Mitman, Jeffrey

From: Mitman, Jeffrey
Sent: Sunday, January 09, 2011 5:42 PM
To: Wescott, Rex
Cc: Ferrante, Fernando
Subject: RE: ~~OUO - Sensitive Information~~ -- APOB Jocassee Hydrograph

Rex, February works for me. It will be good and useful to discuss approaches and understandings. I'm not too concerned with specific values. I'm more interested in ranges of the inputs and what the modeling can tell us about the ranges of potential consequences to ONS. There is always more for me to learn and your help is appreciated.

Jeff

From: Wescott, Rex
Sent: Friday, January 07, 2011 9:14 AM
To: Mitman, Jeffrey
Subject: RE: ~~OUO - Sensitive Information~~ -- APOB Jocassee Hydrograph

I'm occupied with preparation for a hearing up to the end of January, but we should be able to get together in February. I'm sure that we'll have some different values for some inputs, discussing the methodology should be beneficial.

From: Mitman, Jeffrey
Sent: Thursday, January 06, 2011 6:15 PM
To: Wescott, Rex
Cc: Ferrante, Fernando
Subject: RE: ~~OUO - Sensitive Information~~ -- APOB Jocassee Hydrograph

Rex, when you have time I would like to compare methods and results.

Thanks.

Jeff

From: Wescott, Rex
Sent: Thursday, January 06, 2011 8:53 AM
To: Mitman, Jeffrey; Coleman, Neil; Rogers, Walt
Cc: Khanna, Meena; Wilson, George; Rodriguez, Veronica; Ferrante, Fernando
Subject: RE: ~~OUO - Sensitive Information~~ -- APOB Jocassee Hydrograph

Jeff,

Thanks, I was playing some of the same games with the LAW Engineering Jocassee PMF early on using the HEC-1 computer program when I was evaluating the effects of a larger CN value as suggested by Ken See. I also looked at different assumptions of turbine inoperability. I'll have to get all my runs together and compare notes with you and Fernando. I think that there are lots of insights to be gained, especially if we could get a better handle on extreme storm probability, particularly the PMF and fractions of the PMF.

Rex

From: Mitman, Jeffrey
Sent: Wednesday, January 05, 2011 5:23 PM
To: Coleman, Neil; Wescott, Rex; Rogers, Walt

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Cc: Khanna, Meena; Wilson, George; Rodriguez, Veronica; Ferrante, Fernando
Subject: ~~OUO - Sensitive Information~~ -- APOB Jocassee Hydrograph

All, before the break we discussed the calculations that Fernando and I put together in Matlab and Excel. The Excel spreadsheet is attached for your consideration. The Matlab and Excel analyses are consistent. The Matlab results are not included as there is no way to allow user manipulation without a copy of Matlab.

The first Excel tab shows the hydrograph. The current spreadsheet values should mimic the "Law" hydrograph (from Jocassee Dam Hydrologic Analysis by Law Environmental, dated January 1991 as updated through 6/16/2009). It can easily be tweaked to show different scenarios by changing the cells highlighted in red. These red cells are setup to allow different what-if analysis. For example if one turbo-generator is unavailable, change the value labeled "Turbine-Generators Available" from 4 to 3. The 72 hours PMF has been subdivided into 4340 time-steps, each of about 1 minute. Therefore, once a change is made, the spreadsheet will take a second or two to recalculate and display the new results.

The second tab shows the various curves that were derived to represent reservoir and spillway characteristics.

<u>The bottom line is: These tools allow us to explore what conditions would cause Jocassee Reservoir level to exceed 1110 ft. msl.</u>

A couple of points.

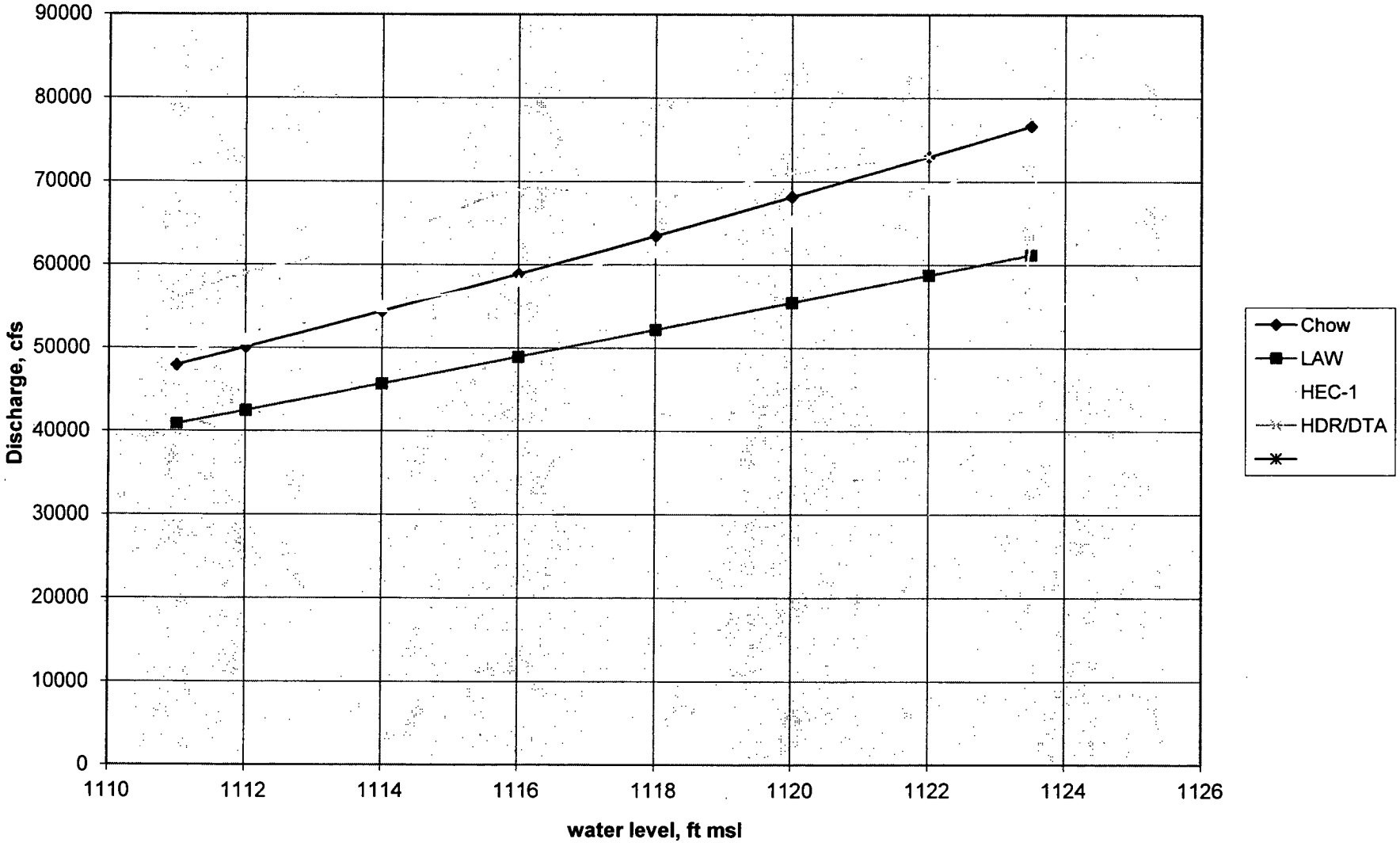
1. The PMP inflow values are taken directly from the "Law" analysis. If there are problems with the PMP inflow they come from "Law" and I have no capability of calculating the inflow. However, the spreadsheet does allow "what-ifs" on fractions of the PMP including those greater than the PMP. To try a storm of "half" the PMP change the cell labeled "Fraction of PMF by Total Volume" from 1 to 0.5. This multiplies the inflow at every time step by 0.5. Its effect is to decrease the <u>total</u> inflow by 50%.
2. All of the parameters for spillway capacity, generator capacity, reservoir volume by reservoir height, etc. are taken directly from various Duke supplied reports including the "Law" analysis and the 1-D results supplied in ~March 2009.
3. I've added the capability to what-if a failure of one or both of the spillways to open. There are spreadsheet switches to model these scenarios. Under these conditions I've assumed that each unopened spillway will overtop when level exceeds 1110 ft. msl as that is the physical top of the spillway. The flow across the top of an unopened spillway is a swag on my part, I've assumed the flow would mimic an opened spillway with a bottom elevation of 1110. It's not accurate, it's probably non-conservative (i.e., it gives too much credit) but it should be reasonably close and much better than assuming the unopened spillway passes no flow.
4. I've differentiated between "early" and "late" turbine-generator flow to allow exploration of the possibility that the TGs might be available early but then fail late potentially due to the unavailability of the switchyard due to the very large storm. The initial condition of the spreadsheet has the TGs available both early and late. If you want to see the impact of TGs unavailable late simply change the "Total Late Generator Flow" to zero (or any other value you may want to explore). The cutoff time between early and late was arbitrarily set at 1900 minutes based on my judgment that they might fail when the storm inflows become substantial which I picked off the PMP graph at a time when the PMP inflows exceeded the TG capacity. This is arbitrary but I don't believe that the choice of time would substantially change the results. If you want to pick a different time, a small change to the spreadsheet would allow additional analysis. (There currently is no spreadsheet "switch" to allow this change.)
5. I've added the capability to explore both "30" and "38" foot wide spillways. The base analysis was performed with a 30 foot spillway. If a 38 foot spillway is used, the results change moderately. I'm not convinced that 38 ft. spillways is appropriate (or inappropriate) because Duke has not provided a bases for the wider value. Likewise, the spillways analysis does not take into consideration that there is a bridge across the top of the spillways starting at ~1123.5 ft. A more accurate calculation would take this bridge into account and change the flow from a "weir" model to an "orifice" model at high reservoir levels. Ignoring the bridge is somewhat non-conservative by increasing the spillway capacity if the level should approach the top of the spillway.

6. Finally, this model is not in any way accurate if level goes over the top of dam. No attempt was made to model flow across the top of the dam. The only thing this model will tell you in this case is that level has exceed 1125 ft. msl.

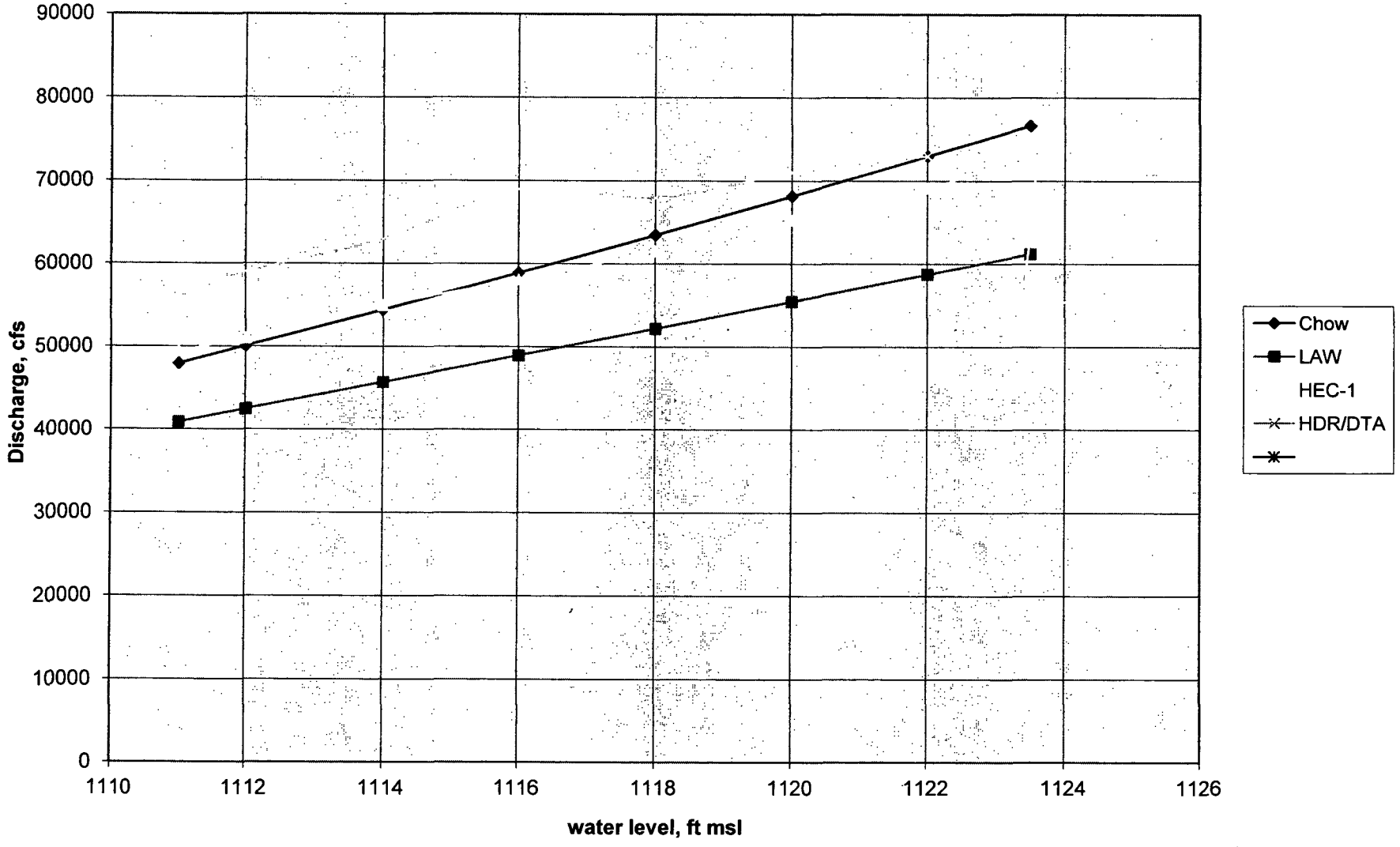
If you have questions or comments, please let me know.

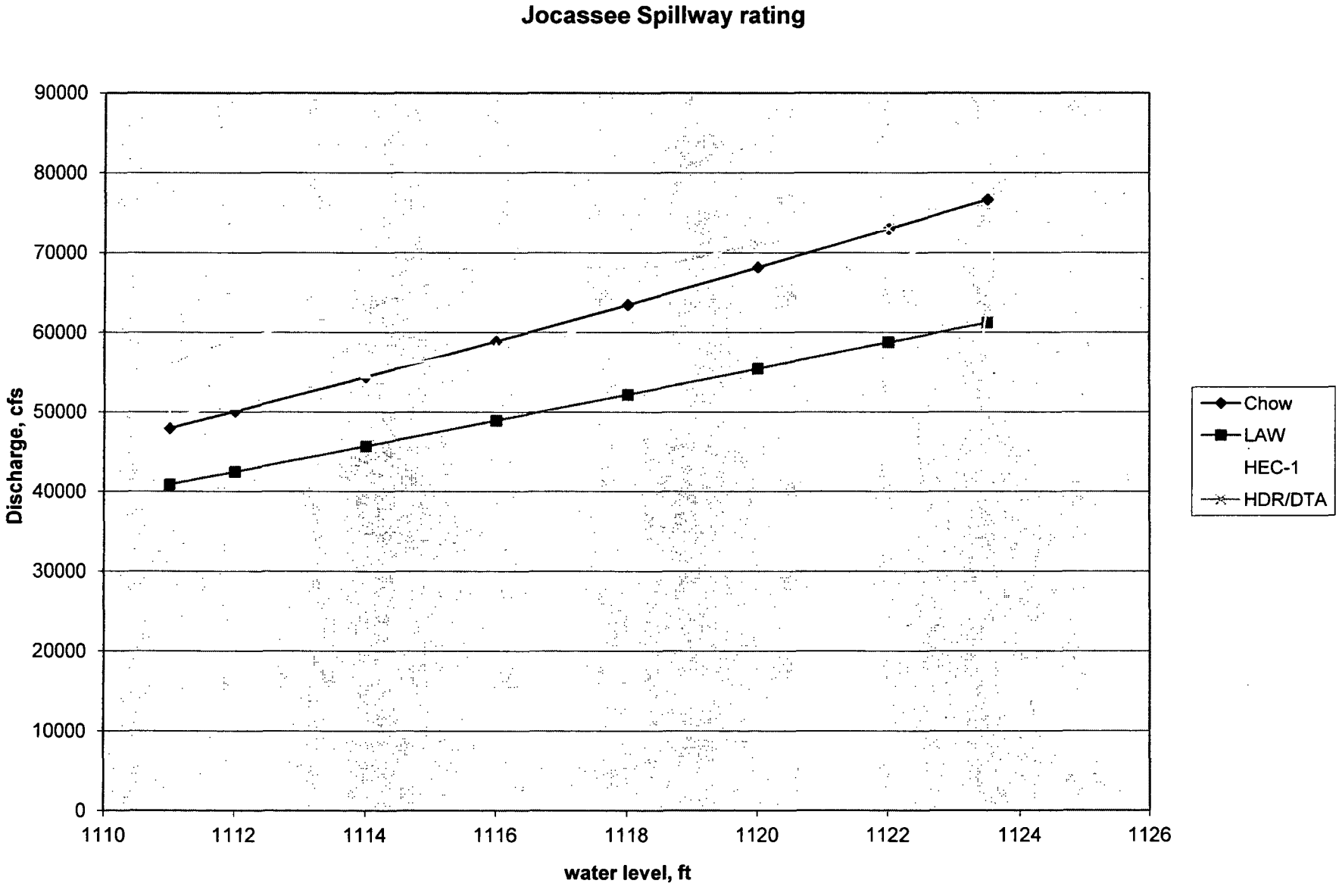
Jeff

Jocassee Spillway Rating



Jocassee Spillway Rating




Jocassee Spillway rating
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Discharge, cfs
1110
1112
1114
1116
1118
1120
1122
1124
1126
water level, ft
Chow
LAW
HEC-1
HDR/DTA

elev	Chow	LAW	HEC-1	HDR/DTA
1111	47937	40,875	49,484	56,000
1112	50,068	42,474	51,020	59,000
1114	54,420	45,696	54,987	63,000
1116	58,891	48,939	58,088	69,000
1118	63,479	52,201	61,545	68,000
1120	68,180	55,475	65,274	71,000
1122	72,992	58,759	69,140	73,000
1123.5	76,671	61,222	71,503	
1123.51			55,663	
1125			58,453	

LAW and I HDR/DTA