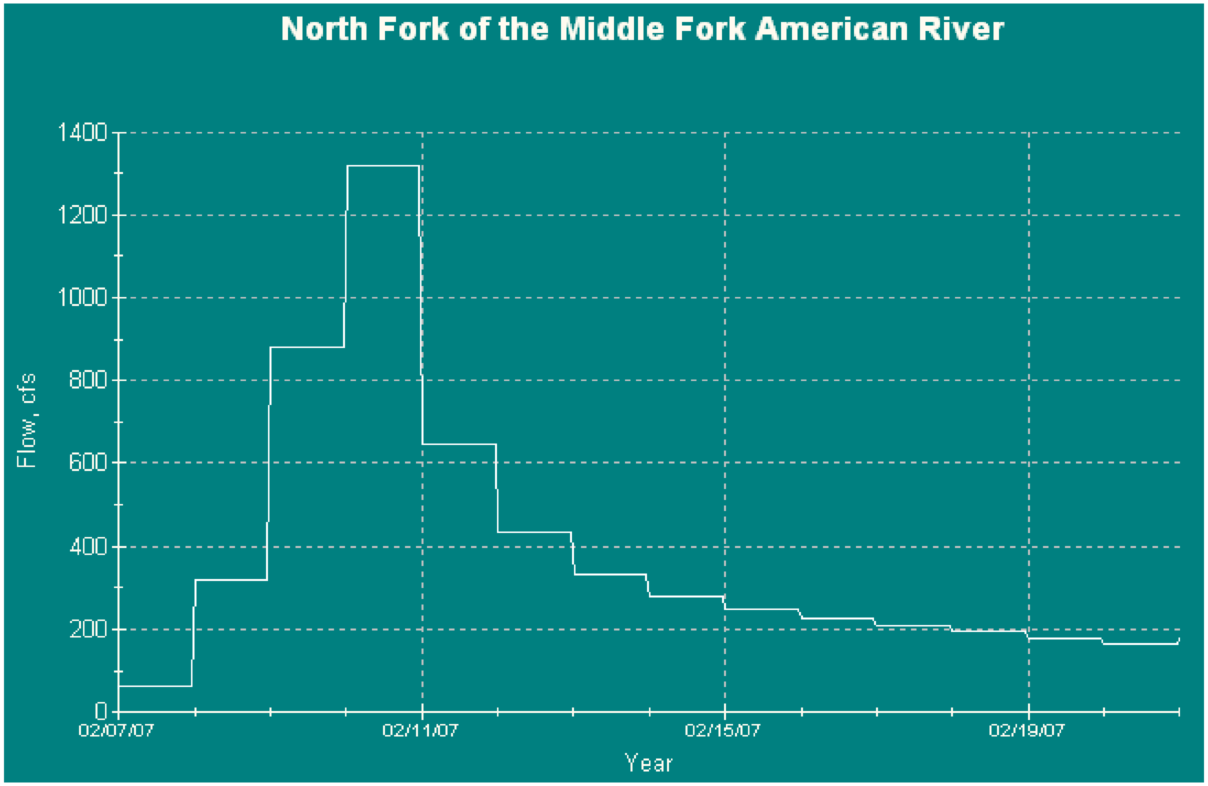
Hourly Model

Hourly Model

- Purpose:
  - Evaluate environmental and recreational impacts of hourly flow changes in the peaking reach
  - Evaluate impacts to Oxbow generation and Ralston Afterbay storage
  - Support water temperature modeling effort
  - Support habitat modeling effort
  - Support recreation flows analysis

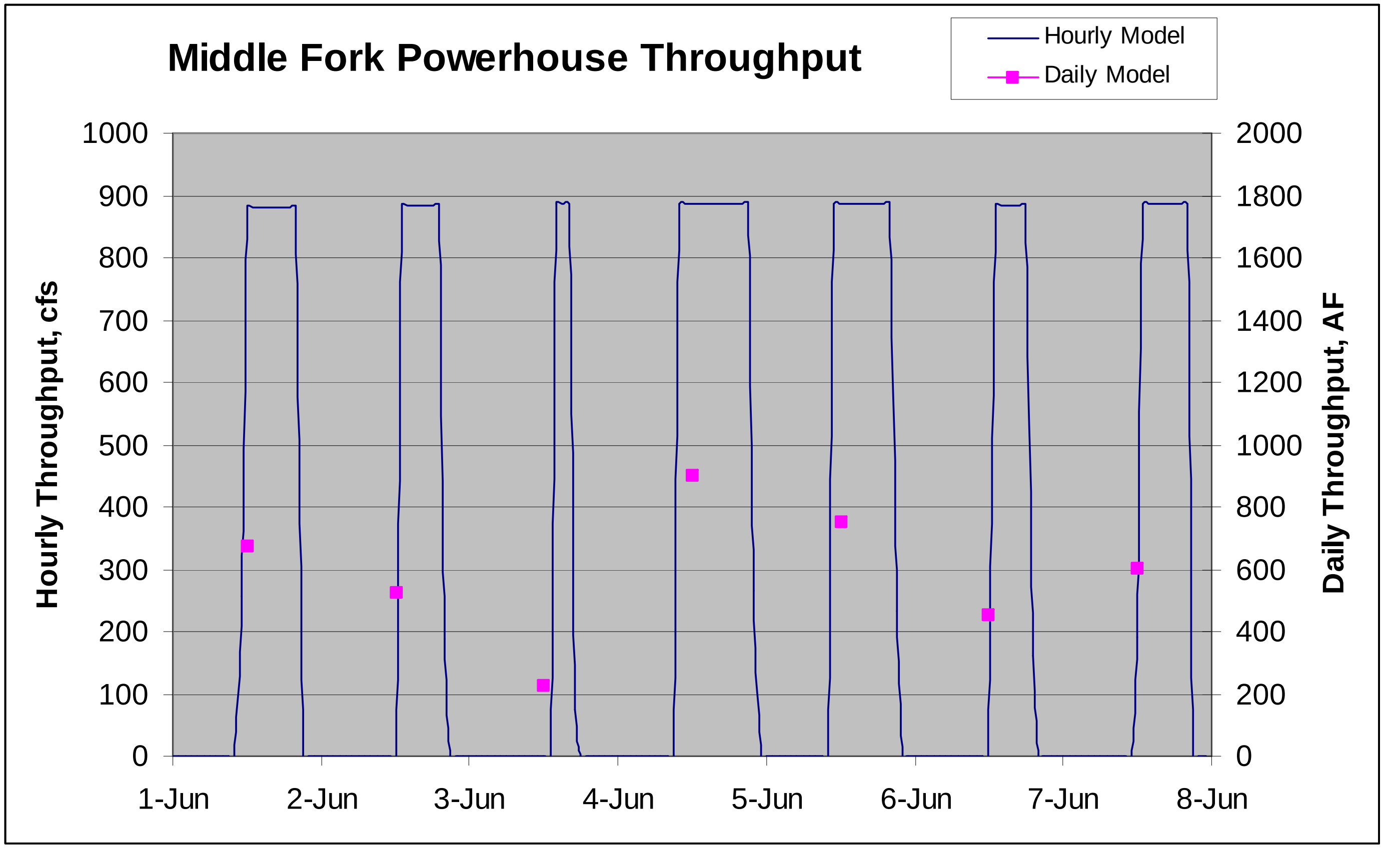
Hourly Model Operation

- All accretion flows are steady within a day, equal to the daily average inflow
- All instream releases and reservoir spills are steady within a day, equal to the daily average flow from the daily model



Hourly Model Operation

- Powerhouses upstream of Ralston Afterbay re-shape daily volume into peaking shape



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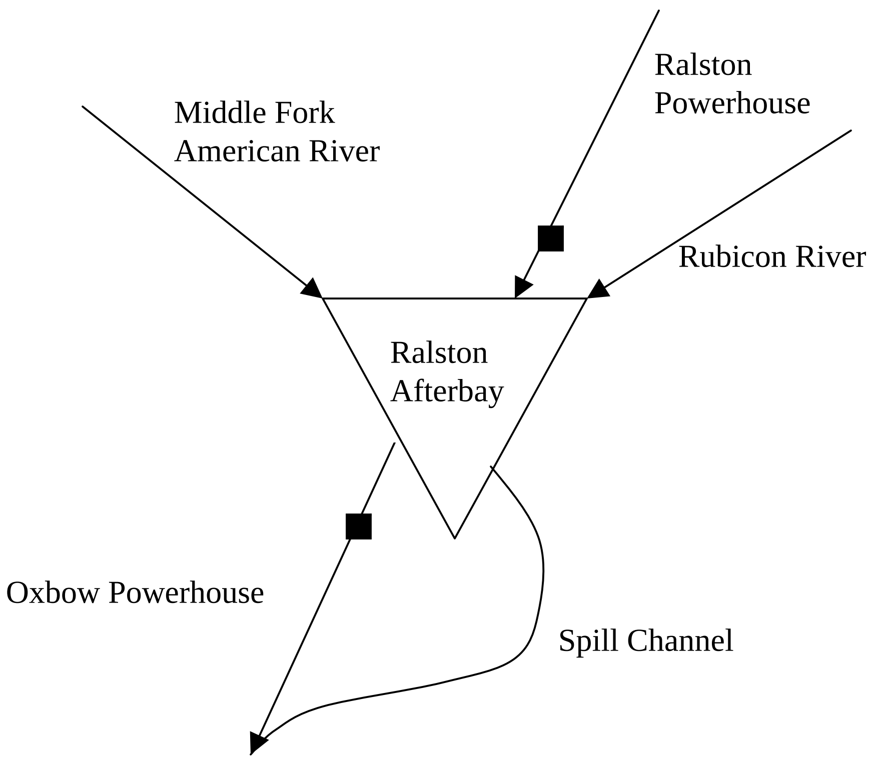
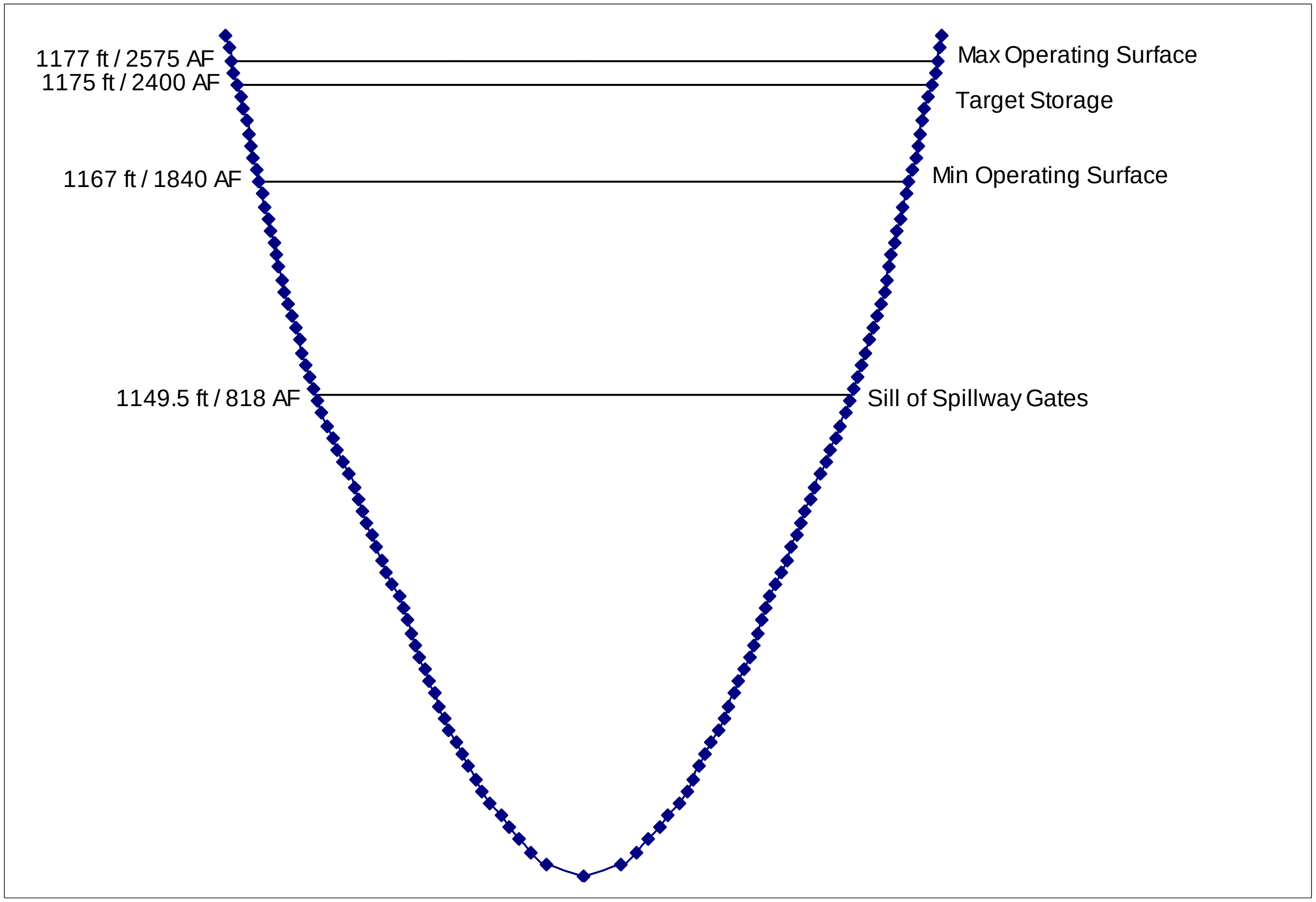
Hourly Model Operation



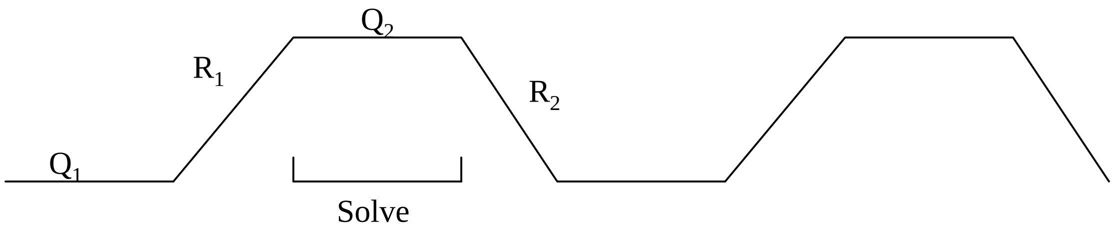
Hourly Model Operation

Ralston Afterbay



Hourly Model Operation

- Oxbow Powerhouse Generation



Hourly Model Operation

- Oxbow Powerhouse, Ralston Afterbay storage and spills re-operated in hourly model
- Oxbow Powerhouse will operate as much as possible, while not causing Afterbay storage to be below 1175 feet (2400 AF) at the end of the day
- When Oxbow Powerhouse is running 24 hours per day at full flow, Afterbay will spill as much water as needed to end the day at or below 1177 feet (2575 AF)

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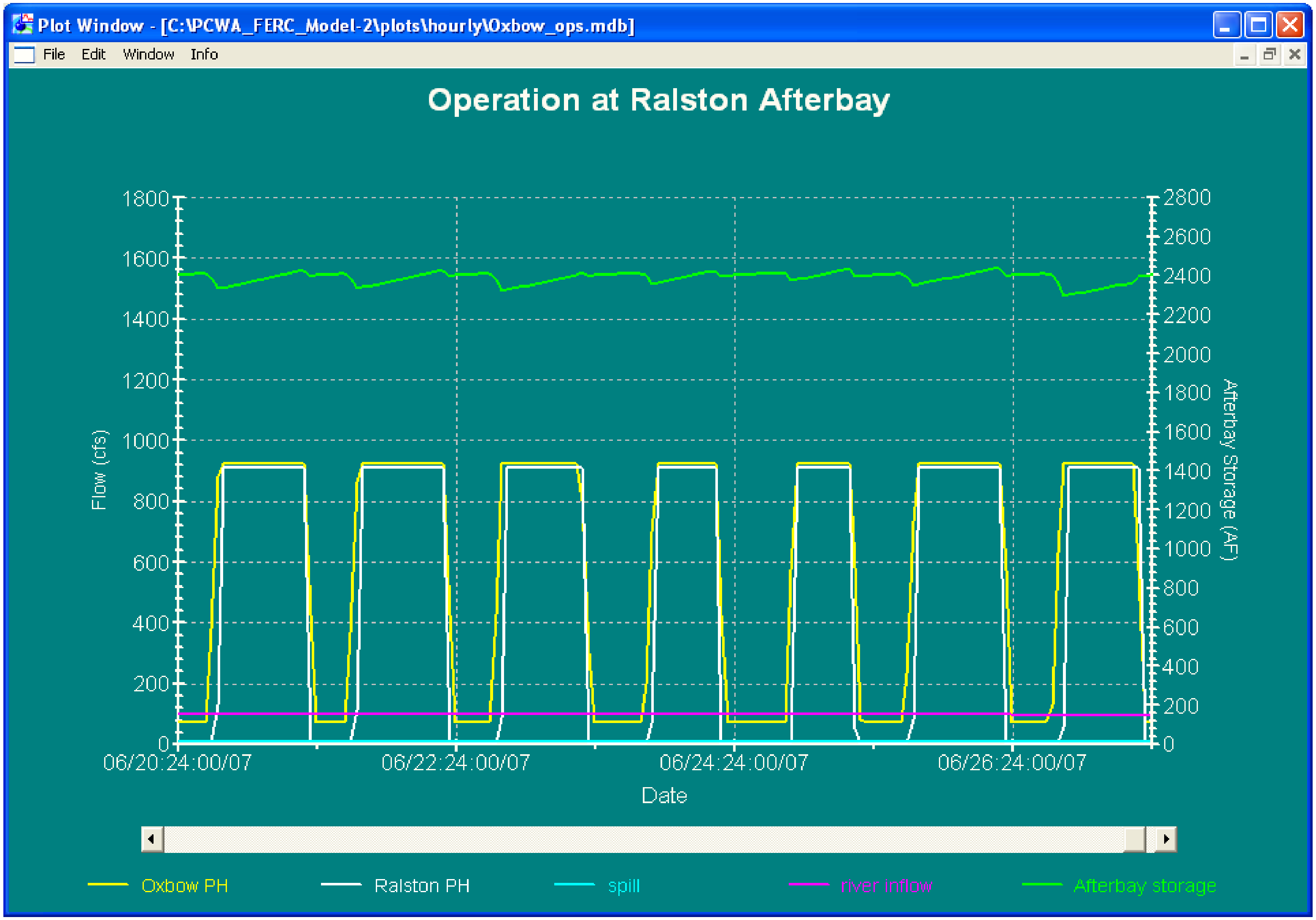
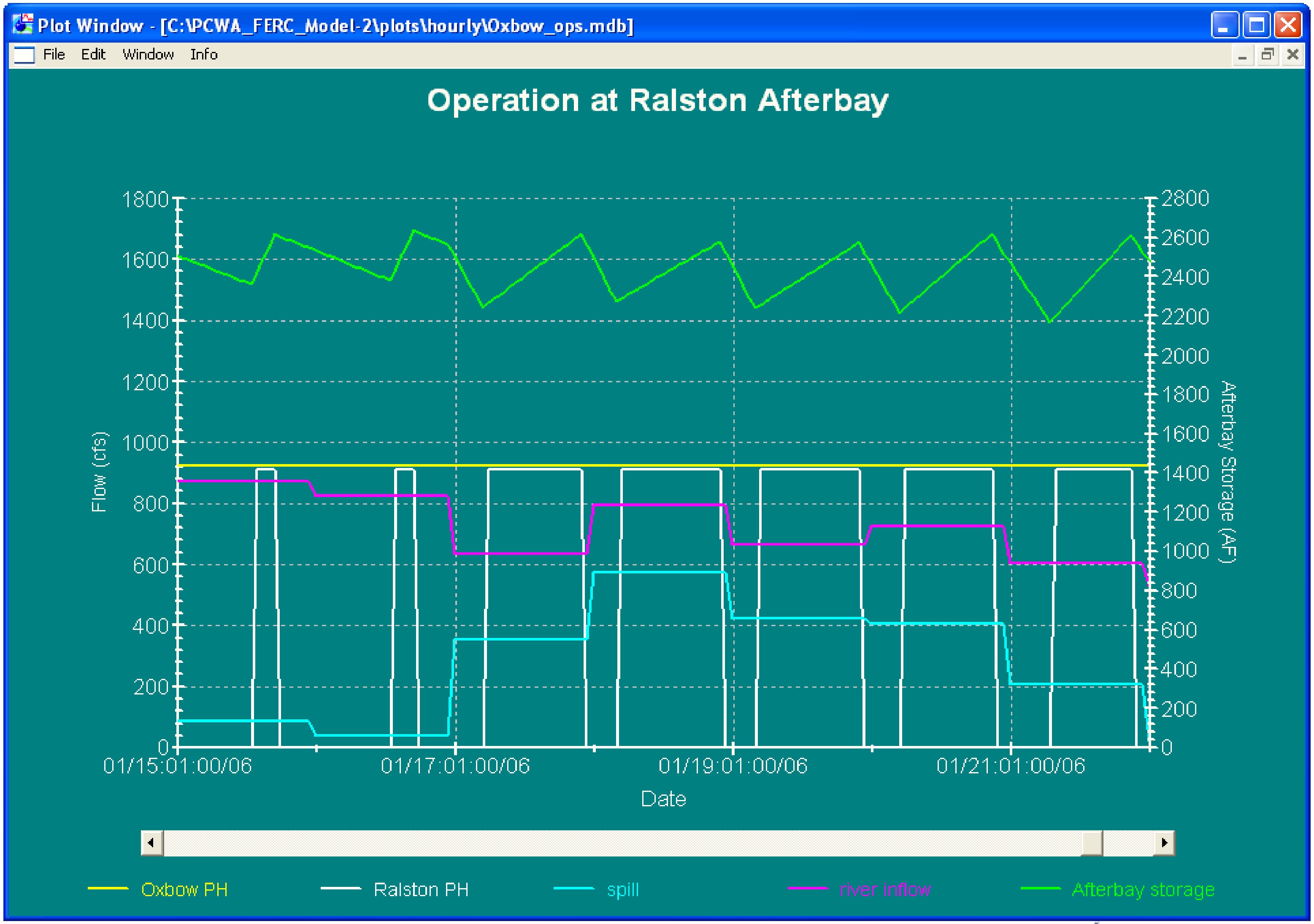
Hourly Model - Afterbay



Hourly Model - Afterbay



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Hourly Model – Travel Time

- Hourly model utilizes travel time downstream of Ralston Afterbay
- Currently travel time is constant regardless of flow
- Developing a relationship for travel time to change with flow

Hourly Model – User Options

- Hourly Model Specific Inputs include:
  - Hourly ramping rates at Oxbow PH
    - Independent up and down ramp rates
    - Feet per hour as referenced at Foresthill gage
  - Recreational flow requests
    - Start Time
    - Magnitude (cfs)
    - Duration (hours)
  - If recreational flow requests not met, need to go back to daily model to accommodate request

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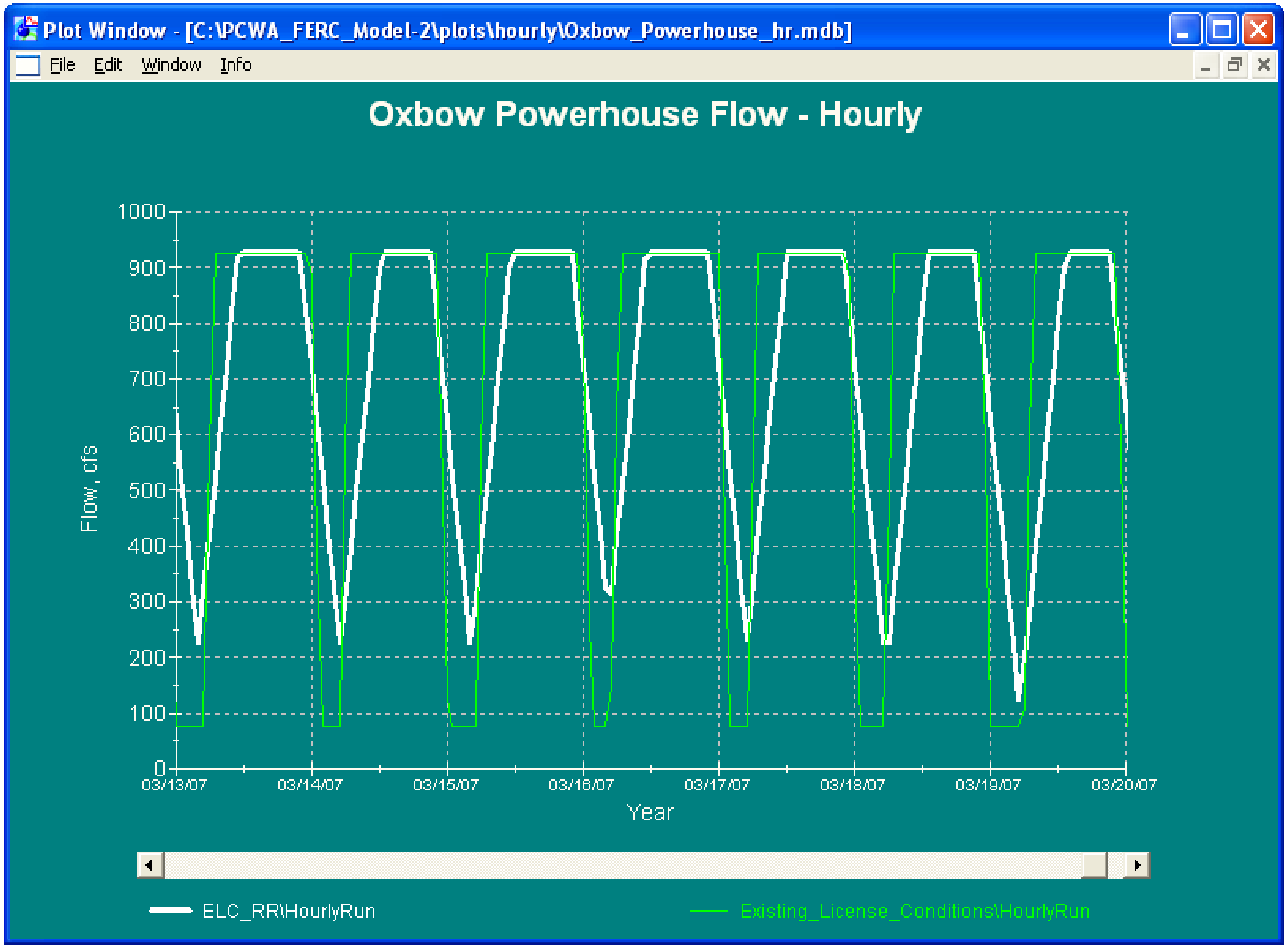
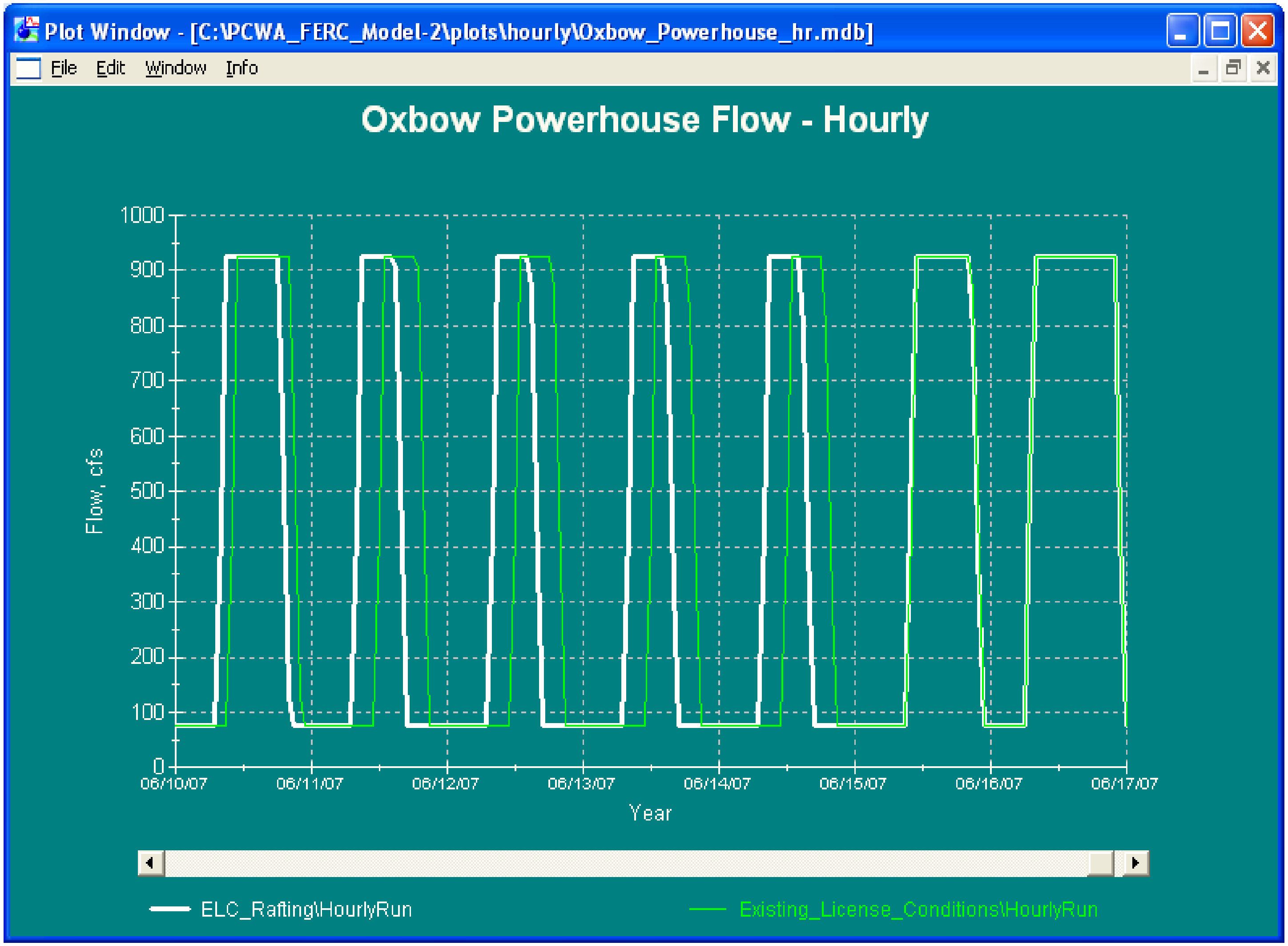
Hourly Model – Ramping Rates



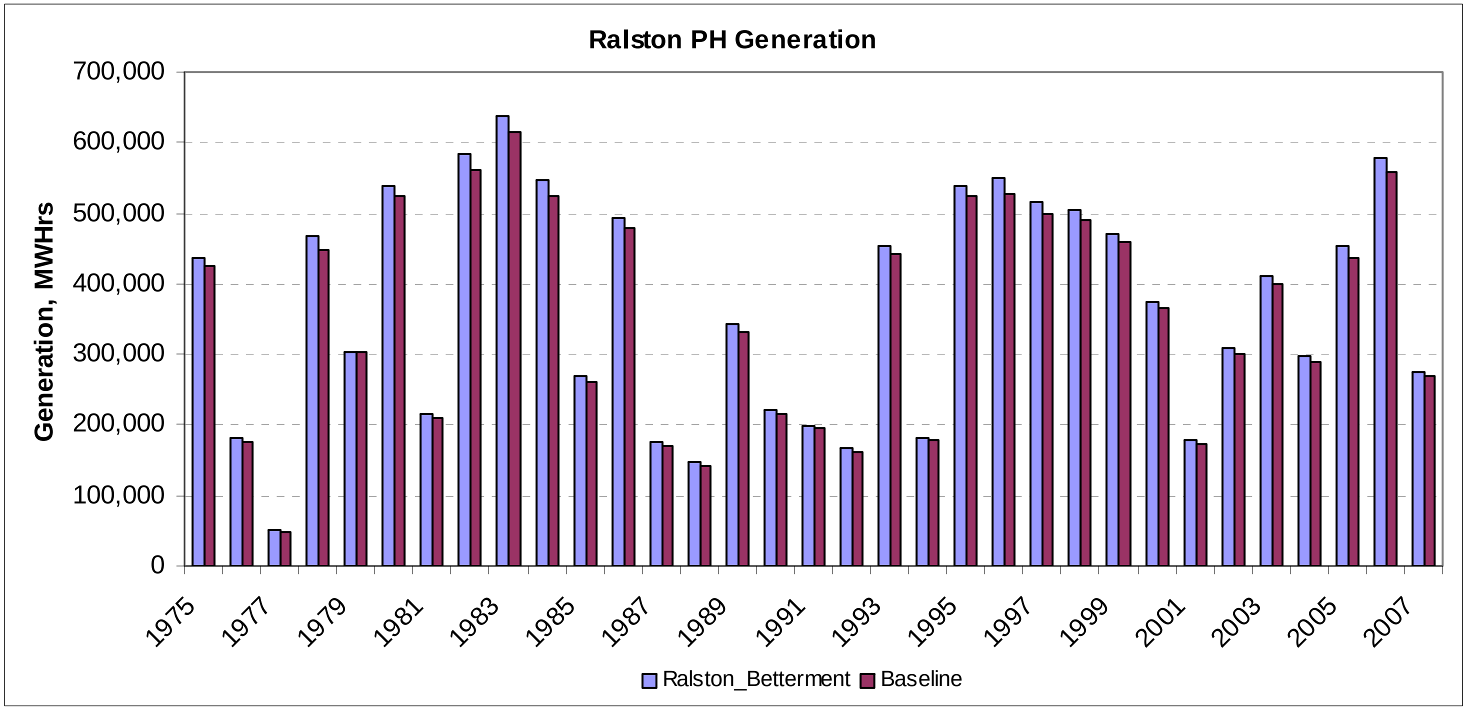
Hourly Model – Recreation Flows



Betterments Results

Betterments Results

- Ralston Powerhouse Upgrade



- Average annual generation increase:

  10.4 GWH at Ralston PH

  2.6 GWH at Middle Fork PH

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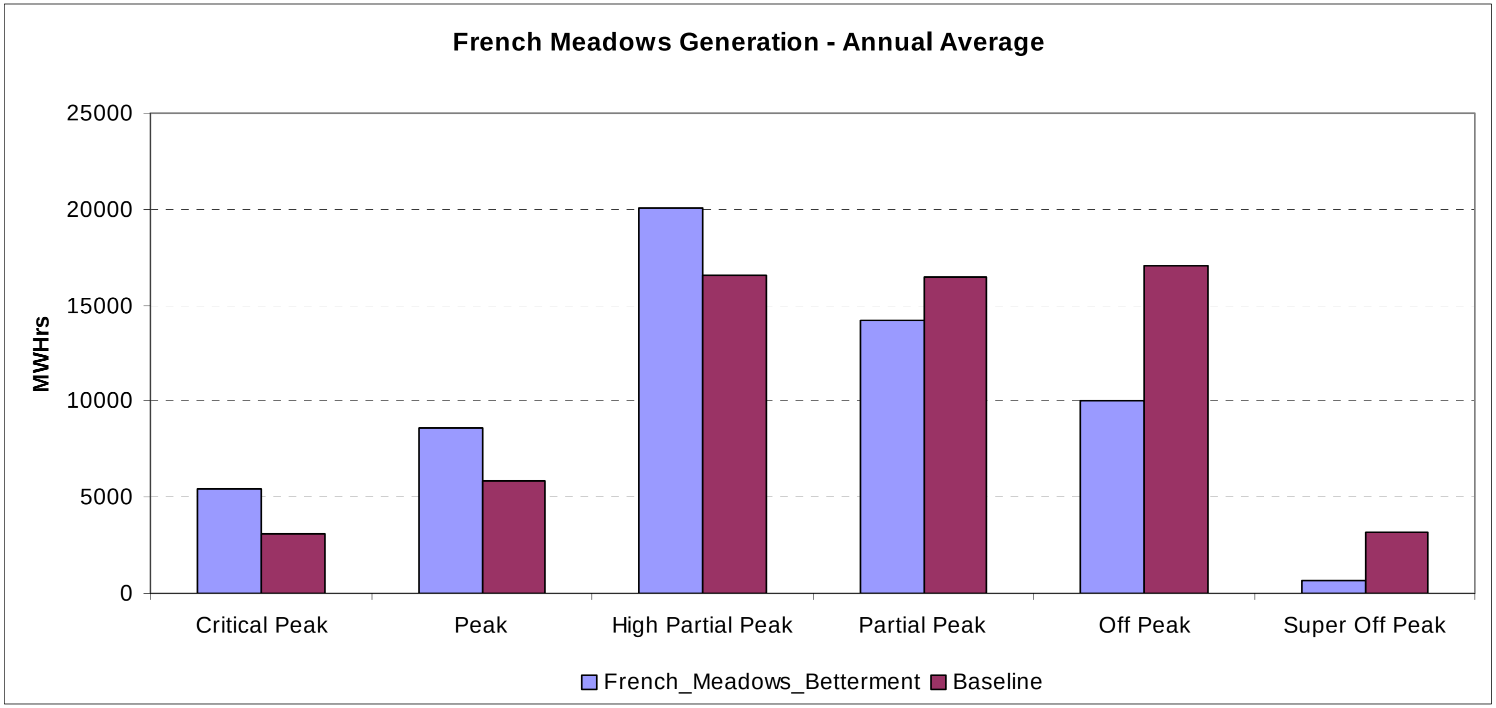
Betterments Results

- Ralston Powerhouse Upgrade
  - Increased Efficiency accounts for 8.4 GWH
  - Increased Throughput Capacity accounts for 2.0 GWH

Betterments Results

- French Meadows Powerhouse Upgrade



- Average annual increase in Peak and Critical Peak hours of 5 GWH
- Total average annual generation decrease of 3 GWH

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Betterments Results

- Hell Hole Seasonal Storage Increase:
  - Additional storage used in 21 of 33 years.
  - Average annual generation increase in those years of 6.3 GWH
  - Reduced spills in 8 of 33 years
  - No elimination of spills
  - Average annual generation increase of 4.7 GWH

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