RECLAMATION

Managing Water in the West

Yellowtail Dam & Bighorn Lake
VARQ

Billings, MT
October 9, 2008
VARQ – What is it

- A series of Revised Flood Control Rule Curves
  Designed to:
  - Reduce wintertime Reservoir drawdown compared to existing operations
  - Provides better assurance of reservoir refill in summer
  - Reduce probability of significant release reduction during spring refill season
Modeled HGH End of Month Reservoir Elevations
Low(1977), Medium(1975), High(1974) Water Years

Elevation in feet

JAN  FEB  MAR  APR  MAY  JUN

Low STDFC  Medium STDFC  High STDFC
Low VARQ  Medium VARQ  High VARQ
Differences between River Basins

• Hungry Horse Dam (South Fork Flathead River)
  – No upstream development
  – 100% Mountain drainage
  – Bob Marshall Wilderness
  – Natural Hydrograph
  – Reservoir Capacity 3.5 maf, Drainage Basin 1,640 sq mi

• Yellowtail Dam (Bighorn River)
  – Significant upstream irrigation development
  – Two large & several smaller upstream reservoirs
  – River is both Mountain and plains feed
  – Hydrograph significantly altered by upstream development
  – Reservoir Capacity 1.1 maf, Drainage Basin 19,650 sq mi
South Fork of the Flathead
South Fork of the Flathead
South Fork of the Flathead
# Bighorn Lake Inflow Percentiles

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td>203.6</td>
<td>388.8</td>
<td>740.6</td>
<td>518.4</td>
<td>1,851.6</td>
</tr>
<tr>
<td>75%</td>
<td>204.4</td>
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<td>613.3</td>
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<tr>
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Bighorn Lake Storage Reservation Curves

End of Month Values

Start of Month Values

Mar | Apr | May | June

Storage Space Reserved

0 | 0 | 0 |

90 Percentile | 75 Percentile | 50 Percentile | 25 Percentile | 10 Percentile
Bighorn Lake Storage Reservation Curves

- 90 Percentile
- 75 Percentile
- 50 Percentile
- 25 Percentile
- 10 Percentile
Rule Curve Evaluation
Three Sample Year Evaluated to Test Results

- 1973 Medium Year
- 2000 Lower Quartile Year
- 2008 Recent Year, 61 Percentile Year (120% of Medium Year)
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<tr>
<td>33% Forecast</td>
<td>138.0</td>
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<td>269.4</td>
<td>157.2</td>
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<tr>
<td>58% Forecast</td>
<td>175.8</td>
<td><strong>292.9</strong></td>
<td><strong>476.8</strong></td>
<td><strong>295.6</strong></td>
<td><strong>1,241.1</strong></td>
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</tr>
<tr>
<td>61% Actual</td>
<td>80.6</td>
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<td>595.1</td>
<td>330.7</td>
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<td>35% Forecast</td>
<td>141.5</td>
<td>219.0</td>
<td>289.6</td>
<td>170.6</td>
<td>820.7</td>
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1,000 acre-feet
Bighorn Lake 2008 Inflow

- Inflow acre-feet for April to July.
- Line chart showing:
  - 2008 Actual
  - April Forecast 35%
  - 61 Percentile Yr

RECLAMATION
Bighorn Lake Storage vs Rule Curves
2008 with 1900 cfs min Release

Storage 1,000 acre-feet

2008 Actual  Apr Forecast Rule Curve  61 Percentile Rule Curve
Discussion & Questions
GorQ – Fall/Winter River Release Rate

- Parameters for calculating Release Rate based on March 31 Reservoir Level Target of Elev. 3618.0
  - Bighorn Lake Apr-Oct Gain = 238,200 af
  - Bighorn Lake Oct 31 Storage = 1,062,900 af
  - Buffalo Bill Nov-Mar Planned Release = 350 cfs
  - Boysen Nov-Mar Planned Release = 700 cfs
  - Calculated Fall/Winter Release Rate = 2,535 cfs