Glen Canyon Dam Adaptive Management Work Group
Agenda Item Information
March 2-3, 2006

Agenda Item
Basin Hydrology

Action Requested
√ Information item only; we will answer questions but no action is requested.
□ Feedback requested from AMWG members.
□ Motion requested: motion language as follows:

Presenters
Tom Ryan, Regional Hydrologist, Upper Colorado Region, Bureau of Reclamation

Previous Action Taken
□ By AMWG:
□ By TWG:
□ By an Ad Hoc Group:
□ Other:

Relevant Science
□ There has been no relevant research or monitoring on this subject.
□ The following describes the relevant research or monitoring on this subject:

Background Information
□ I have attached the background information to be included in the AMWG packet that is distributed 30 days before the meeting, and posted on the website.

√ I will bring detailed handouts to the meeting, plus a digital file of those handouts for posting on the website. In lieu of handouts to be included in the agenda packet, the following is a synopsis or outline of my presentation:

The presentation is intended to provide pertinent information to AMWG members on the hydrology of the Upper Colorado River Basin and projected reservoir operations at Lake Powell/Glen Canyon Dam. Such information is provided to assist the AMWG in developing recommendations to the Secretary on the operation of Glen Canyon Dam, particularly when such recommendations are "near-term" in nature.

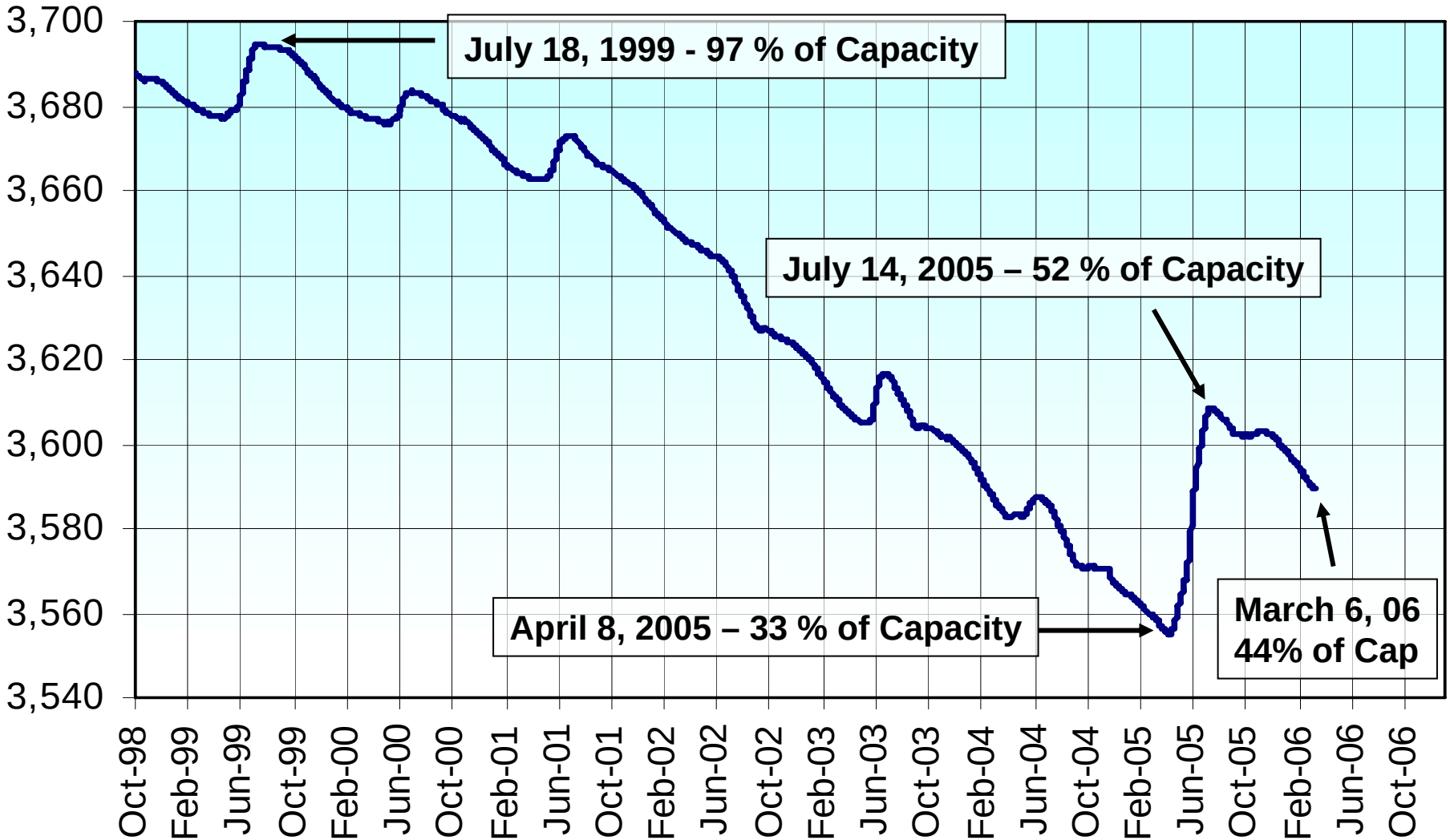
The presentation will cover snowmelt projected runoff for 2006, reservoir storage conditions in the Upper Colorado River and Basin, and drought status. The presentation will discuss the projected operation of Glen Canyon Dam in 2006 under three inflow scenarios: most probable, maximum probable (wet scenario) and minimum probable (dry scenario). The presentation will also discuss the probability of equalization releases (releases greater than 8.23 million acre-feet) from Lake Powell in 2006 and 2007.

RECLAMATION
Managing Water in the West

Upper Basin Hydrology And Glen Canyon Dam Operations

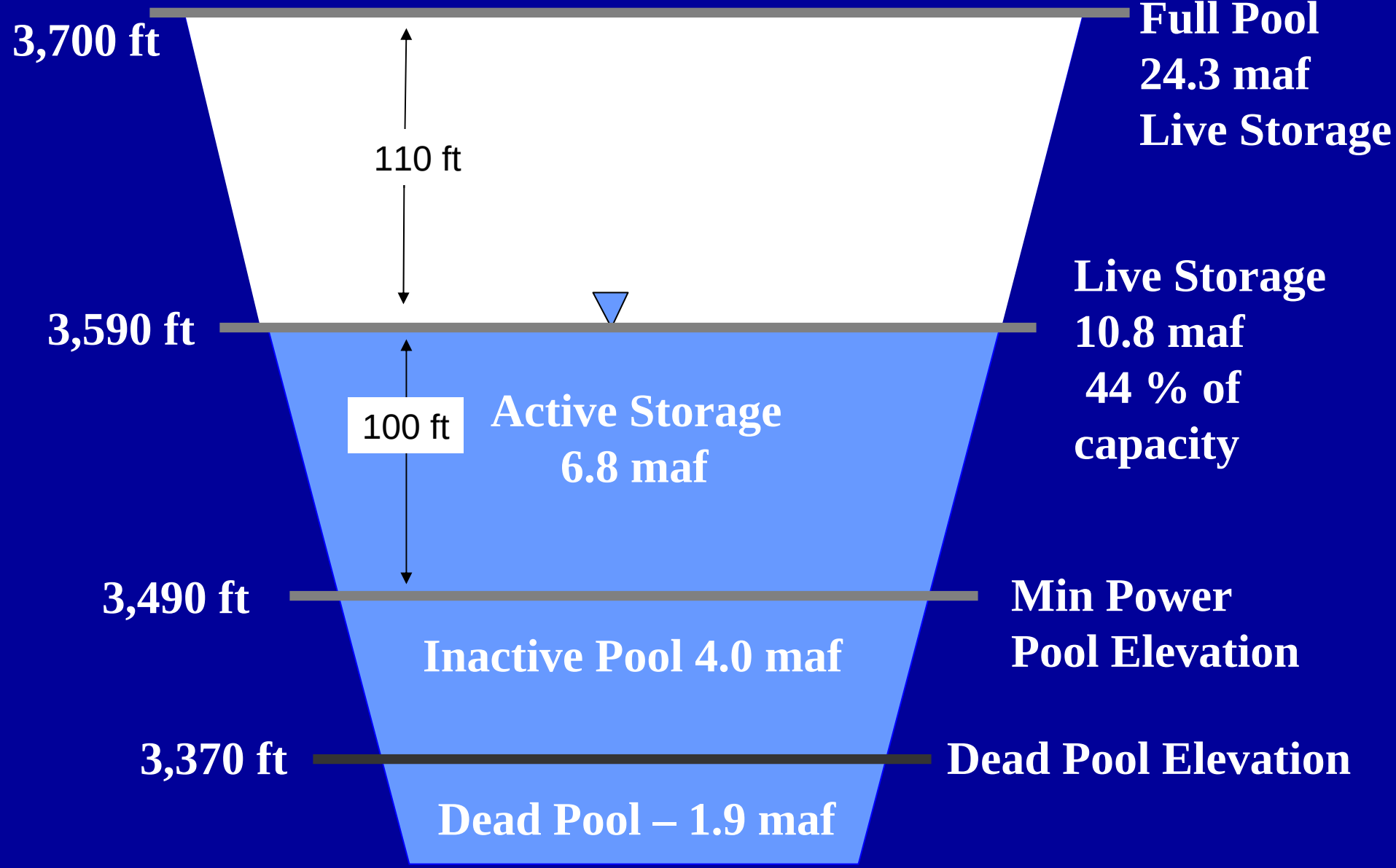
Adaptive Management Work Group Meeting
March 8, 2006
Phoenix, Arizona

Lake Powell Water Surface Elevations
October 1998 through March 6, 2006



RECLAMATION

Lake Powell Capacity

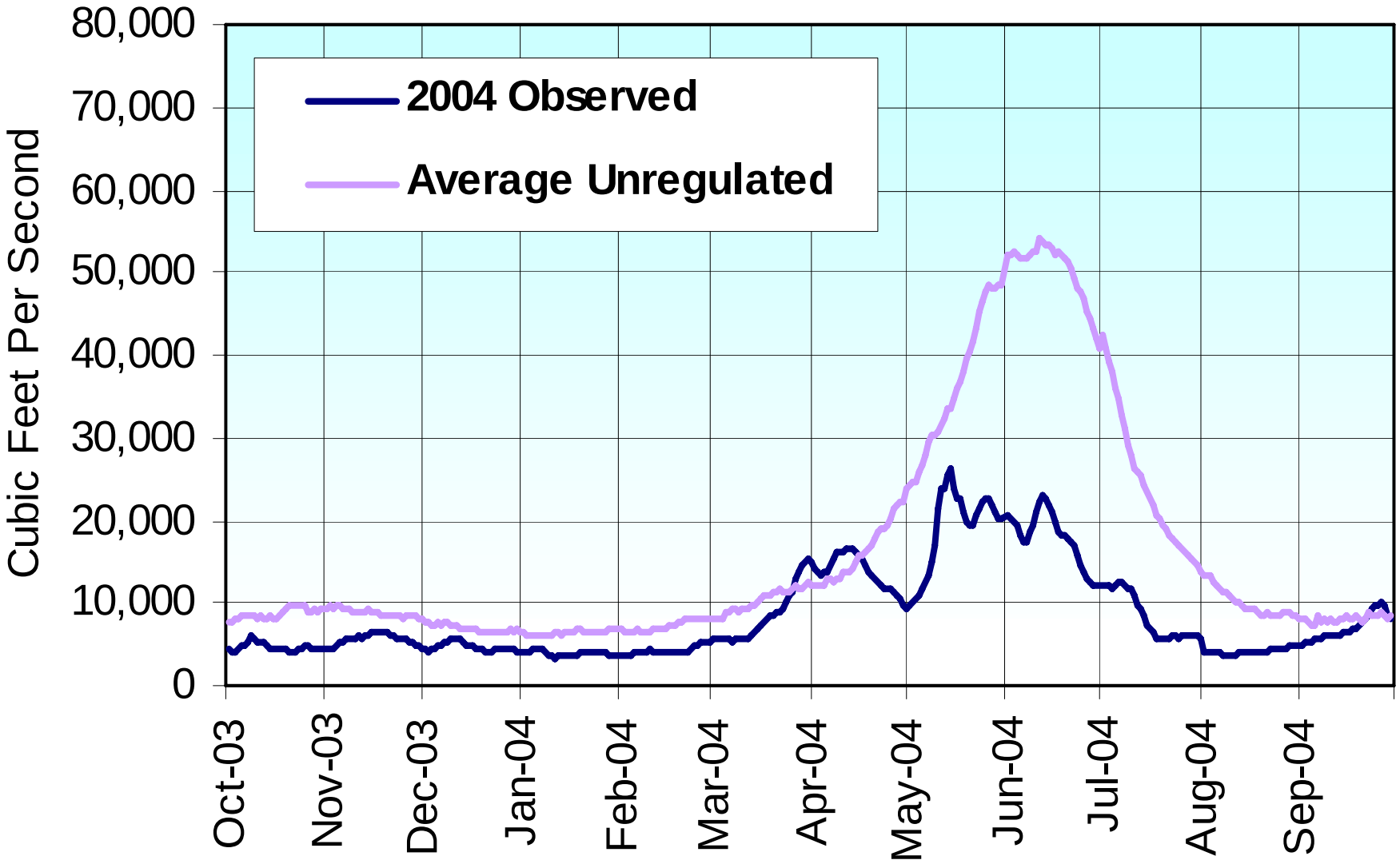


Not to scale

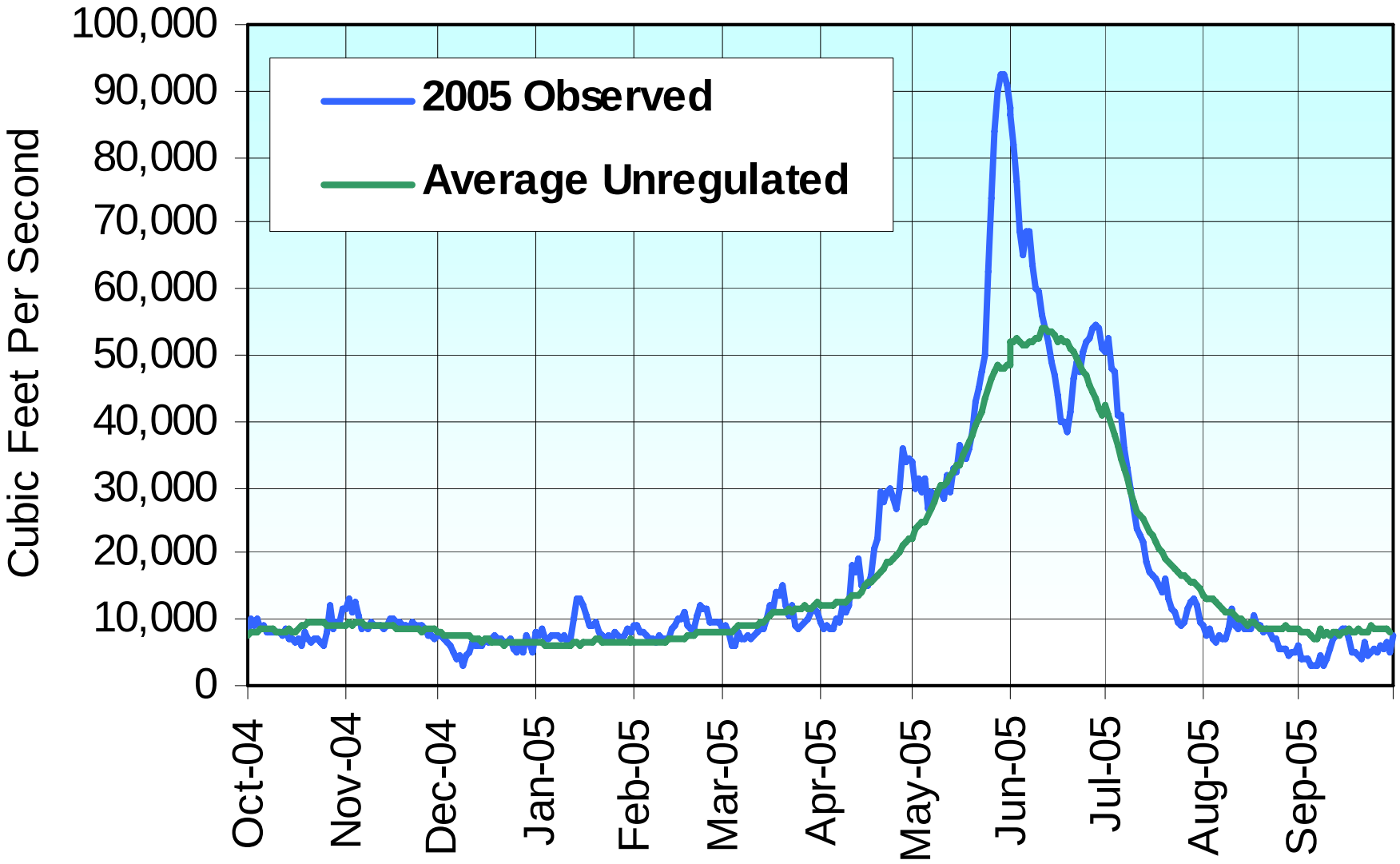
March 6, 2005

RECLAMATION

Lake Powell Unregulated Inflow
Water year 2004

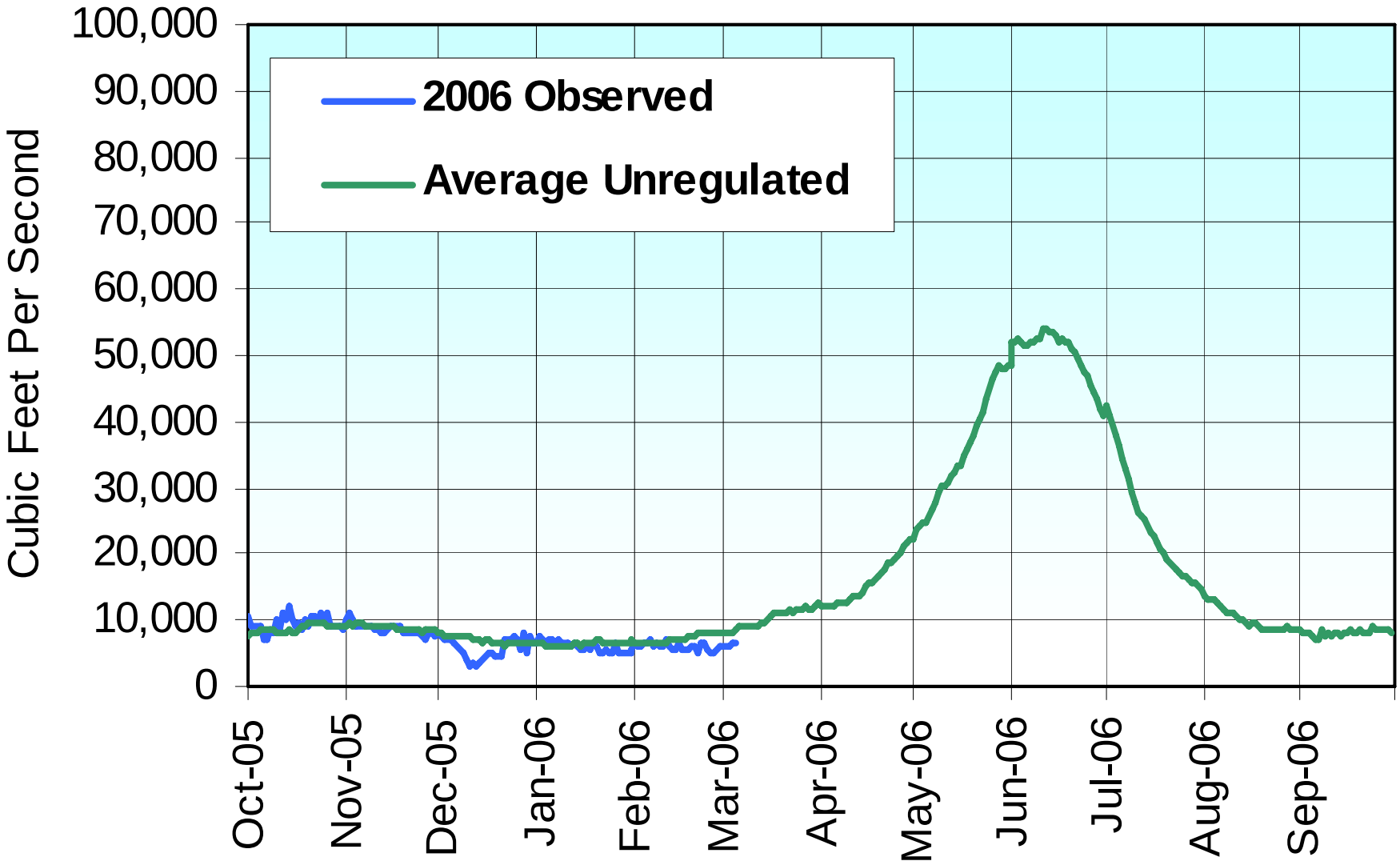


Lake Powell Unregulated Inflow
Water year 2005



RECLAMATION

Lake Powell Unregulated Inflow
Water year 2006

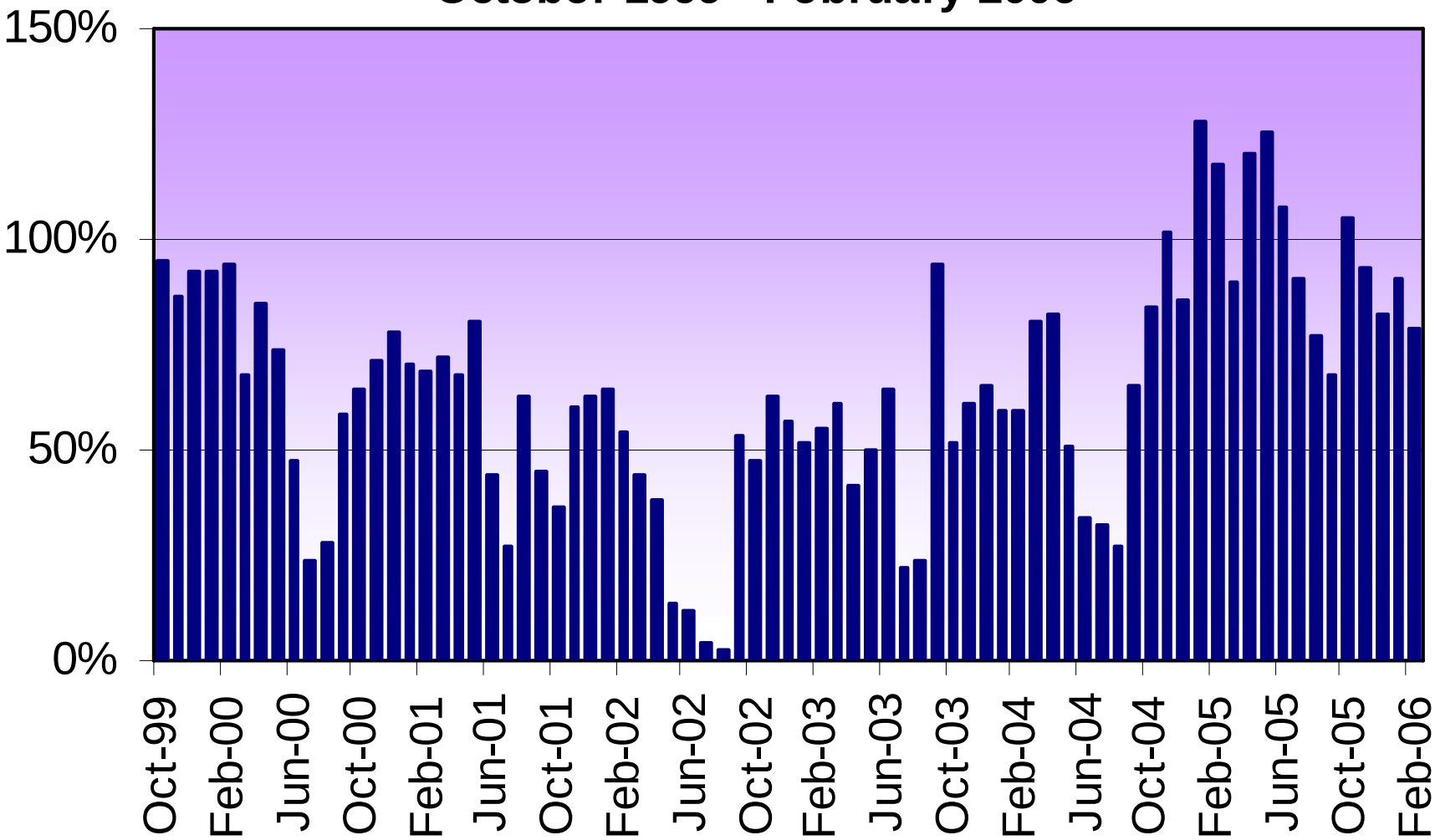


RECLAMATION

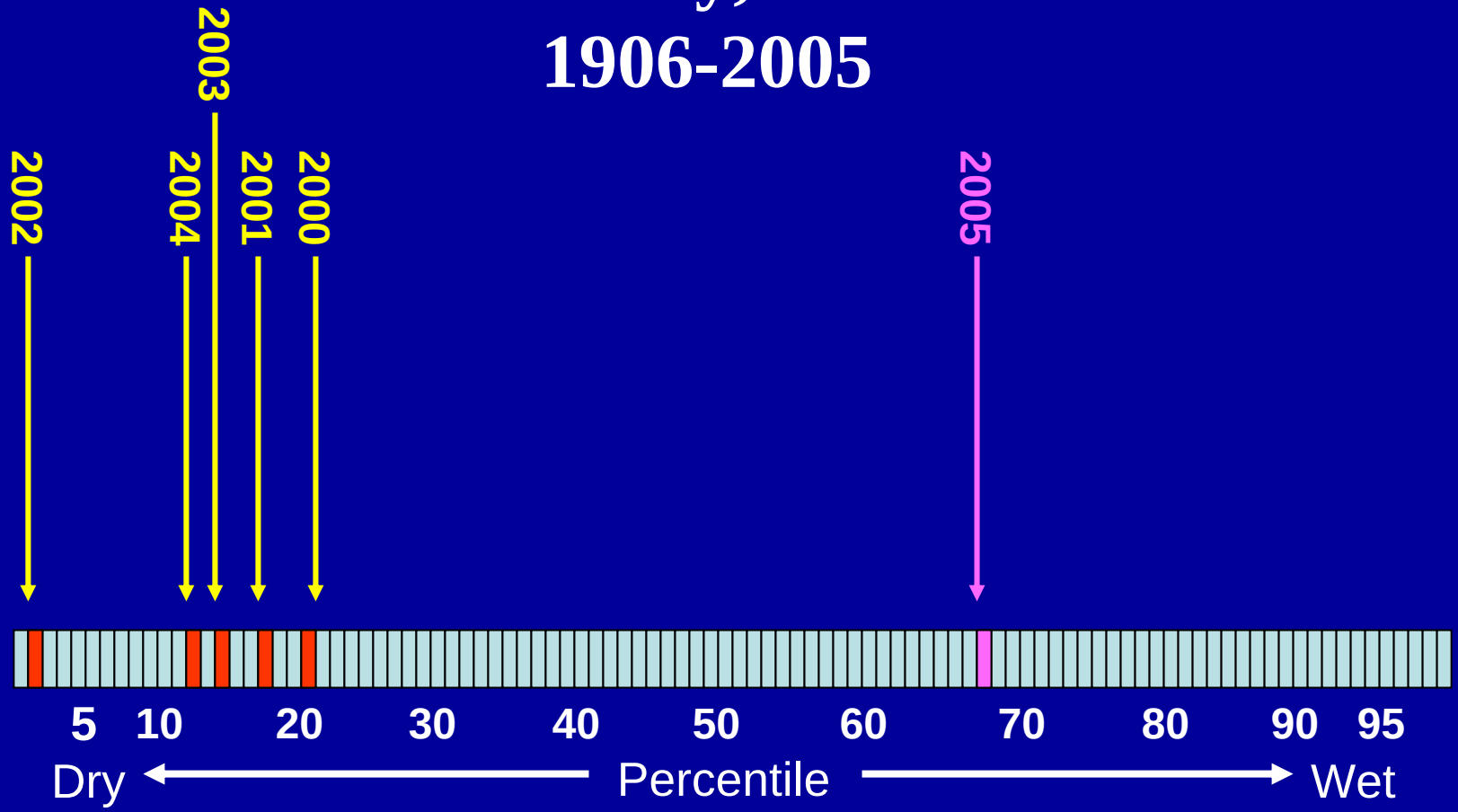
The Drought

RECLAMATION

Unregulated Inflow to Lake Powell as a Percentage of Average October 1999 - February 2006



100 Years of Natural Flow
Lees Ferry, Arizona
1906-2005



Note: 2004 and 2005 are estimated values

RECLAMATION

Lowest Consecutive Years of Natural Flow Lees Ferry, Arizona (average is 15.1 maf)

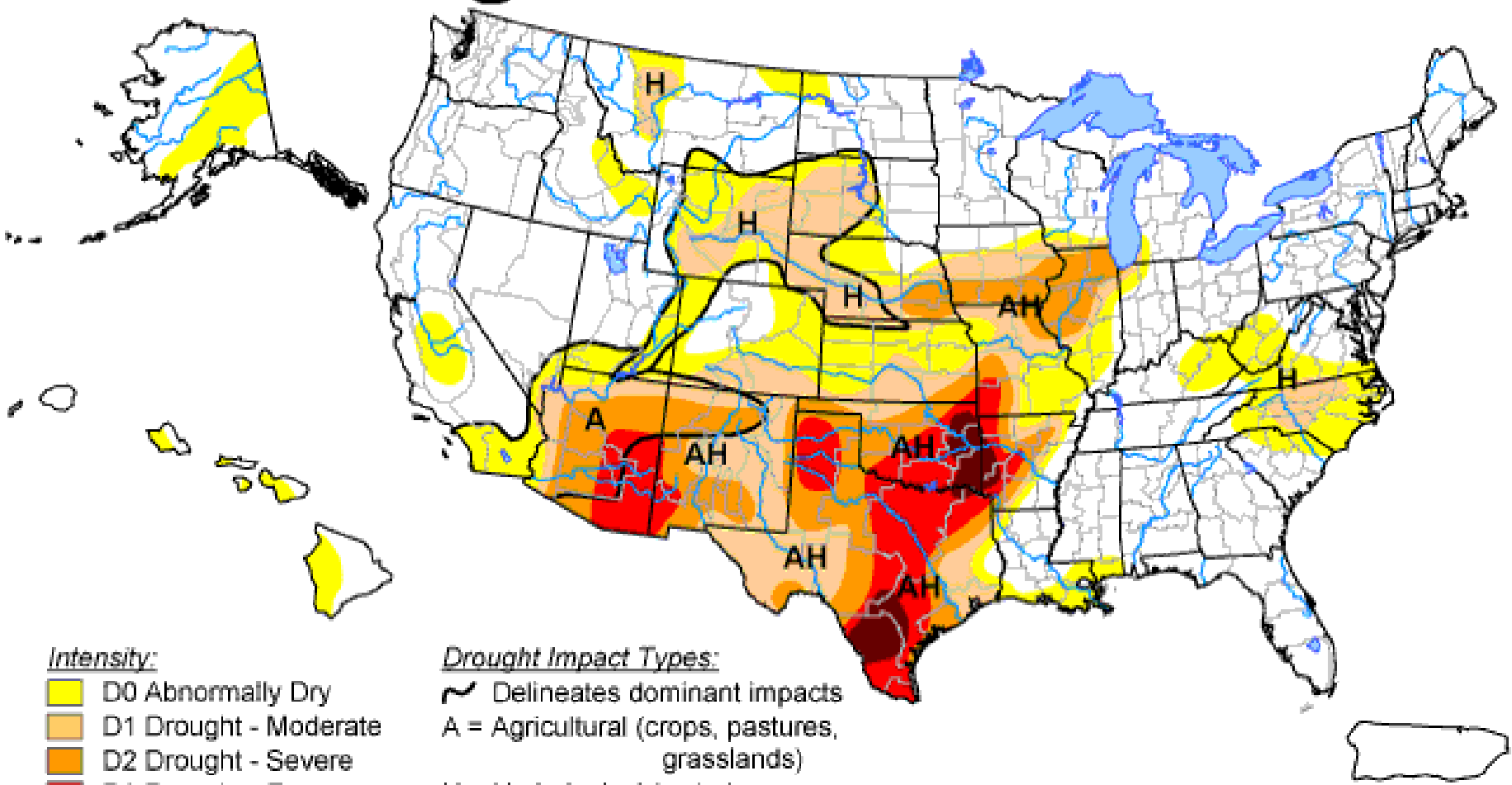
1906-2005

Consecutive Years	Driest Period (Natural flow)
2	2002-2003 (8.2 maf)
3	2002-2004 (8.8 maf)
4	2001-2004 (9.4 maf)
5	2000-2004 (9.7 maf)
6	1999-2004 (10.9 maf)
7	1998-2004 (11.8 maf)
8	1954-1961 (12.1 maf)*

* With a below average year in 2006, this could be replaced by 1999-2006

U.S. Drought Monitor

February 28, 2006
Valid 7 a.m. EST



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

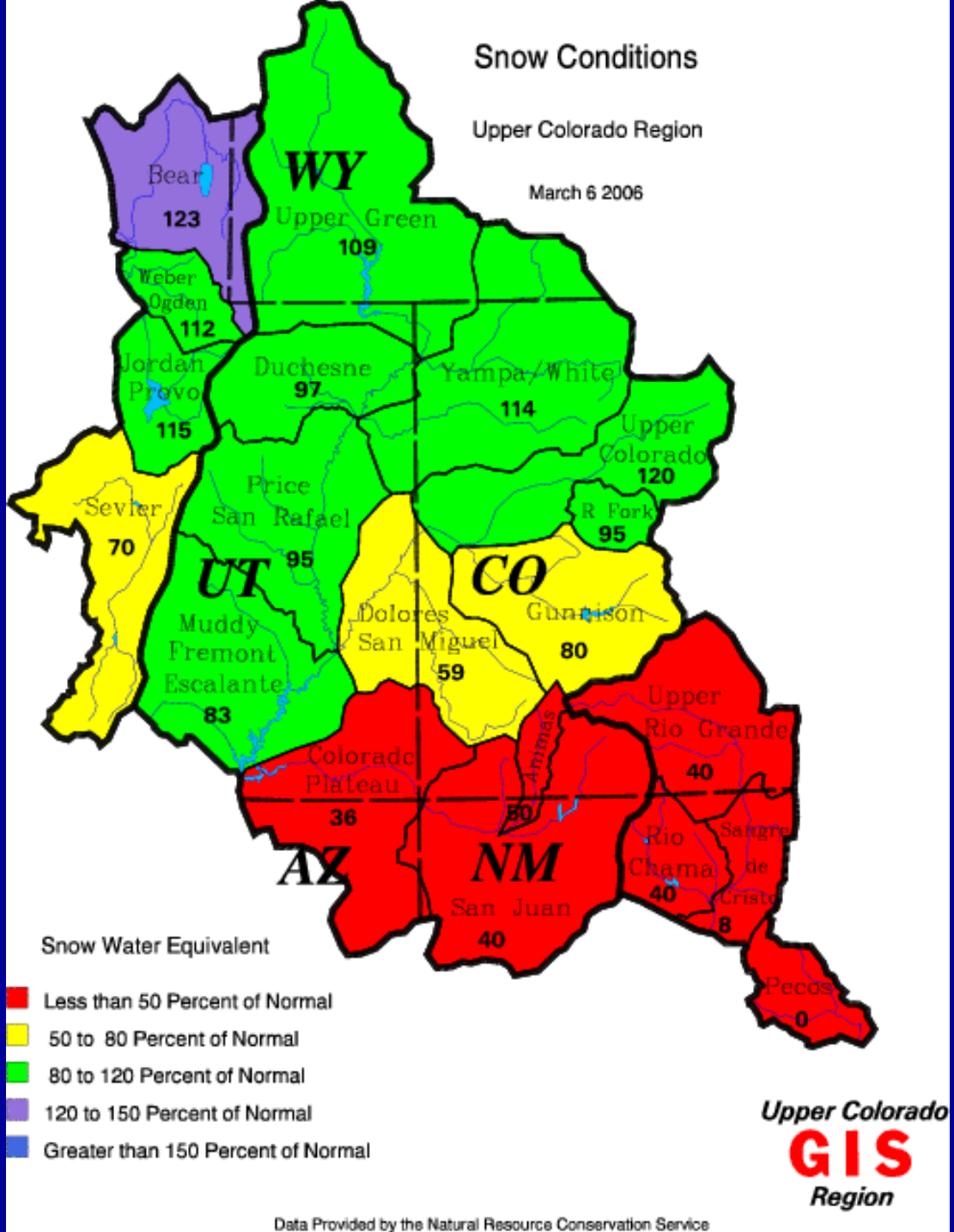
Drought Impact Types:
- Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, March 2, 2006

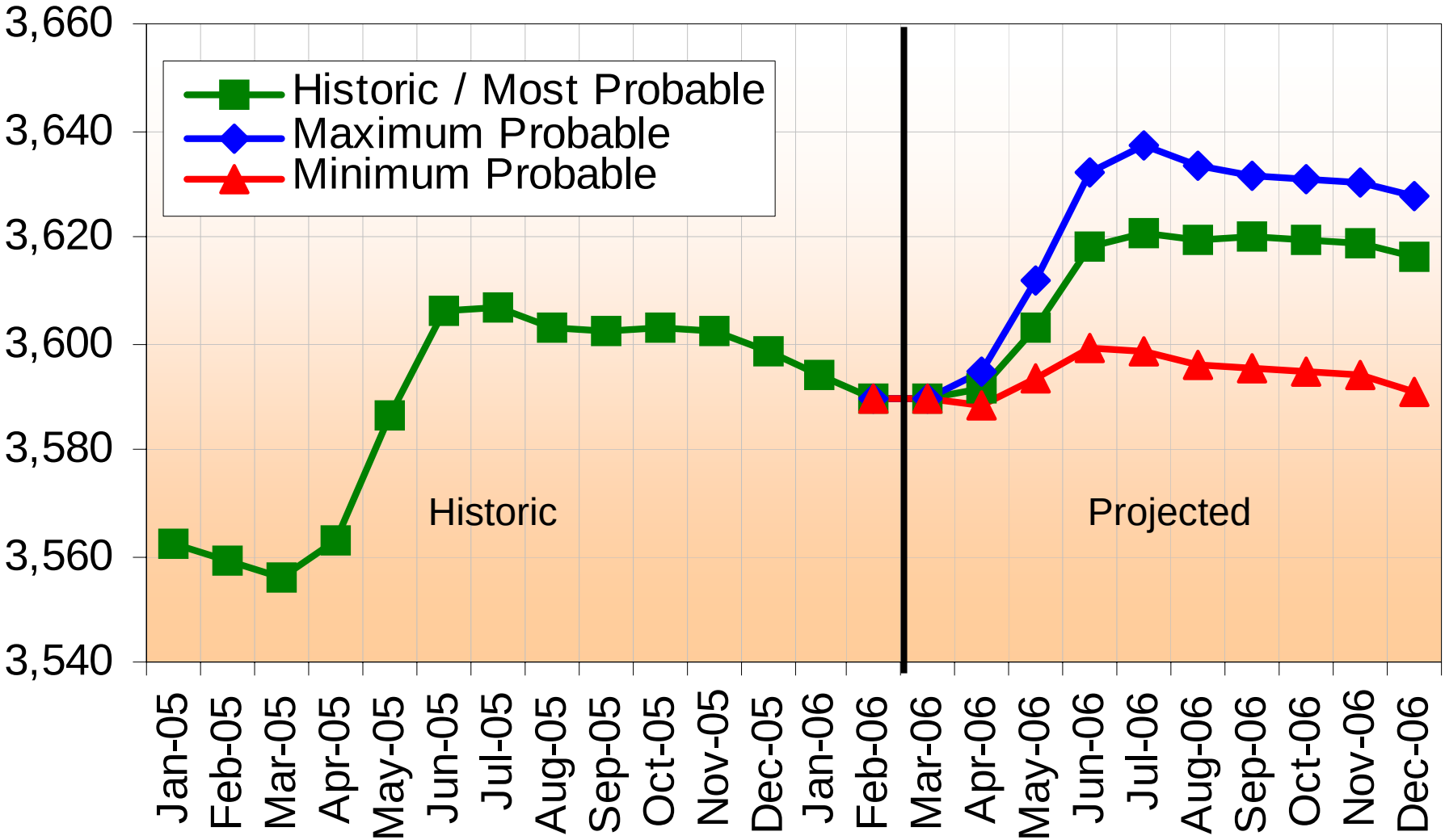
Author: Brian Fuchs, National Drought Mitigation Center



Basinwide Snowpack in the Upper Colorado River Basin Is Currently 90 % of Average (March 6, 2006)

RECLAMATION

Lake Powell End of Month Elevation (Feet)
Based on March 2006 Inflow Projections



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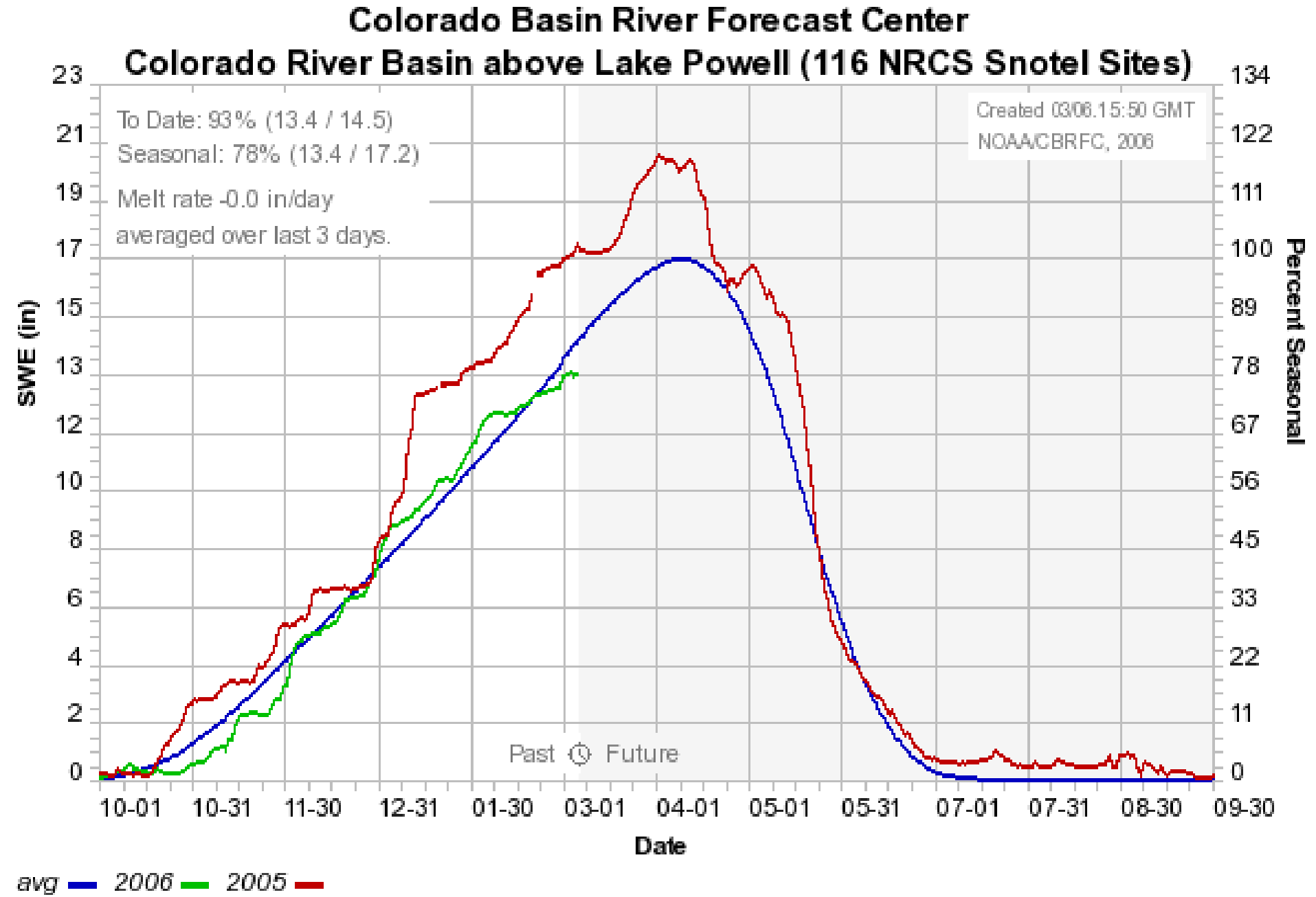
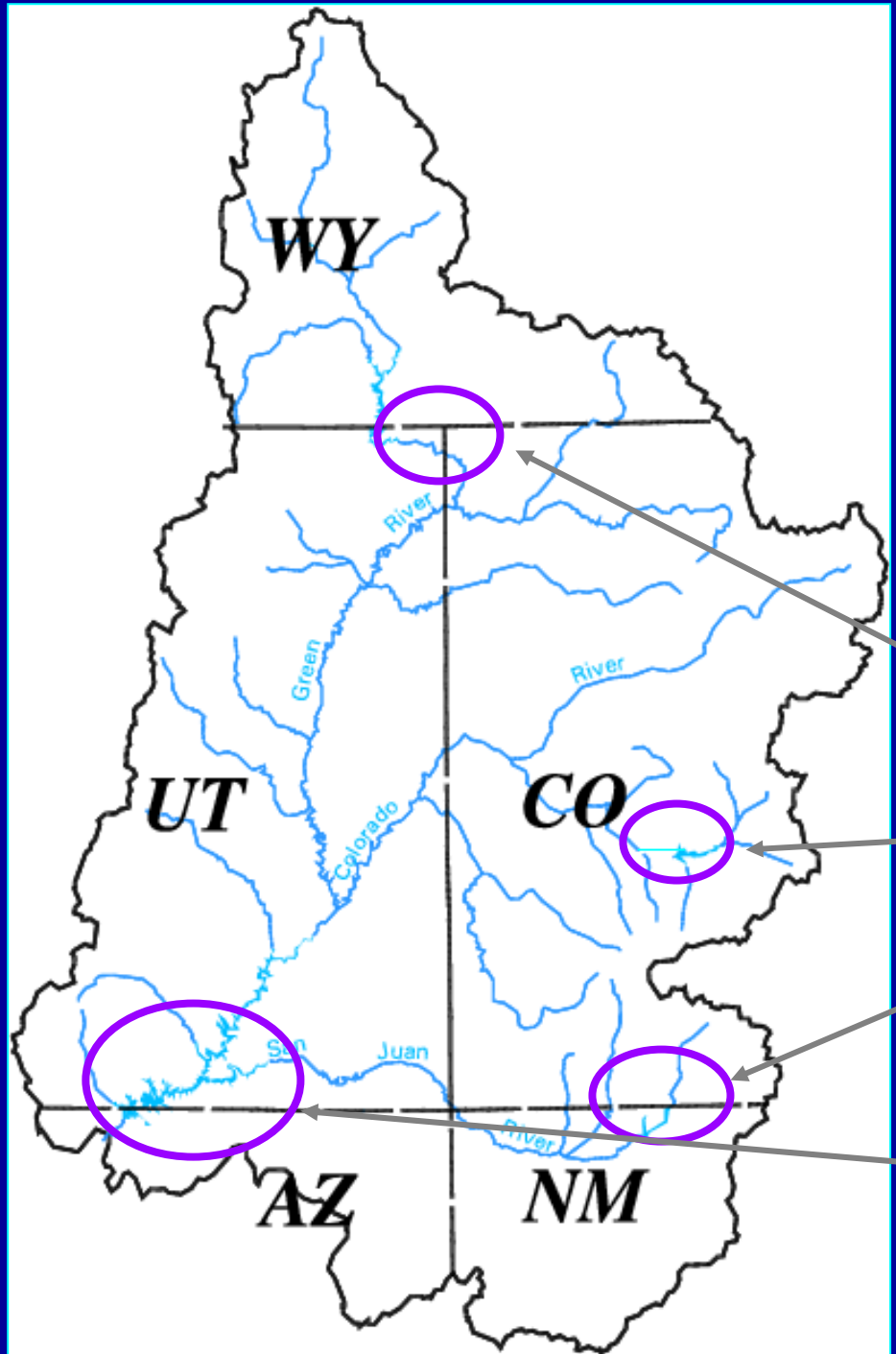

Colorado Basin River Forecast Center
Colorado River Basin above Lake Powell (116 NRCS Snotel Sites)
To Date: 93% (13.4 / 14.5)
Seasonal: 78% (13.4 / 17.2)
Melt rate -0.0 in/day
averaged over last 3 days.
Created 03/06.15:50 GMT
NOAA/CBRFC, 2006
SWE (in)
Percent Seasonal
Past
Future
Date
10-01
10-31
11-30
12-31
01-30
03-01
04-01
05-01
05-31
07-01
07-31
08-30
09-30
avg
2006
2005



Forecasted April–July Unregulated Inflow

(March 2006 Forecasts)

Flaming Gorge – 105 %

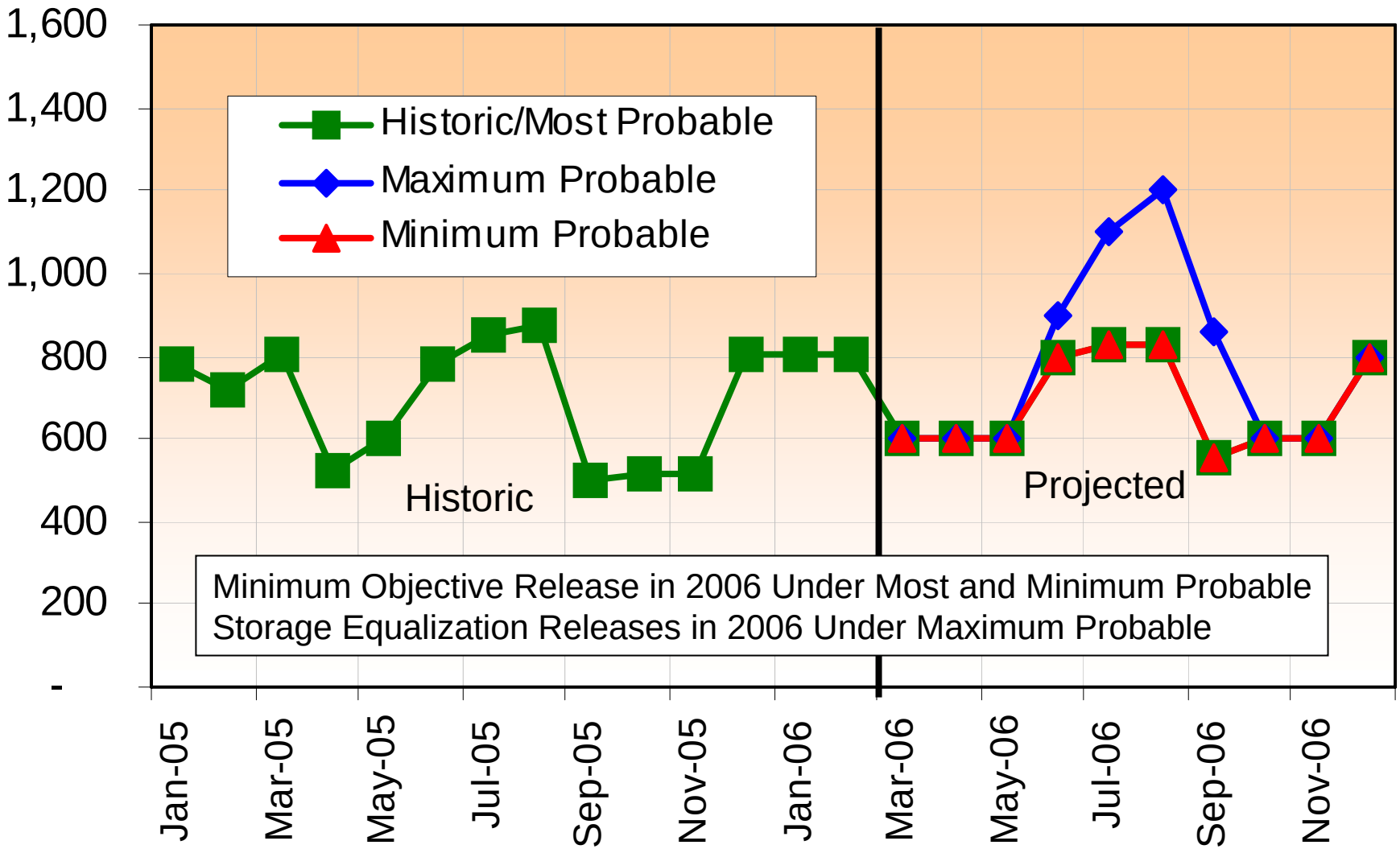
Blue Mesa – 97 %

Navajo – 31 %

Lake Powell – 91 %

RECLAMATION

Lake Powell Releases (Thousand Acre-Feet)
Based on March 2006 Inflow Projections



RECLAMATION

Basin Hydrology – Presentation by Tom Ryan (March 7, 2006)

Lake Powell Water Surface Elevations, Oct 1998 – March 6, 2006. In the summer of 1999, we're essentially full, 97% of capacity and then move into this very serious significant drought. We hit our low point of 33% of capacity just about year ago and then came up 50 feet to a high of approximately 3611 last July at 52% of capacity. This is where we are today at 44% of capacity and have just about hit our low for the year. We should be about steady state for March. We shouldn't see the elevation of the reservoir go much lower. We're at 3589.5 today.

Lake Powell Capacity. Here's a cross-section with some significant elevations on it. We're currently just about 3590, 100 feet above the minimum power pool and there is 6.8 maf separating where we are today from that critical elevation. The probability of reaching that minimum level has gone down by virtue of what we had last year. We were looking at about a 15% probability in a 10-year period a year ago and now it's more like 7 or 8 percent so there is still a risk of getting there but it has been lowered by virtue of one good year last year. 110 feet to the top.

Lake Powell Unregulated Flow, Water Year 2004. Looking back a couple of years, here's the runoff patterns for 2004. It was a pretty miserable runoff, an early runoff. You can see the separation between the average line and what we actually observed and these reduced base flows that we had in October-March and that was indicative of the kind of base flows that we had throughout the drought period. We were typically running about 60% of average during our non-runoff months not to mention the poor runoffs we had in the spring. We saw some significant precipitation at the end of the summer and in the fall and that's when we started to see things turn around in the fall of 2004 and got our base flows coming back up to the average line.

Lake Powell Unregulated Inflow, Water Year 2005. Here's our runoff from last year. You can see that the base flows stayed pretty much near the average line through the winter. We had good fall rains. It stayed wet through the winter, high elevation snow and rain at lower elevations. We had a pretty good runoff. It was early runoff again. For the water year it was 105% of average so it was a decent year but it wasn't an exceptional year on the wet side by any stretch of the imagination. One thing you see here in the late summer is we could start to dry out again and we saw these flows drop below the average line so our base flows were low in July, August, and September of 2005.

Lake Powell Unregulated Inflow, Water Year 2006. One good thing that we had coming into this water year was a good fall wet period. We started out with good soil moisture conditions underneath our snowpack which really is important. But we've seen a little bit of deterioration in our flows in the last month where we've dropped below average and I think for the year we're about 90% of average with our inflows so far.

The Drought. It took a lot of thought in developing this slide. People ask me repetitively if the drought is over. I'm not going to give an answer to that question. I'll present some material and I think we can all judge individually for ourselves. But let's look back a little bit.

Unregulated Inflow to Lake Powell as a Percentage of Average, Oct 1999-Feb 2006. We had over five years where not a single month of inflow was above average and that was from September 1999 until November 2004. We ran 62 months with below average inflow. You can see here in 2005 we went above average but we haven't really seen any big months in this period since we began the drought. Recently, we've been on a downward trend.

100 Years of Natural Flow, Lees Ferry, Arizona, 1906-2005. This is a visualization. We now have 100 years of natural flows in the Colorado River Basin. Our 04 and 05 numbers are still pretty provisional but nevertheless that rounds out an even 100 years of record and each one of these little facets at the bottom represents one year in the Colorado ranked from the driest to the wettest with percentiles associated with them. This is where 2000 hit, this is about a 20^{th} percentile. In other words, 80% of the years are wetter than that so this is exceedance. Here's 2001, a little bit drier. 2002 was the second driest in the 100-year period. So you can see this clustering in terms of just five years in a row, all down on the low part of the keyboard there.

Lowest Consecutive years of Natural Flow, Lees' Ferry, Arizona (average is 15.1 maf). Critical periods in the Colorado are very important because that's what we use in terms of water supply and planning and we have these periods that are the challenges for us to get through in terms of water management and water allocations. We have a couple of critical periods we generally work with. When we have a 12-year critical period, from 1953 thru 1964, where the natural flow averaged about 12.1 maf and then we have a 25-year critical period from 1953 thru 1977 when the natural flow averaged about 13 maf. I thought I'd look to see if we're working on a new critical period. The five driest consecutive years, 2000-2004, is common knowledge that came out of the drought but when you start adding these other years, you see that the sixth driest consecutive year in our period of record is 1999-2004. 1999 was an average year and was actually a little bit above average. The seventh consecutive period of dry flows was 1998-2004. 1998 was also average, a little bit above average. Then when we go to 8 years, then we see it jumps out of this period that includes our recent drought, 54-61 but I have a star here because if this year deteriorates to being about an 85% average year, then that eighth consecutive year period would be 1999-2006. It shows how heavily weighting that five year drought period is in terms of our overall period of record and the potential for creating a new critical period.

U.S. Drought Monitor. As most of you know, it is extremely dry in southern tier of the United States. Arizona is extremely dry as well as southwestern Colorado, New Mexico, and on into Texas. However, we still see some residual drought up in Wyoming and a little bit in Colorado, eastern Utah and southwestern Utah as well.

Basinwide Snowpack in the Upper Colorado River Basin. Aggregate basinwide snowpack above Lake Powell as of yesterday was 90% of average, big gradient, above to average in the north and significant dry conditions in the south. You're not going to see much runoff in the San Juans and Animas and New Mexico and Arizona are hurting real bad. I don't think I've ever seen such a gradient. Up in here you've got about 120% above average in the upper green and then it deteriorates as you move south.

Lake Powell End of Month Elevation (Feet) Based on March 200y Inflow Projections. These are three hydrologic scenarios. The most probable is what is forecasted, that's our most likely place that we'll end up given our current snow conditions and the forecast that comes from the Weather Service and the Natural Resource Conservation Service. We're looking at increasing storage in Lake Powell. Under the most probable, we get up to about 3620 so that's above 9 feet above where we were last year for a high. We did have a dry month in February. The forecast last month was for 105% of average, April thru July runoff. There is an 80% chance that Lake Powell will end up between these bands here so there is still considerable uncertainty in terms of what happens this spring. If we have a dry, warm spring, you're going to trend more towards the red line. If you have a wet, cool spring, you're going to trend more towards the blue line.

Colorado River Basin Forecast Center. This is a progression of our snowpack through the year. As you can see, we've been pretty much been hugging the average line. The red line is last year and here you kind of see this dry period that we've had in the last month or so.

Forecasted April-July Unregulated Inflow. Here is the forecast. Lake Powell, 91%; Navajo, very low at 31%; Flaming Gorge at above average and the same for Blue Mesa. I'm actually surprised that Blue Mesa is this high.

Lake Powell Releases (Thousand acre-Feet). With the most probable, the releases will be an 8.23 maf year; 600,000 acre-feet for April and May; 800,000 acre-feet of release in June; 8.25 in July and August, and 550,000 in September would round out an 8.23 year. If it does go wet under the maximum probable, we would trigger some equalization releases. We would reach 3630 which is our current 602a align when we start equalizing storage with Lake Mead. Under that maximum probable scenario, it turns out there is about 1 maf of equalization that would take place this summer so it's not likely, it's probably about a 25% chance that we'll have any equalization this year but it is possible that if it does go wet this spring, that we'll see additional releases this summer out of Lake Powell, above 8.23.