Description of document:	Bureau of Reclamation records discussing the problems and risks to the reliable generation of electric power at Hoover Dam associated with reduced and declining water levels at Lake Mead, 2015-2016
Requested date:	13-January-2016
Released date:	21-June-2016
Posted date:	01-August-2016
Source of document:	Freedom of Information Act Request Bureau of Reclamation PO Box 61470, LC-3555 Boulder City NV 89006-1470 Fax: (720) 544-0100

United States Department of the Interior
BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

IN REPLY REFER TO:

JUN 21 2016

LC-3503
1.1.2
(BOR-2016-00195)

VIA ELECTRONIC MAIL AND FED EX

Subject: Response to Freedom of Information Act (FOIA) Request – BOR-2016-00195

This letter responds to your FOIA request dated January 13, 2016, received in our office on May 25, 2016, received in our office on May 25, 2016. You requested:

"I request a copy of any records, such as documents, memos, white papers, correspondence or emails, discussing the problems and risks to the reliable generation of electric power at Hoover Dam associated with reduced and declining water levels at Lake Mead. I limit my request to records during calendar year 2015 and calendar year 2016. I limit my request to records that are located either at the Bureau of Reclamation Lower Colorado Region Office or the Offices at Hoover Dam. I do not request records that are published online, such as on the Bureau of Reclamation website. Instead, I request records that are internal to Bureau of Reclamation, and/or that are not published online."

The Bureau of Reclamation located twelve records consisting of two hundred five pages. All two hundred five pages are being released in full.

The fees incurred in processing your request have been waived.

If you consider the partial denial of these records to be a denial of your request pursuant to 43 CFR § 2.57(a)(1), you must submit a written appeal by facsimile at 202-208-6677, by electronic mail (FOIA.Appeals@sol.doi.gov), or by mail to:

Freedom of Information Act Appeals Officer
Department of the Interior
Office of the Solicitor
1849 C Street, NW, MS 6556
Washington, DC 20240

The FOIA Appeals Officer must receive your appeal no later than 30 workdays from the date of this letter. Appeals arriving or delivered after 5 p.m. EDT, Monday through Friday, will be deemed received on the next workday. You must include with your appeal copies of all correspondence between you and Reclamation concerning your FOIA request. Please include a copy of your original FOIA request and

this letter. Failure to include this documentation with your appeal will result in the Department of the Interior's rejection of your appeal. The appeal should be marked, both on the envelope and the face of the letter, with the legend, "FREEDOM OF INFORMATION APPEAL." Your letter should include any reason(s) why you believe Reclamation's response is in error. Include your name, daytime telephone number, an electronic mail address, or a fax number in case the Department needs additional information or clarification about the nature of your appeal.

For your information, Congress excluded three discrete categories of law enforcement and national security records from the requirements of the FOIA. See 5 U.S.C. § 552(c). This response is limited to those records that are subject to the requirements of the FOIA. This is a standard notification that is given to all our requesters and should not be taken as an indication that excluded records do, or do not, exist.

As part of the 2007 FOIA amendments, the Office of Government Information Services (OGIS) was created to offer mediation services to resolve disputes between FOIA requesters and Federal agencies as a non-exclusive alternative to litigation. Using OGIS services does not affect your right to pursue litigation. You may contact OGIS in any of the following ways:

Mail to: Office of Government Information Services (OGIS)
8601 Adelphi Road
College Park, MD 20740-6001

Email: ogis@nara.gov
Telephone: 202-741-5770
Toll-free: 1-877-684-6448

Web: http://ogis.archives.gov
Facsimile: 202-741-5769

Pursuant to 43 CFR § 2.19, we are making available our FOIA Public Liaison to assist in formulating the request or resolving any disputes between you and Reclamation. Our FOIA Liaison is Mr. Gary McDanel. He can be reached by telephone at 303-445-3337.

Should you have questions, please contact the FOIA Officer, Aaron Alton, at the above Bureau of Reclamation address, phone 702-293-8020, or e-mail LCR-FOIA@usbr.gov.

Sincerely,

Aaron A. Alton
FOIA Officer

Enclosure - 1

Conner, Kelly <kconner@usbr.gov>

Fwd: Basic Power Points

1 message

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:26 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

---------- Forwarded message ----------
From: **Cook, Mark** <mrcook@usbr.gov>
Date: Fri, Sep 11, 2015 at 1:04 PM
Subject: Basic Power Points
To: RSLynch@rslynchaty.com
Cc: Robert Skordas <RSkordas@usbr.gov>

Rob Skordas asked me to send you a couple of PowerPoints that may be helpful in educating people about Hydro and Hoover. I've also included a map of the Colorado Basins. Please feel free to give us a call if there is anything else you need.

Mark R Cook, PE

U.S. Dept. of the Interior | Bureau of Reclamation
Lower Colorado Dams Office | LCD-1050
Manager, Hoover Dam
702-494-2302
mrcook@usbr.gov

---

2 attachments

Overview of Hoover Hydropower and Lower CR Operations.pptx
2964K

Basic Hoover Energy and Capacity .ppt
320K

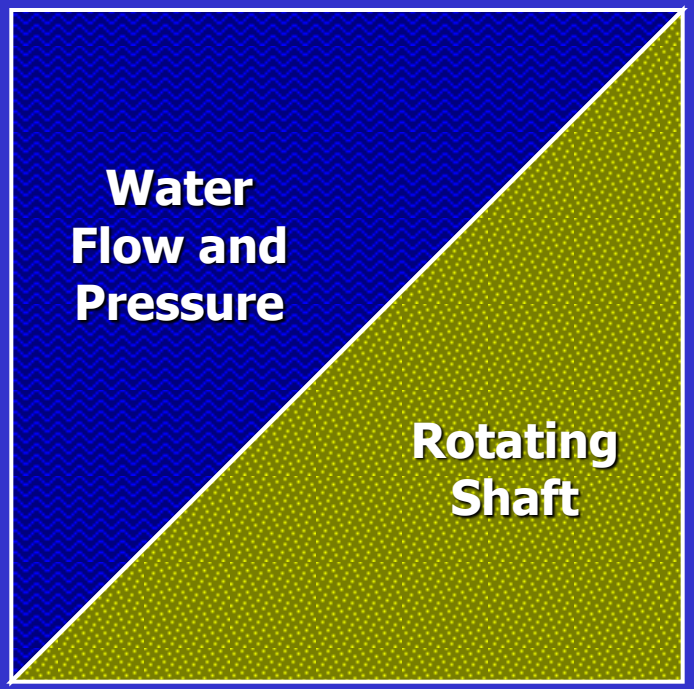
RECLAMATION

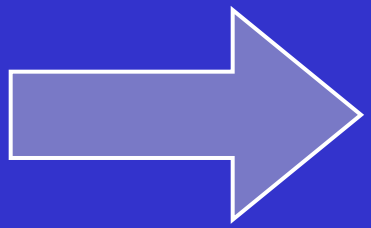
Managing Water in the West

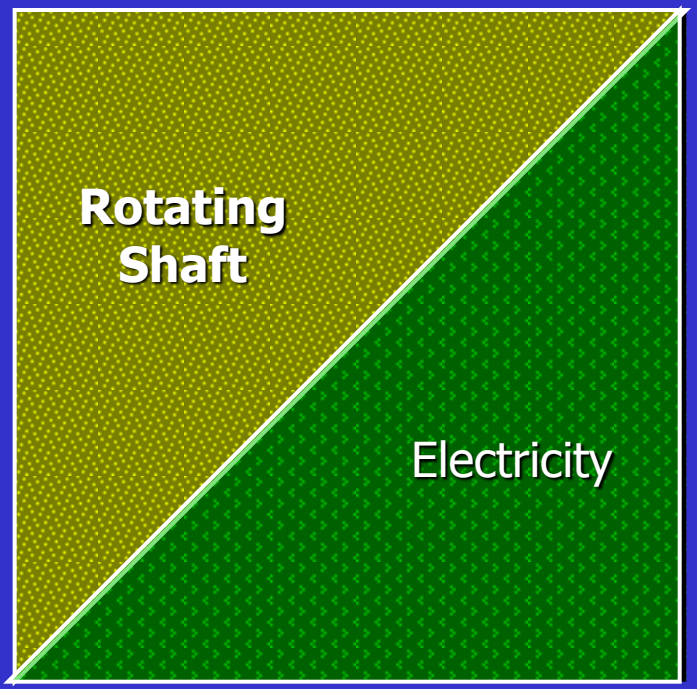
Overview of Hoover Dam Hydropower Drought Impacts and Reponses

U.S. Department of the Interior
Bureau of Reclamation

Energy Conversion







Turbine Energy Conversion

Generator Energy Conversion

Hoover Power Calculation

Power can be calculated if you know the flow and the pressure of the water, and the efficiency of the machinery used to convert flow and pressure to electricity.

HOOVER POWER CALCULATION

(Also works at any hydro dam)

Power Output = (Efficiency of turbine/generator) x (FLOW) x (HEAD) / 11,819

Megawatts = (Efficiency) x (Cubic Feet Per Second) x (Feet) / 11,819

Note: The Feet of Head is the Forebay elevation minus the Tailbay elevation. At Hoover today this is 1153.5-647=506.5 feet

EXAMPLE #1: Calculating the Power Output

- Hoover Unit N-1 has 2700 cfs flowing through the turbine.
- Lake Mead is at elevation 1154 and the tailbay is at elevation 1647.
- The head (or pressure) of the water is 1154-1647=507 feet.
- The efficiency of Hoover Unit N-1 is 89%.
- The Power Output of Hoover Unit N-1 is (.89 x 2700 x 507)/11,819=102 Megawatts

HOOVER EFFICIENCY CALCULATION

(Also works at any hydro dam)

$$\text{Efficiency} = \frac{11{,}819 \times (\text{Power Output})}{(\text{FLOW}) \times (\text{HEAD})}$$

$$\%\ \text{Efficiency} = \frac{11{,}819 \times (\text{Megawatts})}{(\text{Cubic Feet per Second}) \times (\text{Feet})}$$

Calculating the Efficiency

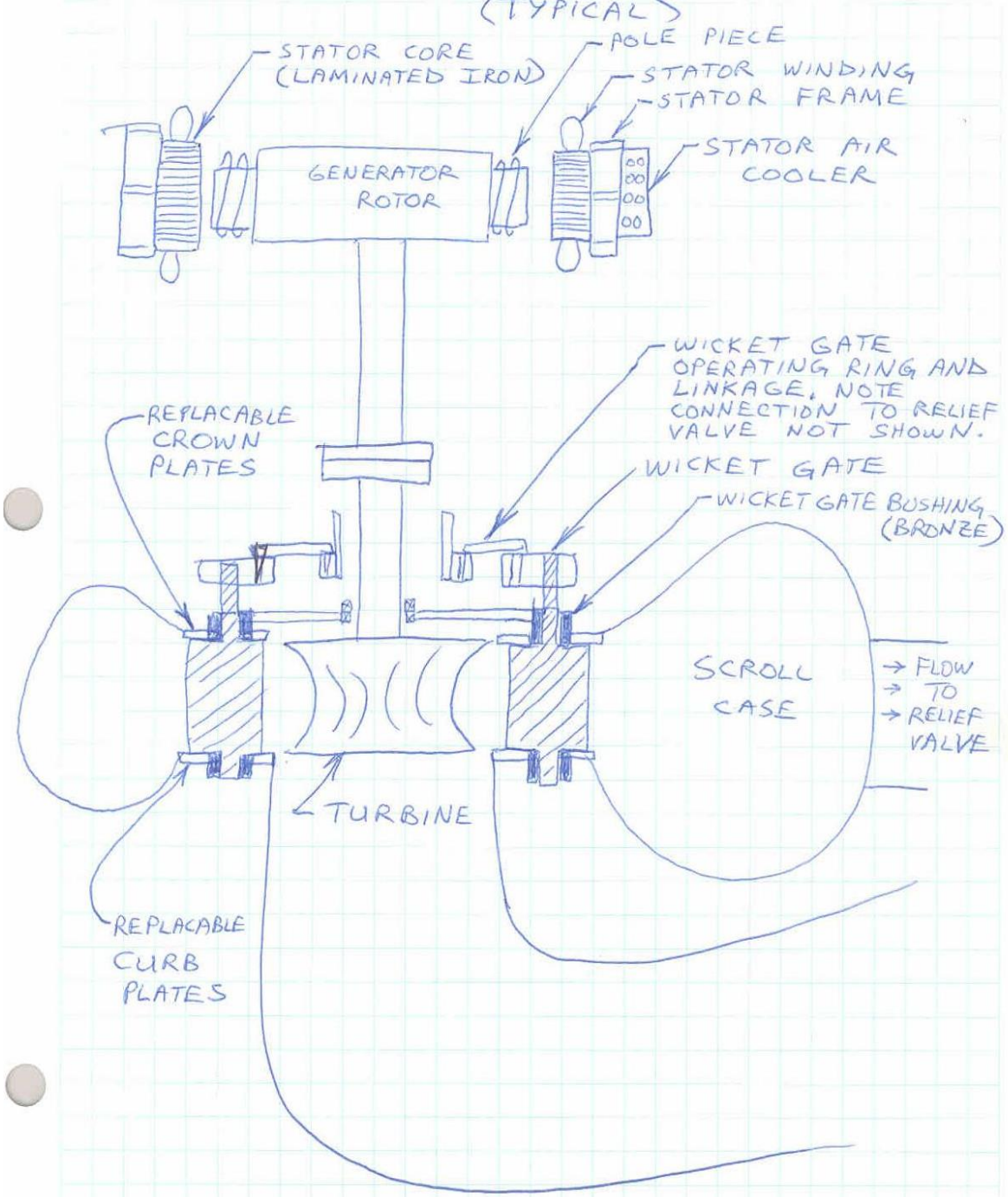
Hoover Unit N-1 has 2700 cfs flowing through the turbine.

Lake Mead is at elevation 1154 so the head (or pressure) of the water is 1154-647 = 507 feet.

The Power Output of Hoover Unit N-1 is 102 Megawatts

The efficiency of the unit is:

(11,819 x 102) divided by (2700 x 507) = 89% efficiency


(TYPICAL)
STATOR CORE (LAMINATED IRON)
POLE PIECE
STATOR WINDING
STATOR FRAME
STATOR AIR COOLER
GENERATOR ROTOR
WICKET GATE OPERATING RING AND LINKAGE. NOTE CONNECTION TO RELIEF VALVE NOT SHOWN.
REPLACABLE CROWN PLATES
WICKET GATE
WICKET GATE BUSHING (BRONZE)
SCROLL CASE
→ FLOW → TO → RELIEF VALVE
TURBINE
REPLACABLE CURB PLATES

Capacity

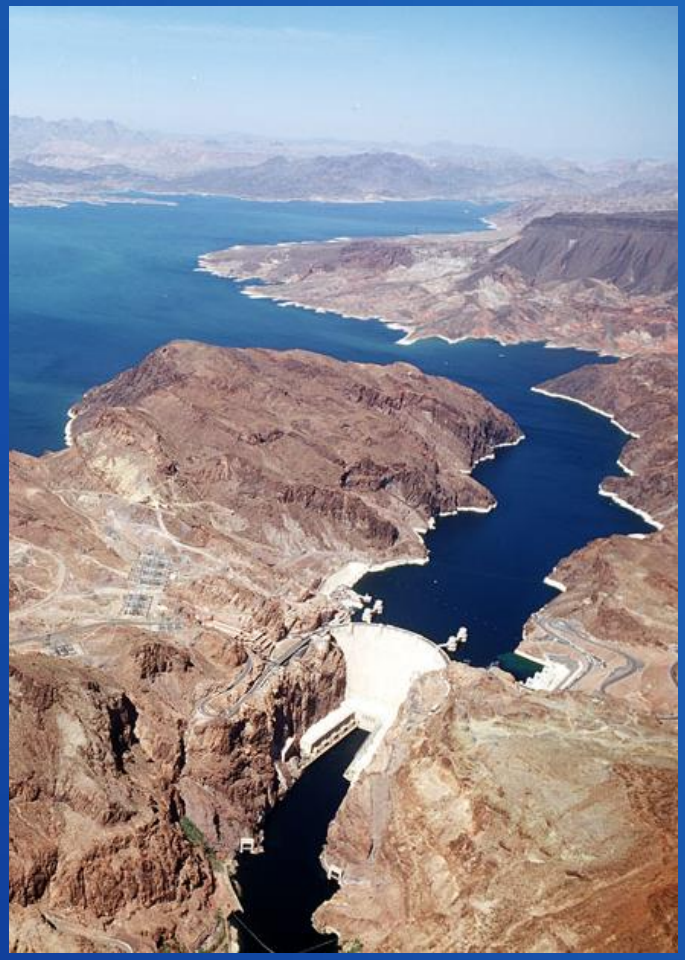
- **The grid needs reserves available incase a generator goes down**
- **Hoover units can produce 130MW**
- **If running at 100MW, 30MW is still available**
- **This ability to generate 30MW is a marketable resource.**

1928 Boulder Canyon Project Act, Section 6

- Authorizes… “[t]hat the dam and reservoir provided for by section 1 hereof shall be used:
  - First, for river regulation, improvement of navigation, and flood control;
  - second, for irrigation and domestic uses and satisfaction of present perfected rights in pursuance of Article VIII of said Colorado River compact; and
  - third, for power.”

Operation of Lake Mead and Hoover Dam

- Two modes of operation govern the releases from Lake Mead
  - Flood Control (releases in excess to downstream water delivery requests)
  - Meet the downstream water delivery requests
- Flood Control operations governed by U.S. Corps of Engineers regulations

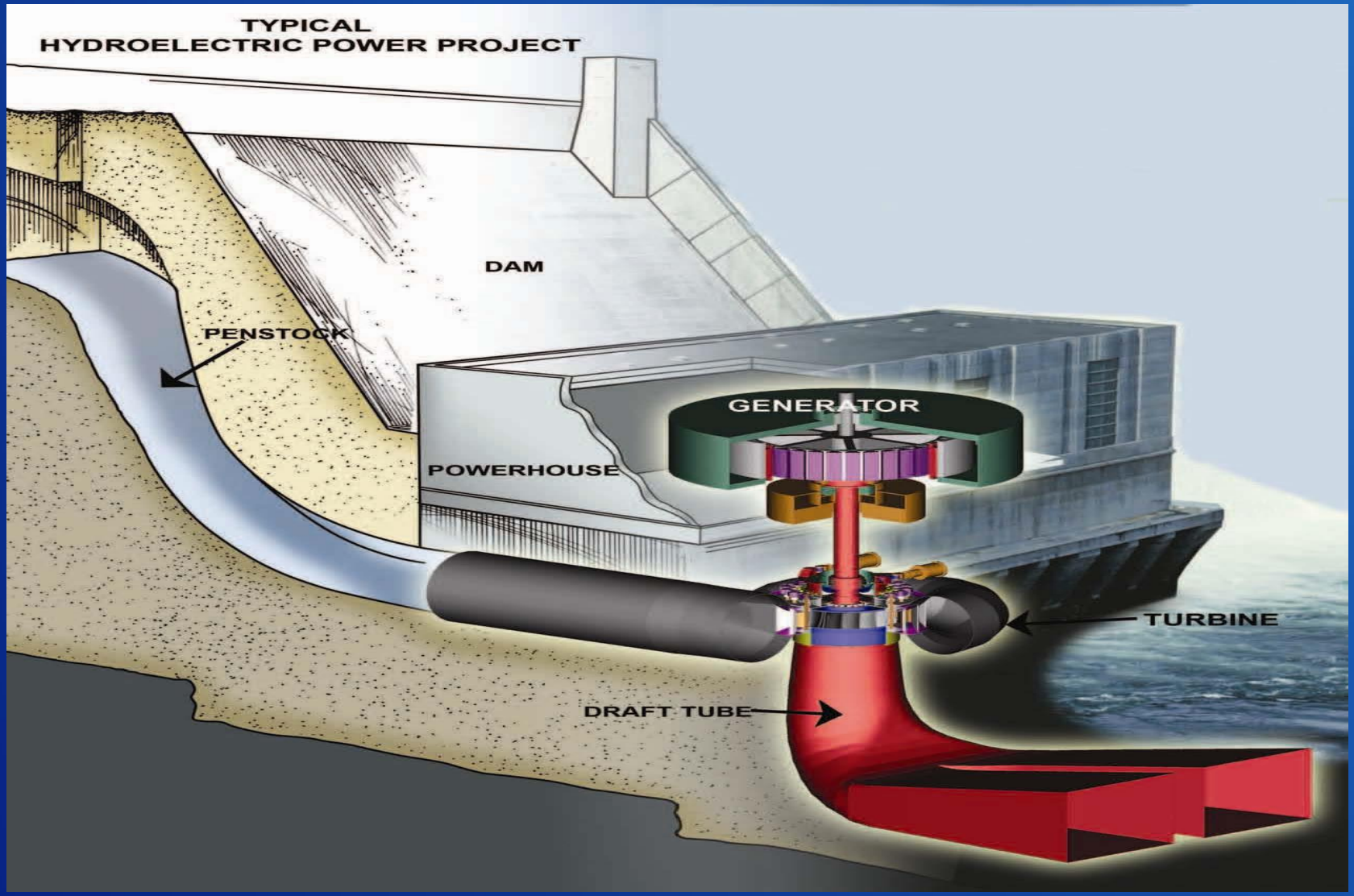


RECLAMATION

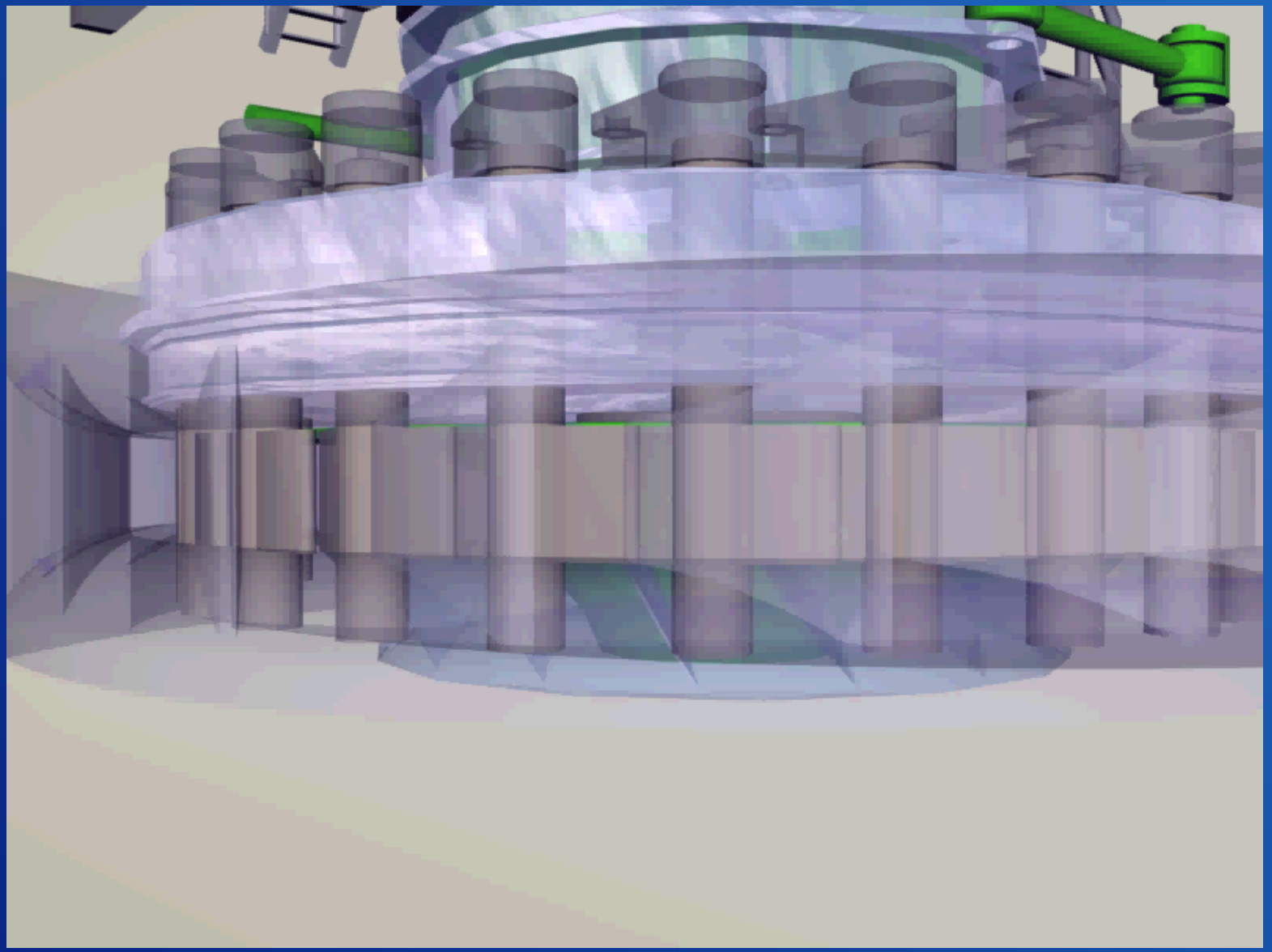
Operation of Hoover Dam

- Hoover is a peaking powerplant
- Monthly energy targets are disaggregated into each contractor's share by Western
- Each contractor schedules its energy to meet energy demands on a real-time basis
- Monthly gross energy target is met within ± 2 percent
- Reclamation may change monthly gross energy target within the month based on system conditions

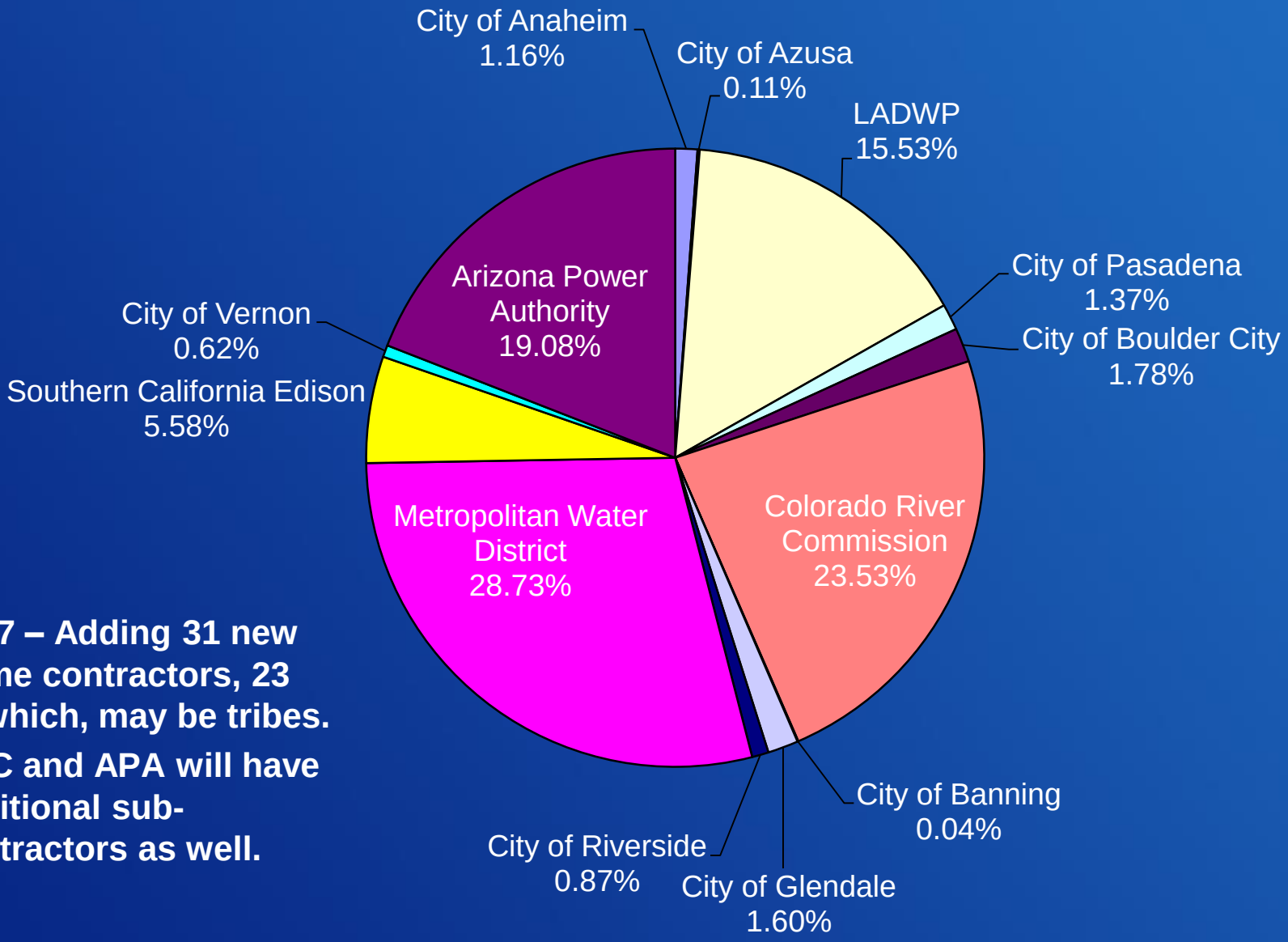
Hydropower Fundamentals



RECLAMATION



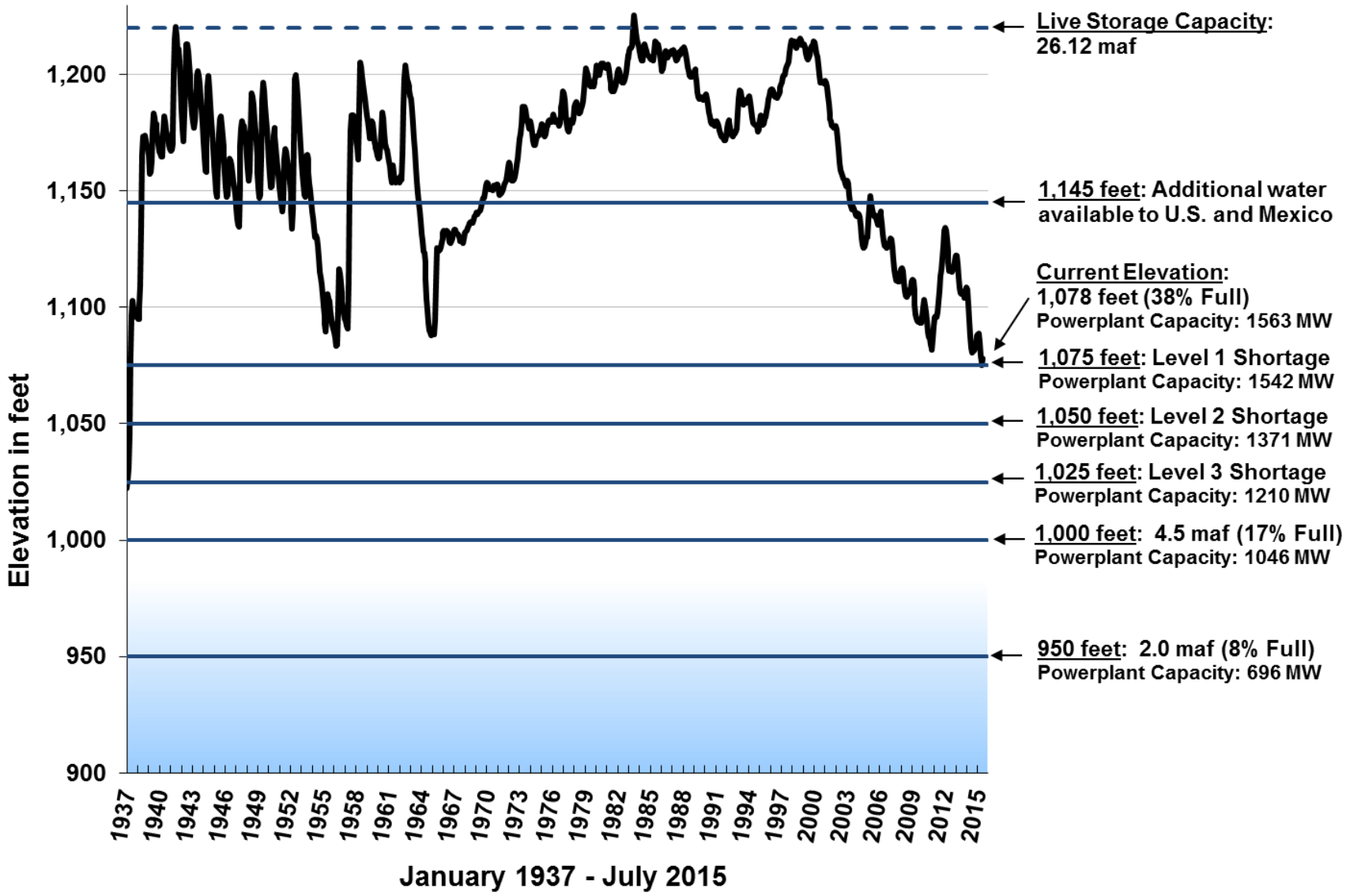
Power Allocations



- **2017 – Adding 31 new prime contractors, 23 of which, may be tribes.**
- **CRC and APA will have additional sub-contractors as well.**

RECLAMATION

Lake Mead Historical Elevations and Critical Elevations



RECLAMATION

Impacts of Lower Lake Elevations

- Loss of total generation capacity
- Loss of regulation capacity
- Decreased energy supplied to the customers
- Decreased Revenue for Title 1 Salinity Programs
- Increased rough zones
- Increased Maintenance (cavitation) concerns

Pressure, Flow, Power Relationship

$$Power(MW) = \frac{Flow(CFS) \times NetHead(Feet)}{11819} \times UnitEfficiency(\%)$$

Cavitation

Formation of bubbles as the pressure falls low enough for flow to vaporize. As pressure increases, the vapor bubbles will collapse and if near a surface will do so with enough intensity to remove/pit stainless steel.

As the surface is damaged rough surfaces are left behind propagating damage.

RECLAMATION

Efficiency and Capacity Improvements at Hoover Dam

- Major Overhauls of Turbine Components
- Stainless Steel Wicket Gates
- Opening Existing Wicket Gates beyond 100%
- Unit Controls Modernization
- Wide Head Range Turbine

Turbine Overhaul Work

- Purpose of this work is to restore the machinery to a more efficient operating condition

- Major Overhauls of Turbine Components
  - Installation of new seal rings improves the efficiency of turbine energy conversion.

  - Installation of new wicket gates prevent water leakage when units are shut down by restoring gate tolerances.

Stainless Steel Wicket Gates and Over stroking Wicket Gates

- **Benefits result from the 105 MW of capacity added at lower lake levels as of January 2015.**

- **Additional 9 MW are scheduled over the next 2 years**

Unit Controls Modernization Benefits

- A major role of Hoover is providing Regulation and Reserves to the power grid
  - Regulation refers to Hoover's ability to change loads quickly
  - Reserves refer to Hoover's non-spin and spin capacity

- UCM improves efficiency while units are providing regulation for the power system.
  - Faster operating mode transitions such as starting and stopping a unit
  - Faster changing from condense mode to generate mode
  - Faster transition/loading through the unit rough zones
  - Faster load-following response.

- UCM improves maximum capacity available to the market

UNIT CONTROLS MODERNIZATION (UCM)
Local Control Panels

PRIOR TO CHANGES
Relays for unit control, solid state relay protection, analogue meters, pistol grip manual controls, and "window" type annunciator for alarms.

AFTER CHANGES
Programmable logic controller for unit control, digital relay protection, touch screen for manual control, monitoring, and alarms.

RECLAMATION

Wide Head Turbines

- **5 Turbines Total**
  - **4 Full Size**
  - **1 Half Size**

RECLAMATION

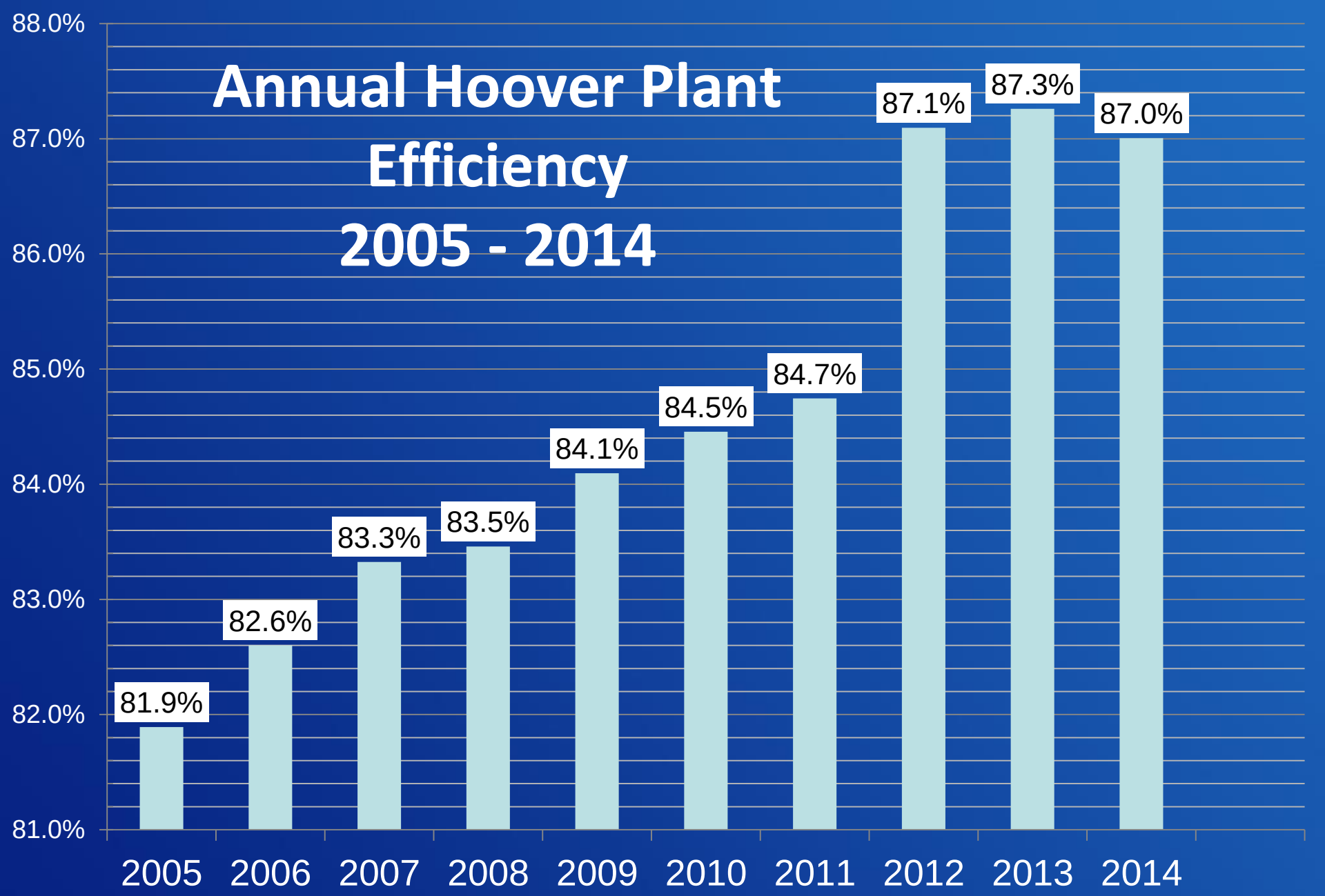
A8 Turbine

- Old Turbine had High Vibration, No AGC Capability
- New Turbine has Full Range of Operation Capability
  - No roughening air required
- Half Size Allows for More Efficient Plant Loading

RECLAMATION

Unit A8 Unit Efficiency History

RECLAMATION



RECLAMATION

Constraint Expectation – 1050 ft

- All units will have decreased power capability and efficiency
- 11.5 units can operate, but we expect little to no regulation ability at the high efficiency top end
  - With low tail water submersions, cavitation damage will occur when operated above the rough zone
- 4.5 units will have regulation ability, but will have minimal rough zones

- Estimated Plant Capacity: 1371 MW

Constraint Expectation- 1000 ft

- All units will have decreased power capability and efficiency
- 11.5 units can operate, with minimal operational regulation below the rough zones
  - Cavitation damage is expected at high loads all tail water elevations
- 4.5 units will have regulation ability at the top end, but with larger rough zones

- Estimated Plant Capacity: 1046 MW

Constraint Expectations – 950 ft

- All units will have decreased power capability and efficiency
- 11.5 units may be able to run, but with cavitation or vibration damage at any load
- 4.5 units will have minimal regulation ability at the top end due to rough zones increasing and capacity decreasing
  - With low tail water submersions, none of the units will be operated at full load

- Estimated Plant Capacity: 696 MW

Conner, Kelly <kconner@usbr.gov>

Fwd: Drought Effect on Power PPT from PRO

2 messages

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:31 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

---------- Forwarded message ----------
From: **Bunk, Daniel** <dbunk@usbr.gov>
Date: Thu, Jul 16, 2015 at 6:03 PM
Subject: Re: Drought Effect on Power PPT from PRO
To: "Hvinden, Steven" <shvinden@usbr.gov>
Cc: "Cook, Mark" <mrcook@usbr.gov>, "Palumbo, David" <dpalumbo@usbr.gov>, Robert Skordas <rskordas@usbr.gov>

Hi all,

I made updates based on Steve's comments relating to the water operations portion of the slide show (items 4 and 5). The updated PPT is attached here as version 3.

Let me know if you have additional comments.

Thanks,
--
Dan

On Thu, Jul 16, 2015 at 1:30 PM, Hvinden, Steven <shvinden@usbr.gov> wrote:

> Folks,
>
> My thoughts about additional slides or points to cover:
>
> 1. How much does it cost to operate and maintain each year Hoover (off budget) and who pays?
>
> 2. Decision making framework for making major replacements, etc, at Hoover?
>
> 3. Who are the major power contractors by state?
>
> 4. Details on how YAO gathers up the weekly and daily water orders and interacts with BCOO so the water can be scheduled each day.
>
> 5. Our water operations control center at BCOO and hours it is open (weekends, etc).
>
> On Thu, Jul 16, 2015 at 7:46 AM, Cook, Mark <mrcook@usbr.gov> wrote:

Dan,
This approach looks good to me. I only had one edit on your section; I took out the widehead turbine slides since I will have already talked about them.
In my section, I clarified regulation, ramping, and reserves a little and fixed a slide that had a rogue animation.

Overview of Hoover Hydropower and Lower CR Oper...

Thanks,
Mark

On Thu, Jul 16, 2015 at 1:00 AM, Bunk, Daniel <dbunk@usbr.gov> wrote:

> Hi all,
>
> I put together some slides on the Lower Basin operational framework, how operations are implemented and coordinated with hydropower, and drought impacts and responses.
>
> I combined these operational slides with Mark's hydropower slides into one presentation divided into two parts. Let me know what you think of this approach and if it looks like any key topics are missing.
>
> I'll be in the office tomorrow but in meetings for about 80% of the day. There may be a delay in my response to your feedback.
>
> Thanks,
> --
> *Dan*
>
> On Wed, Jul 15, 2015 at 7:53 AM, Palumbo, David <dpalumbo@usbr.gov> wrote:
>
> > Hi Mark:
> >
> > Thank you very much for putting this together. I will review this morning and get you some thoughts.
> >
> > Also, if others could do the same that would be great and very helpful.
> >
> > Thanks,
> >
> > David
> >
> > On Tue, Jul 14, 2015 at 3:51 PM, Cook, Mark <mrcook@usbr.gov> wrote:
> >
> > > I set up a folder in Google Drive to work from for this PowerPoint. You should have received access to the folder in a separate email. This link should work as well:
> > > https://drive.google.com/open?id=0B_8r5GCGrB4DflpaSkNJd3J5RlRlSURJM3F5cG5tRERISzdkUE5QZzBwTDlEcEUzd2ZCTWs
> > > Please let me know if you have any trouble accessing it. The PowerPoint references a video that is also in the folder. It was too large to email.
> > >
> > > It needs the BCOO slides inserted in it and may be a little on the long side. Please feel free to edit and change anything.
> > >
> > > Thanks,
> > > Mark
> > >
> > > On Mon, Jul 13, 2015 at 2:14 PM, Palumbo, David <dpalumbo@usbr.gov> wrote:

Overview of Hoover Hydropower and Lower CR Operations_Briefing for CRBC_071715_v3.pptx
10502K

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:32 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

--------- Forwarded message ---------
From: **Bunk, Daniel** <dbunk@usbr.gov>
Date: Thu, Jul 16, 2015 at 1:00 AM
Subject: Re: Drought Effect on Power PPT from PRO
[Quoted text hidden]

Overview of Hoover Hydropower and Lower CR Operations_Briefing for CRBC_071715_v1.pptx
9342K

Fwd: Hoover Power 101?

1 message

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:31 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

---------- Forwarded message ----------
From: **Bunk, Daniel** <dbunk@usbr.gov>
Date: Mon, Jul 20, 2015 at 4:47 PM
Subject: Re: Hoover Power 101?
To: Tanya Trujillo <ttrujillo@crb.ca.gov>, Angela Rashid <arashid@crb.ca.gov>
Cc: "Palumbo, David" <dpalumbo@usbr.gov>, Robert Skordas <rskordas@usbr.gov>, Mark Cook <mrcook@usbr.gov>, Jennifer McCloskey <jmccloskey@usbr.gov>, Steve Hvinden <shvinden@usbr.gov>, Chau Nguyen <CNguyen@usbr.gov>

Hi Tanya and Angela,

The presentation from Friday's meeting is attached.

Please let Mark and I know if you have additional questions.

Thanks,
--
Dan

On Mon, Jul 20, 2015 at 2:46 PM, Tanya Trujillo <ttrujillo@crb.ca.gov> wrote:

> David, Dan, Robert and Mark,
>
> We very much appreciated the hospitality you provided for us on Friday and the very valuable information you provided about hydropower production. Is it possible to get a copy of the presentations?
>
> Thanks again,
>
> Tanya
>
> ---
>
> **From:** "Palumbo, David" <dpalumbo@usbr.gov>
> **Date:** Wed, 15 Jul 2015 08:56:14 -0700
> **To:** Tanya Trujillo <ttrujillo@crb.ca.gov>
> **Cc:** Angela Rashid <arashid@crb.ca.gov>, Jennifer McCloskey <jmccloskey@usbr.gov>, Steve Hvinden <shvinden@usbr.gov>, Daniel Bunk <DBunk@usbr.gov>, Robert Skordas <rskordas@usbr.gov>, Mark Cook <mrcook@usbr.gov>

Subject: Re: Hoover Power 101?

Hi Tanya and Angela:

I wanted to let you know that we modified the schedule slightly (noted below) to accommodate a lunch at Hoover Dam. The 10:00 am to 4:00 pm window remains the same (just some minor internal shuffling).

- 10:00 am - 12:00 pm: Presentation in Boulder City
- 12:00 pm - 12:30 pm: Travel to Hoover Dam
- 12:30 pm - 1:30 pm: Lunch at Hoover Dam Spillway House
- 1:30 pm - 3:30 pm: Tour of Hoover Dam
- 3:30 pm - 4:00 pm: Travel to Boulder City

With respect to lunch, I was wondering if you all have any dietary restrictions or preferences that we should be aware of (we were thinking submarine sandwiches).

With respect to the tour, I wanted to note that folks will need to have closed-toed shoes (steel-toed not required). We will provide all other PPE.

We are looking forward to our discussions on Friday.

Thanks a lot,

David
702-622-4064 (c)

On Tue, Jul 7, 2015 at 6:03 PM, Palumbo, David <dpalumbo@usbr.gov> wrote:

> Hi Tanya and Angela:
>
> We are set for next Friday at 10:00 am.
>
> With respect to the logistics, I thought the following may work:
>
> - 10:00 am - 12:00 pm: Presentation in Boulder City
> - 12:00 pm - 1:00 pm: Lunch
> - 1:00 pm - 1:30 pm: Travel to Hoover Dam
> - 1:30 pm - 3:30 pm: Tour of Hoover Dam
> - 3:30 pm - 4:00 pm: Travel to Boulder City
>
> We could arrange to pick you up and drop you off at the airport if that helps.
>
> Any thoughts are great. We are open.
>
> Thank you,
>
> David
> 702-622-4064 (c)
>
> On Mon, Jul 6, 2015 at 5:48 PM, Palumbo, David <dpalumbo@usbr.gov> wrote:
>
> > Hi Tanya:
> >
> > That sounds great.
> >
> > I believe next Friday (7/17) would work well here. I am just checking schedules with a few folks.
> >
> > Would you be available for a brief telephone call tomorrow to discuss logistics and agenda

details?

Thanks,

David
702-622-4064 (c)

On Mon, Jul 6, 2015 at 11:56 AM, Tanya Trujillo <ttrujillo@crb.ca.gov> wrote:

> Thanks for the fast response David. Angela and I are ready and willing to come out to Boulder City if that works on your end. Any chance that there would be a day next week that works between July 15-17? We would also be open during those days for a webinar option if that would be easier. If not, we can keep working to find some dates that work.
>
> Also, if August 12 works for your schedule, please plan to come to Ontario for our Board meeting. We usually have around 50 people present who represent our various agencies (not including our Board members). Receiving an update on power issues would be much appreciated and we can help you tailor the presentation to our group.
>
> Thanks again,
>
> Tanya
>
> ---
>
> **From:** "Palumbo, David" <dpalumbo@usbr.gov>
> **Date:** Fri, 3 Jul 2015 13:57:59 -0700
> **To:** Tanya Trujillo <ttrujillo@crb.ca.gov>
> **Cc:** Angela Rashid <arashid@crb.ca.gov>
> **Subject:** Re: Hoover Power 101?
>
> Hi Tanya:
>
> I am doing well and the 4th of July will be a nice break. I hope it is the same for you.
>
> With respect to Item 1, we could put together a presentation either by webinar or in-person (we could come to Ontario as well). If we did it in BC, we could include a visit to Hoover if that helps. This, of course, is completely at your discretion. Any venue would work.
>
> As a very high-level and preliminary agenda for consideration, we could speak about the following items: (i) Hydropower Overview: (ii) Lower Basin Dam Operations with a focus on Hoover; (iii) Drought Impacts to Lower Basin Hydropower; (iv) Boulder Canyon Project Post 2017.
>
> If you would like to select the venue, we can work on getting it scheduled as well as start to detail and firm an agenda.
>
> With respect to Item 2, I could be present for the August 12 Board Meeting and provide that presentation or I could have someone else do so as well (Also, I am sure we could cover the subsequent Board Meeting if it needs to be pushed out.).
>
> It will be nice to catch up.
>
> Thanks a lot and take care,
>
> David
> 702-622-4064 (c)
>
> On Thu, Jul 2, 2015 at 3:28 PM, Tanya Trujillo <ttrujillo@crb.ca.gov> wrote:

Hi Dave,

I hope you are doing well – and are looking forward to a fun 4th of July celebration with your family this weekend.

One of our engineers, Angela Rashid, and I have been working on getting more background together regarding Lower Basin hydropower issues. Terry suggested that you would be the best contact for me regarding setting up two things:

1. Orientation to Hoover power (for me and Angela). We are very flexible about this and would be happy to start with a webinar – or would be happy to travel to BC. And of course, it will take some planning to figure out what might work best.
2. Potential presentation from someone at BOR re drought impacts on power at our August 12 Colorado River Board of California meeting in Ontario, CA. Again, we are very flexible about this – and also flexible about the month that this could be done.

Any assistance you can provide would be appreciated. I am looking forward to catching up with you.

Thank you,

Tanya

818-389-2288 (cell)
Ttrujillo@crb.ca.gov

Overview of Hoover Hydropower and Lower CR Operations_Briefing for CRBC_071715_presented.pdf
3533K

RECLAMATION

Managing Water in the West

Overview of Hoover Dam Hydropower and Lower Colorado River Basin Reservoir Operations: Drought Impacts and Reponses

Briefing for the Colorado River Board of California
July 17, 2015

U.S. Department of the Interior
Bureau of Reclamation

Presentation Outline

Part 1:

- Hoover Dam and Hydropower
- Drought Impact Responses

Part 2:

- Overview of the Basin
- Law of the River and Operational Framework
- Lower Colorado River Water Operations
- Drought Response Planning

RECLAMATION

Managing Water in the West

Part 1:

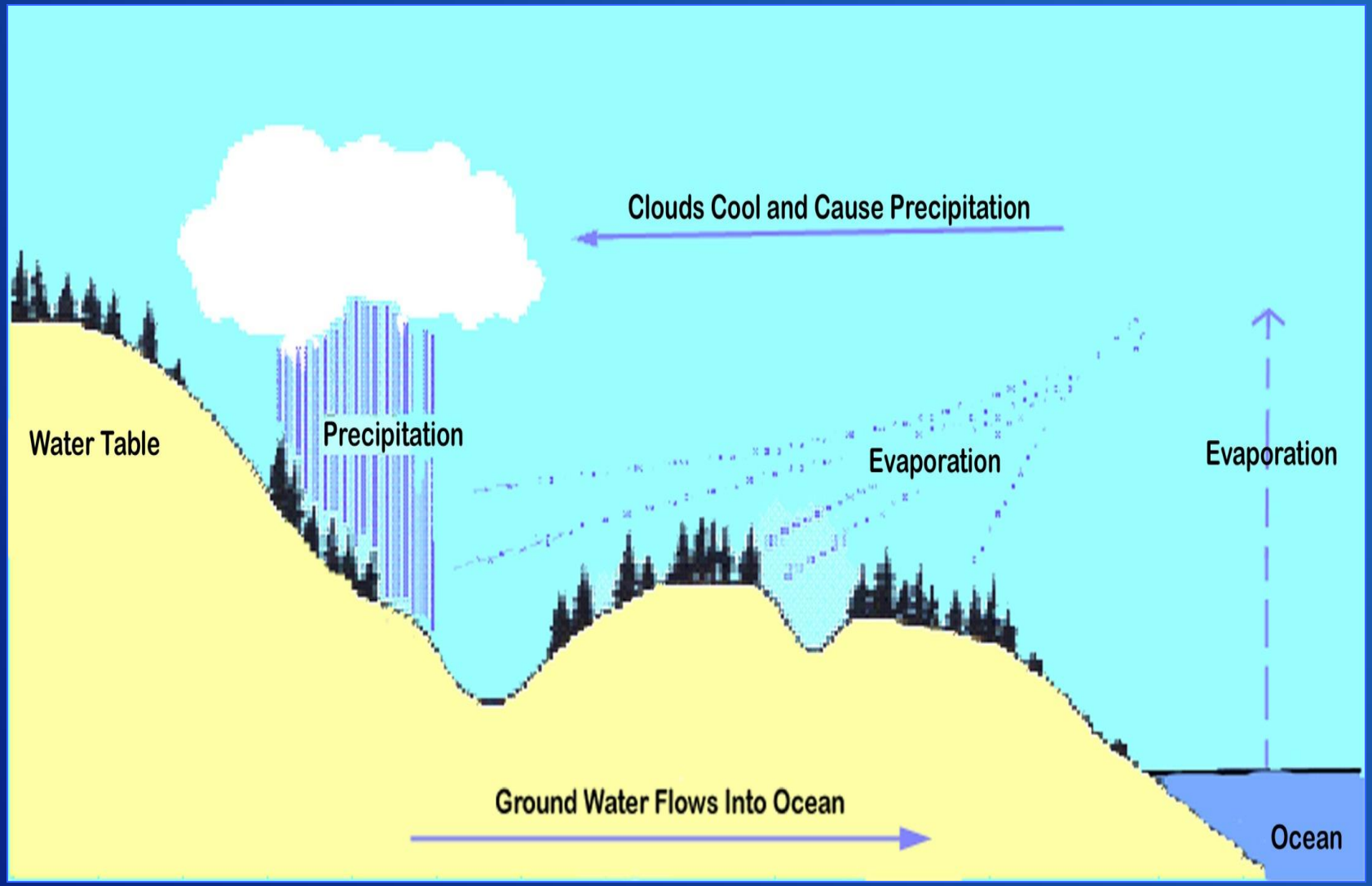
Hoover Dam, Hydropower, and Drought Impact Responses

U.S. Department of the Interior
Bureau of Reclamation

Project Purposes

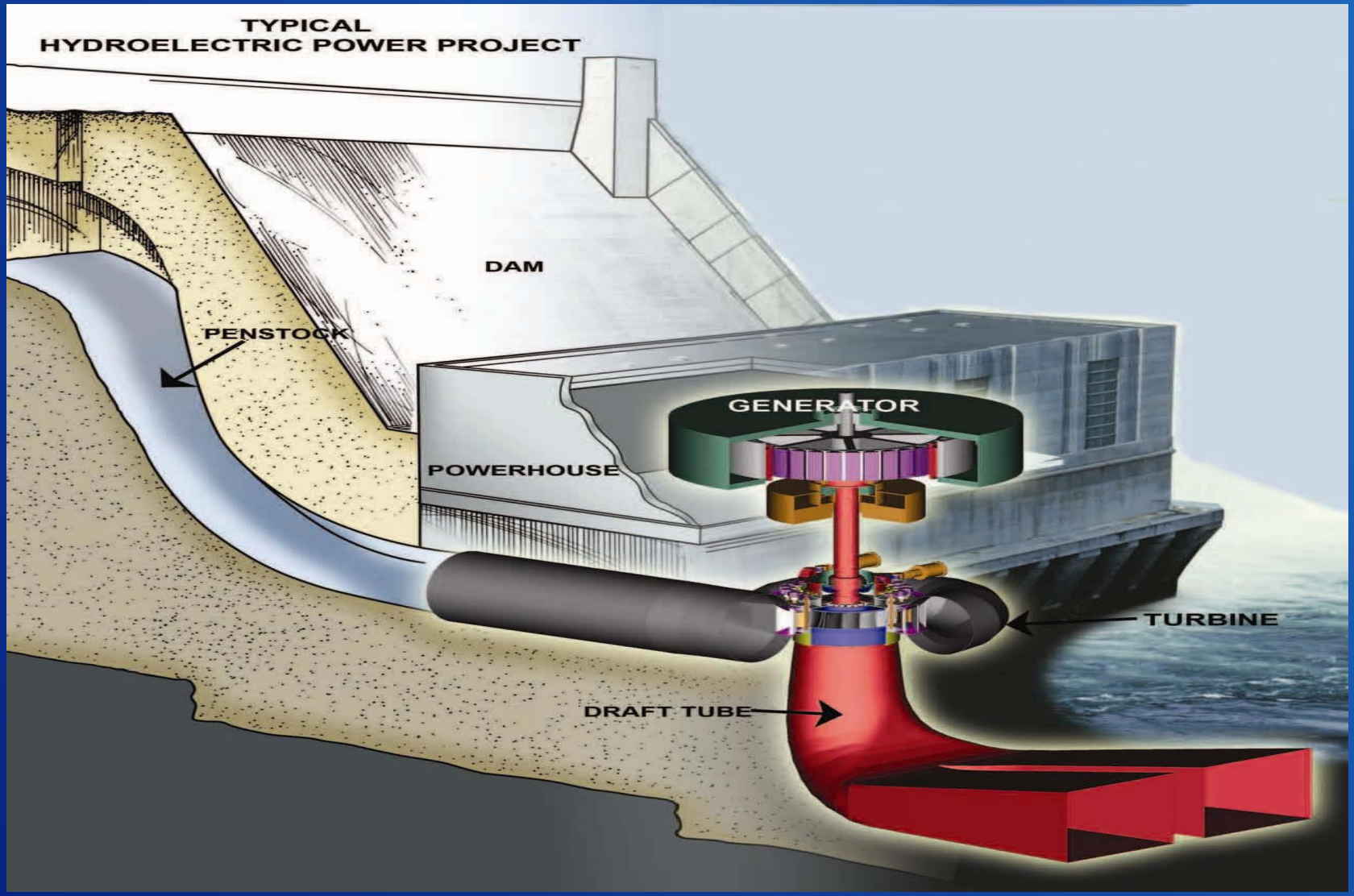
- Flood Control
- Storage of Water to meet downstream deliveries
- Recreation
- Fish & Wildlife
- Power Generation/Capacity and Ancillary Services such as:
  - Voltage control
  - System restoration
  - Blackstart power

Nature's Water Cycle



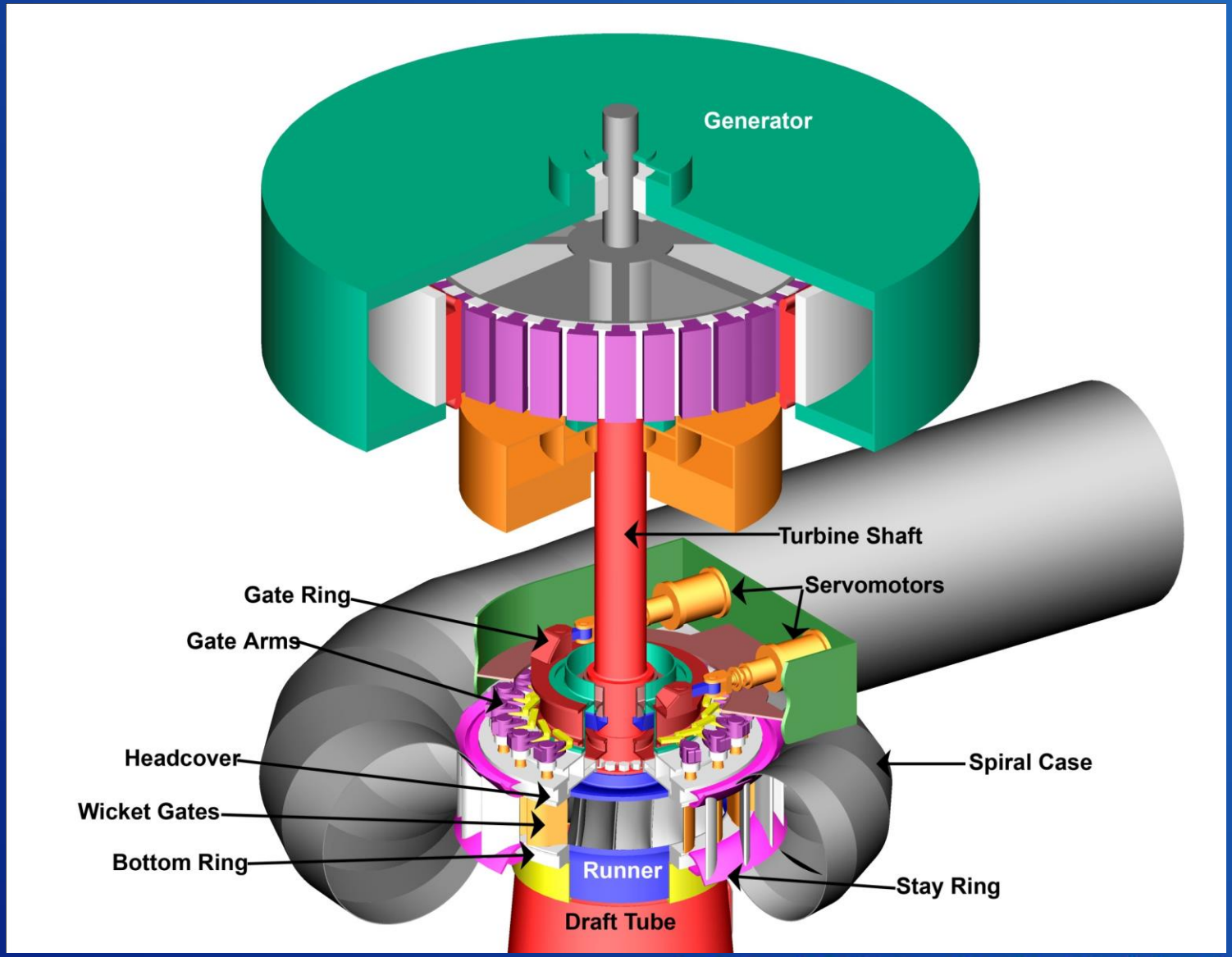
RECLAMATION

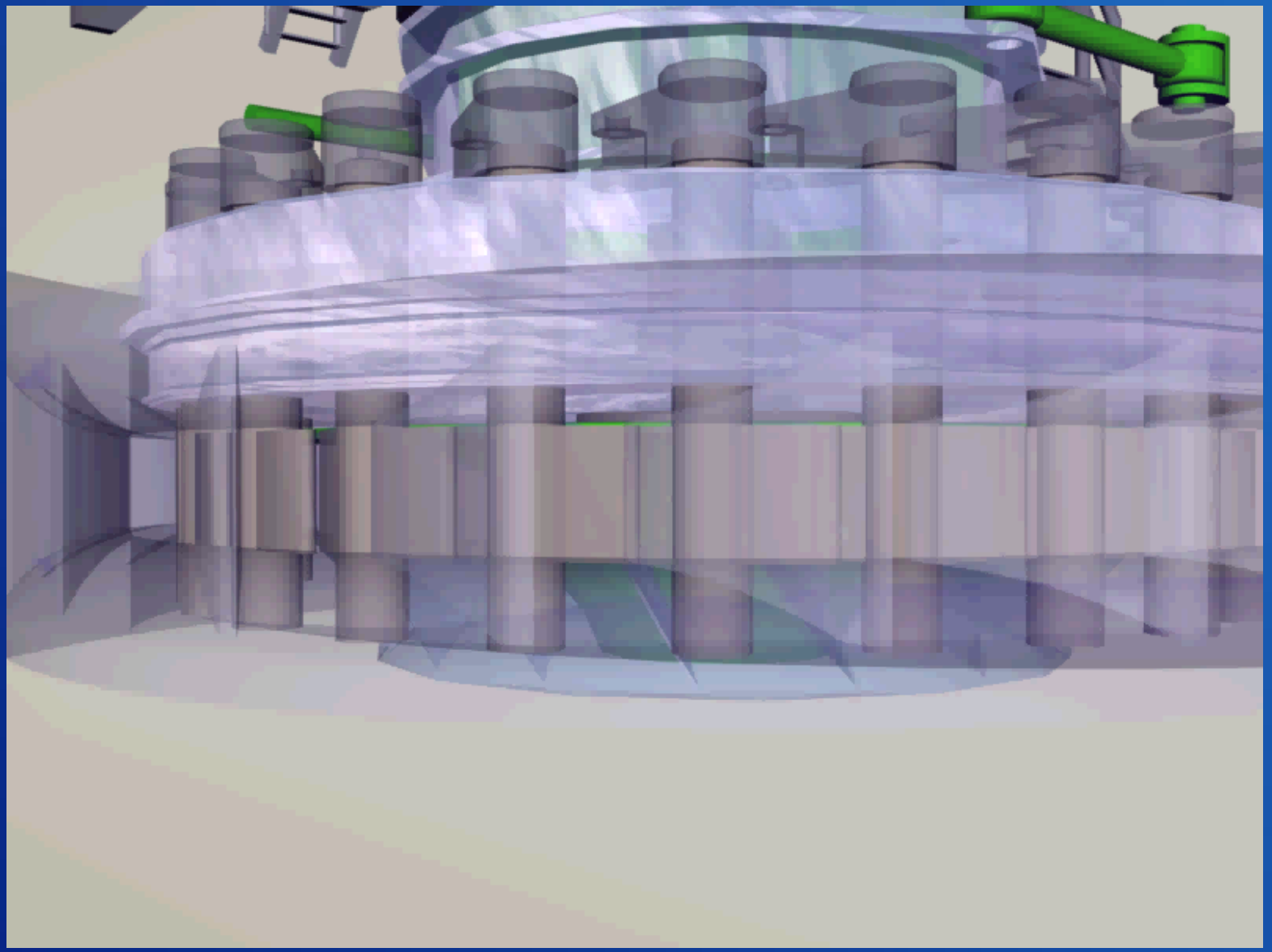
Hydropower Fundamentals



RECLAMATION

Typical Francis Turbine Generator

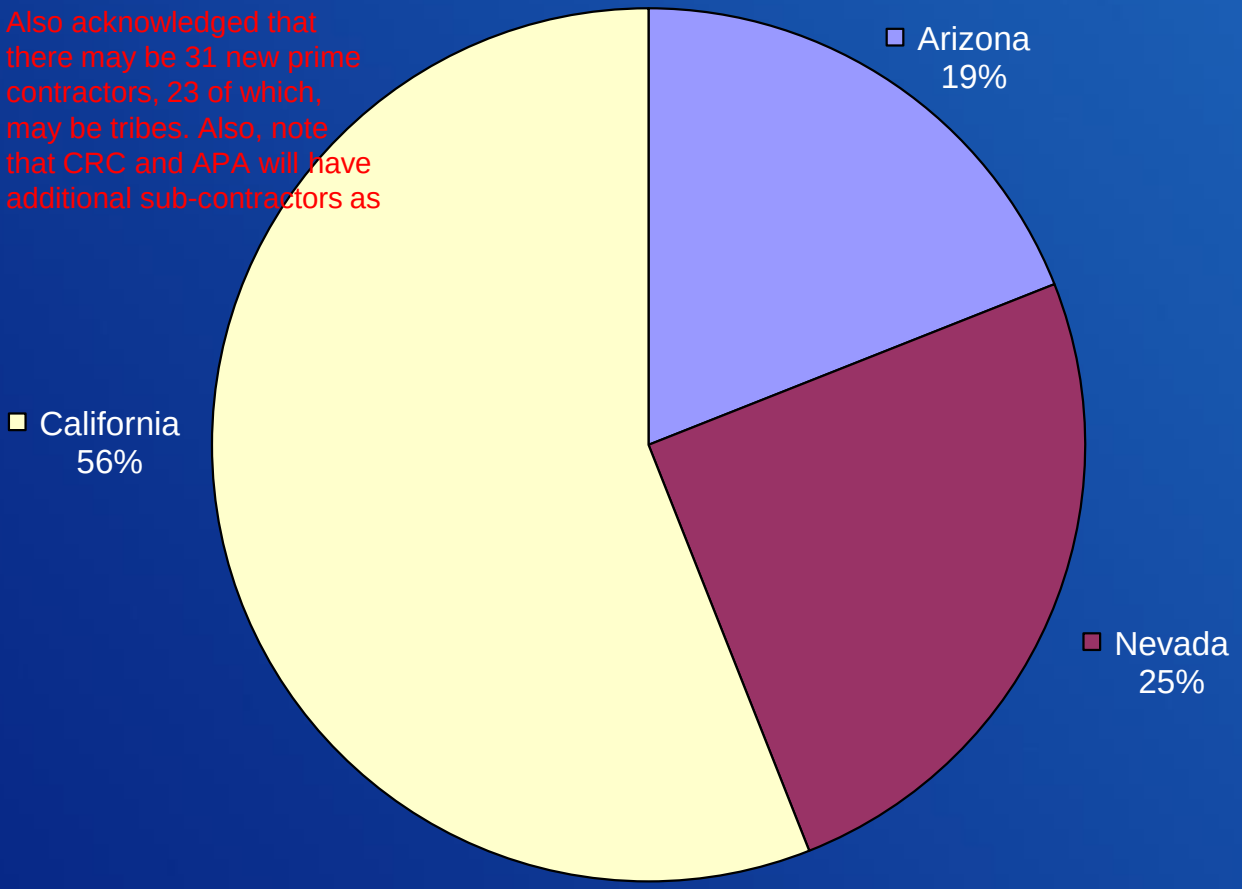




Power Allocations

Add breakdown to include prime entities for Schedules A & B

Also acknowledged that there may be 31 new prime contractors, 23 of which, may be tribes. Also, note that CRC and APA will have additional sub-contractors as



RECLAMATION

Boulder Canyon Project - Post 2017

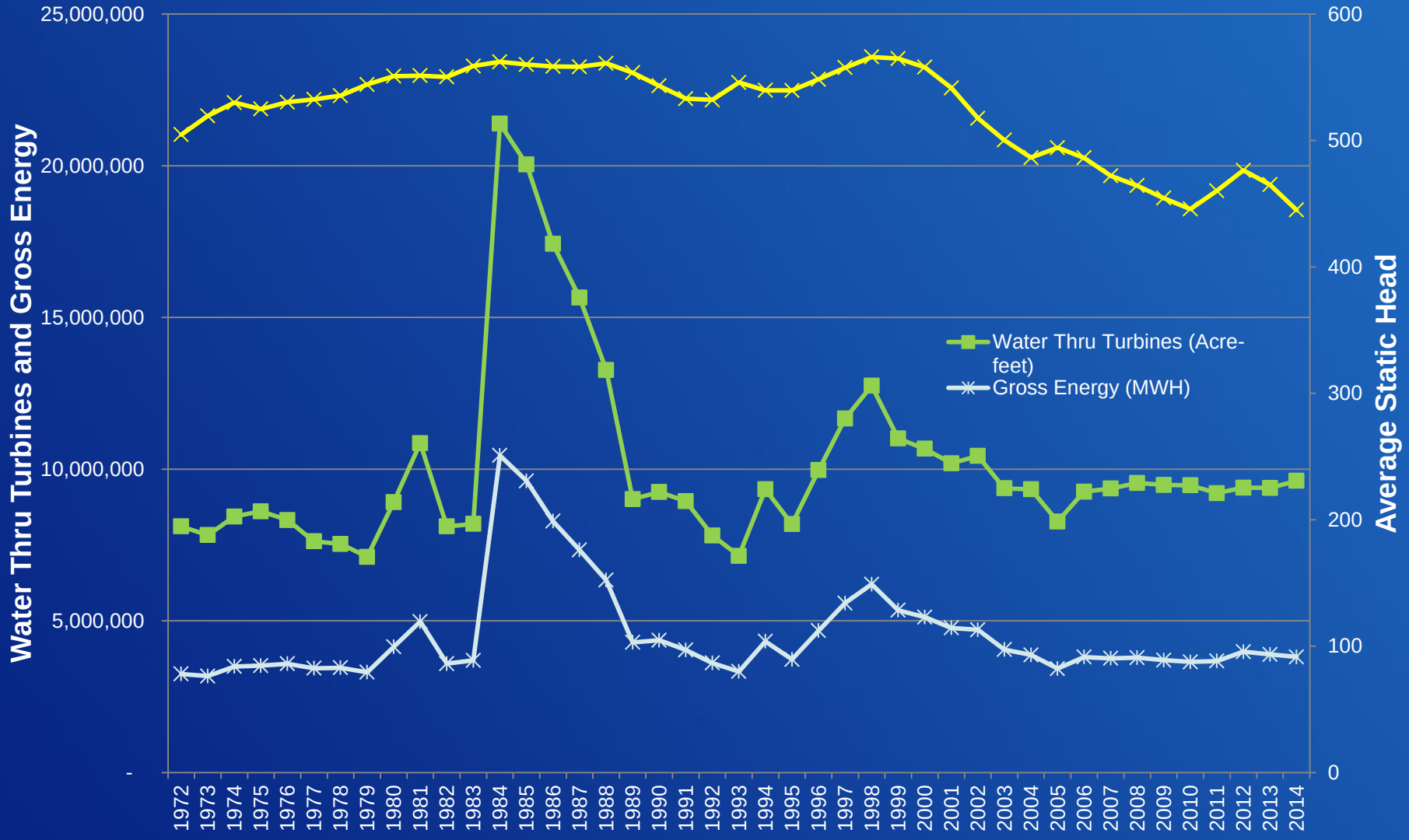
- XXX of 1934
  - 50 Years (1937 – 1987)
  - Schedule A (XXX MW)
- Hoover Power Plant Act of 1984
  - 30 Years (1987 – 2017)
  - Schedules B & C (XXX MW)
- Hoover Power Allocation Act of 2011
  - 50 Years (2017 – 2067)
  - Schedule D (XXX MW)

Pressure, Flow, Power Relationship

$$Power(MW) = \frac{Flow(CFS) \times NetHead(Feet)}{11819}$$

Add term for efficiency coefficient

Recent History



RECLAMATION

Impacts of Lower Lake Elevations

- **Loss of total generation capacity**
- **Loss of regulation capacity**
- **Decreased energy supplied to the customers**
- **Increased rough zones**
- **Increased Maintenance (cavitation) concerns**

Add Value of Hoover as peaking plant and Dynamic Signal Information.

Also, verbally mention impacts to costs and revenues for Basin Fund

Cavitation

Formation of bubbles as the pressure falls low enough for flow to vaporize. As pressure increases, the vapor bubbles will collapse and if near a surface will do so with enough intensity to remove/pit stainless steel.

As the surface is damaged rough surfaces are left behind propagating damage.

RECLAMATION

Efficiency and Capacity Improvements at Hoover Dam

- Major Overhauls of Turbine Components
- Stainless Steel Wicket Gates
- Opening Existing Wicket Gates beyond 100%
- Unit Controls Modernization
- Wide Head Range Turbine

Turbine Overhaul Work

- Purpose of this work is to restore the machinery to a more efficient operating condition

- Major Overhauls of Turbine Components
  - Installation of new seal rings improves the efficiency of turbine energy conversion.

  - Installation of new wicket gates prevent water leakage when units are shut down by restoring gate tolerances.

Stainless Steel Wicket Gates and Over stroking Wicket Gates

- **Benefits result from the 105 MW of capacity added at lower lake levels as of January 2015.**

- **Additional 9 MW are scheduled over the next 2 years**

Unit Controls Modernization Benefits

- A major role of Hoover is providing Regulation, Ramping, and Reserves to the power grid
  - Regulation and Ramping refer to Hoover's ability to change loads quickly
  - Reserves refer to Hoover's non-spin and spin capacity

- UCM improves efficiency while units are providing regulation for the power system.
  - Faster operating mode transitions such as starting and stopping a unit
  - Faster changing from condense mode to generate mode
  - Faster transition/loading through the unit rough zones
  - Faster load-following response.

- UCM improves maximum capacity available to the market

UNIT CONTROLS MODERNIZATION (UCM)
Local Control Panels

PRIOR TO CHANGES
Relays for unit control, solid state relay protection, analogue meters, pistol grip manual controls, and "window" type annunciator for alarms.

AFTER CHANGES
Programmable logic controller for unit control, digital relay protection, touch screen for manual control, monitoring, and alarms.

RECLAMATION

Wide Head Turbines

- **5 Turbines Total**
  - **4 Full Size**
  - **1 Half Size**

RECLAMATION

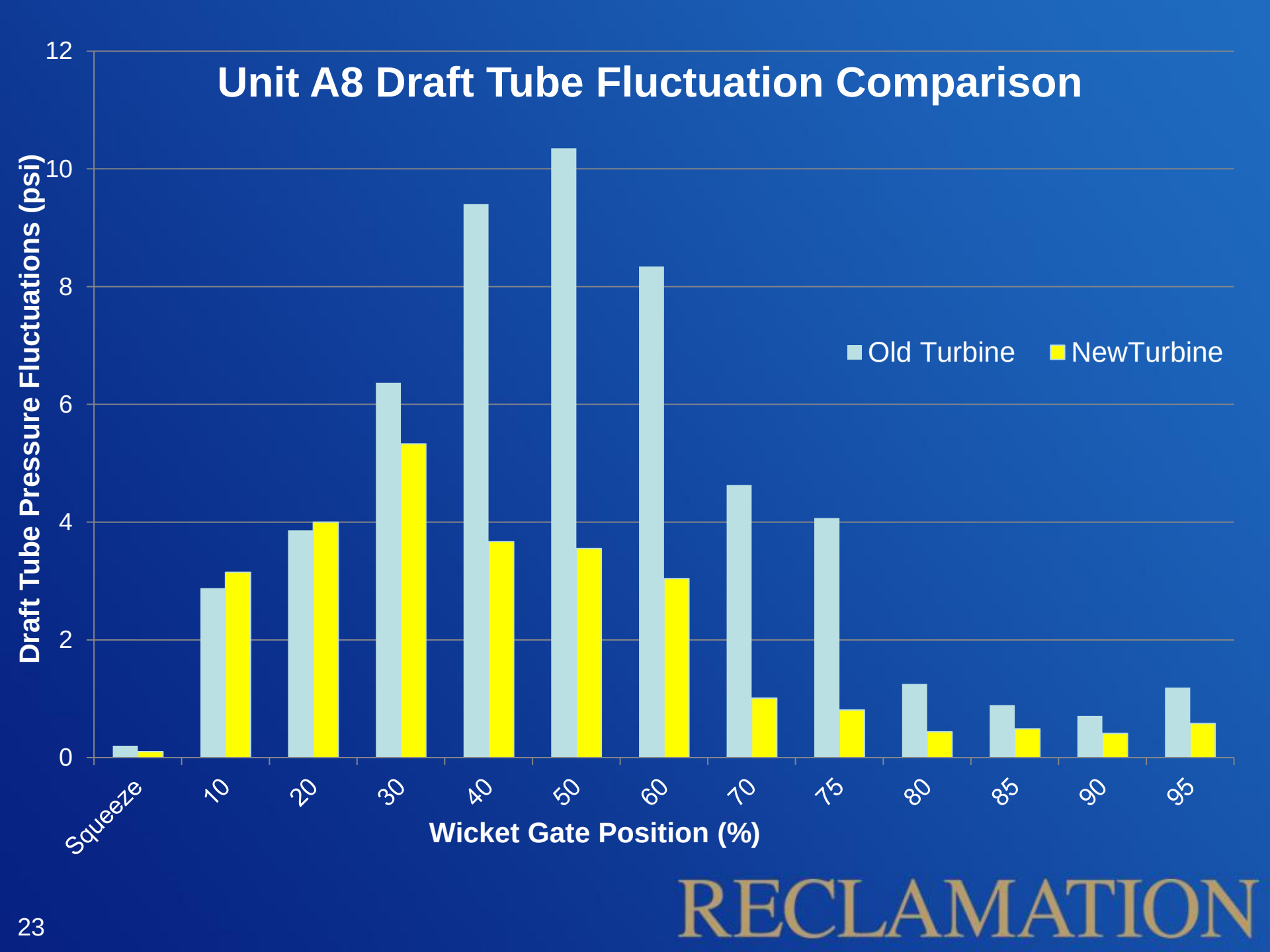
A8 Turbine

- Old Turbine had High Vibration, No AGC Capability
- New Turbine has Full Range of Operation Capability
  - No roughening air required
- Half Size Allows for More Efficient Plant Loading

RECLAMATION

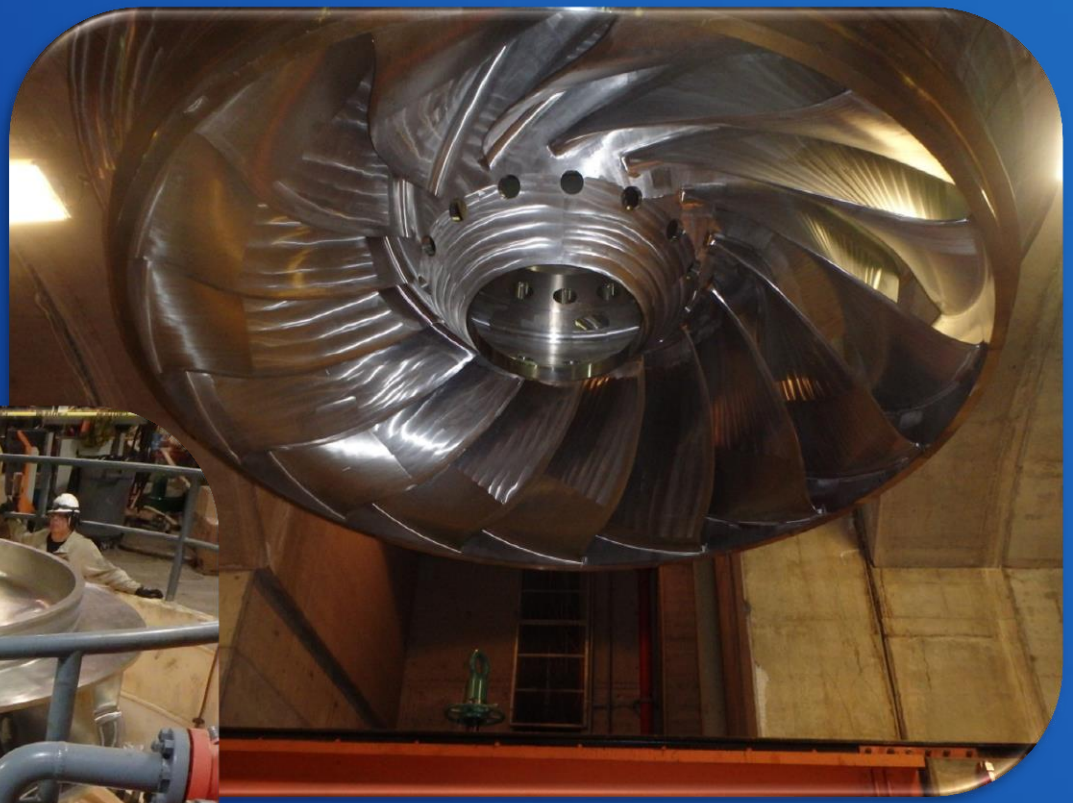
Unit A8 Unit Efficiency History

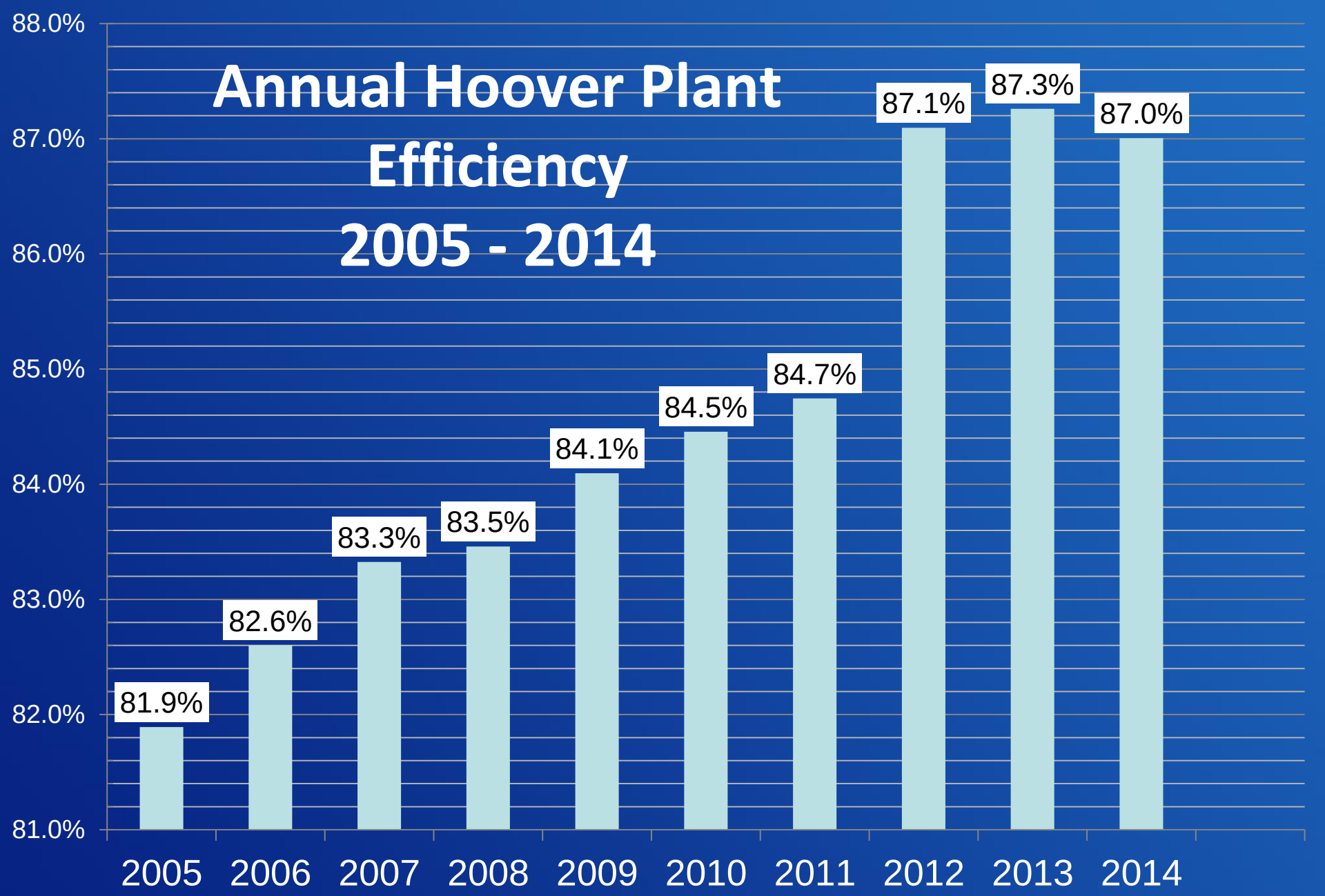
RECLAMATION



RECLAMATION

A1 Turbine Installation





RECLAMATION

Constraint Expectation – 1050 ft

Add 1075

- All units will have decreased power capability and efficiency
- 11.5 units can operate, but we expect little to no regulation ability at the high efficiency top end
  - With low tail water submersions, cavitation damage will occur when operated above the rough zone
- 4.5 units will have regulation ability, but will have minimal rough zones

- Estimated Plant Capacity: 1371 MW

Constraint Expectation- 1000 ft

- All units will have decreased power capability and efficiency
- 11.5 units can operate, with minimal operational regulation below the rough zones
  - Cavitation damage is expected at high loads all tail water elevations
- 4.5 units will have regulation ability at the top end, but with larger rough zones

- Estimated Plant Capacity: 1046 MW

Constraint Expectations – 950 ft

- All units will have decreased power capability and efficiency
- 11.5 units may be able to run, but with cavitation or vibration damage at any load
- 4.5 units will have minimal regulation ability at the top end due to rough zones increasing and capacity decreasing
  - With low tail water submersions, none of the units will be operated at full load

- Estimated Plant Capacity: 696 MW

RECLAMATION

Managing Water in the West

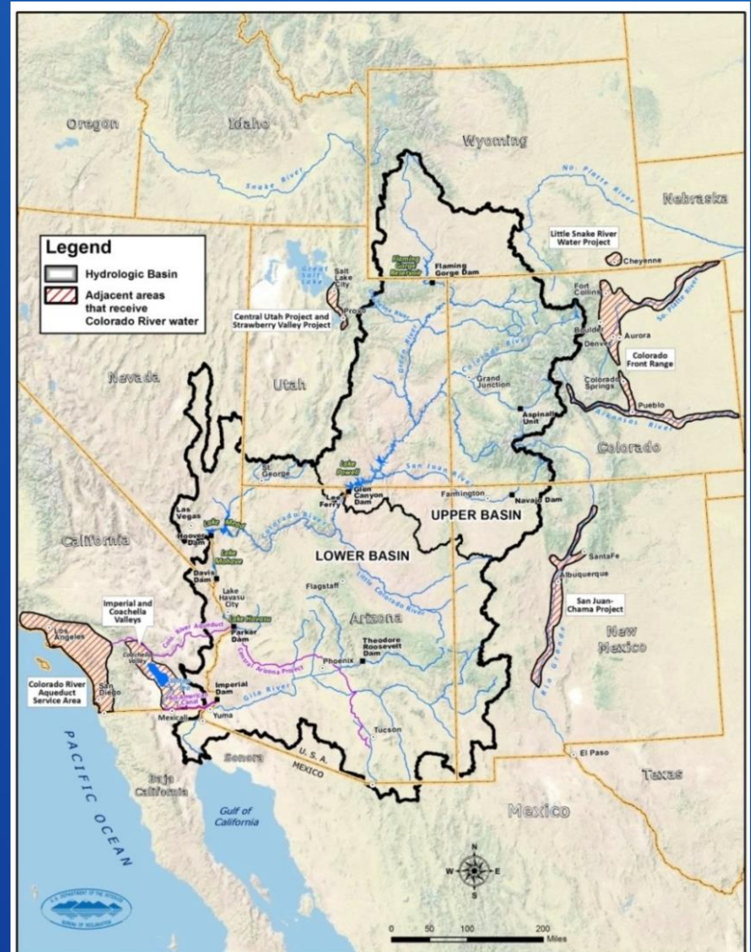
Part 2:

Operational Framework, Reservoir Operations, and Drought Response Planning

U.S. Department of the Interior
Bureau of Reclamation

Overview of the Colorado River System

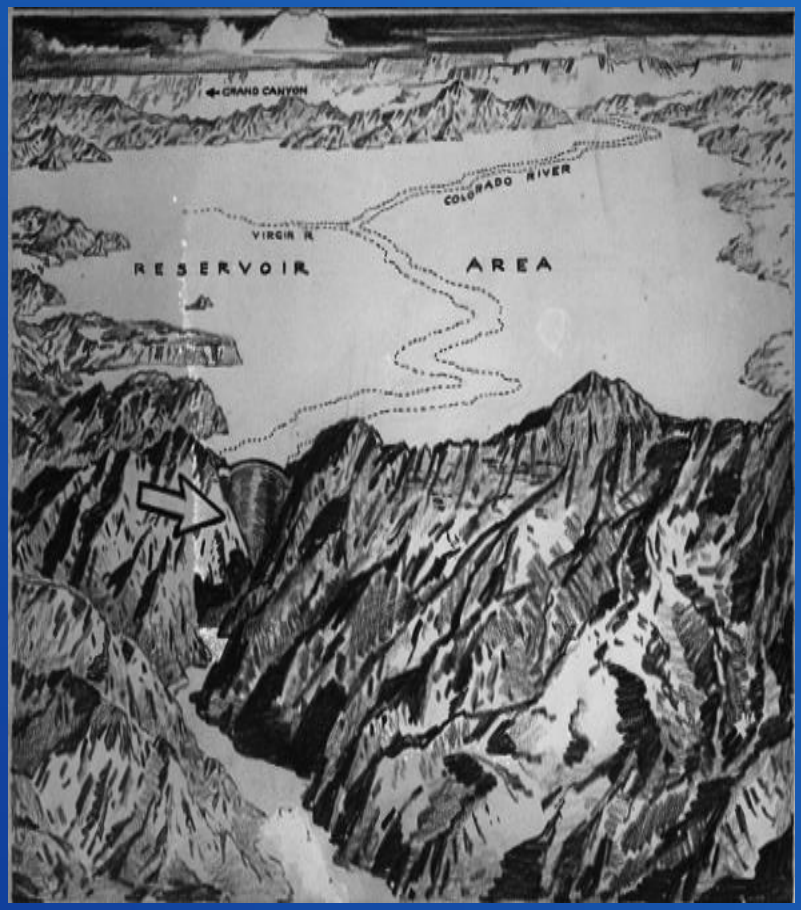
- 16.5 million acre-feet (maf) allocated annually
  - 7.5 maf each to Upper and Lower Basins
  - 1.5 maf to Mexico
- 13.0 to 14.5 maf of consumptive use annually
- 16 maf of average annual "natural flow"
  - 14.8 maf in the Upper Basin and 1.3 maf in the Lower Basin
- Inflows are highly variable year to year
- 60 maf of storage (4 times the annual inflow)
- Operations and water deliveries governed by the "Law of the River"



RECLAMATION

Colorado River Basin "Law of the River"

- Colorado River Compact, 1922
- Boulder Canyon Project Act, 1928
- US-Mexico Water Treaty, 1944
- Upper Colorado River Basin Compact, 1948
- Colorado River Storage Project Act, 1956
- Consolidated Supreme Court Decree, Arizona v. California, 1964 (and following)
- Colorado River Basin Salinity Control Act, 1974 (and following)
- Colorado River Basin Project Act, 1968



Sketch of proposed Boulder Canyon dam site and reservoir, circa 1921

RECLAMATION

Key Provisions in the 1928 Boulder Canyon Project Act

- Ratified the 1922 Compact
- Authorized the construction of Hoover Dam, including dam and reservoir priorities for water use, and related irrigation facilities in the lower Basin
- Authorized and directed the Secretary of the Interior to function as the sole contracting authority for Colorado River water use in the Lower Basin
- Apportioned the Lower Basin's 7.5 maf among the states of Arizona, California, and Nevada

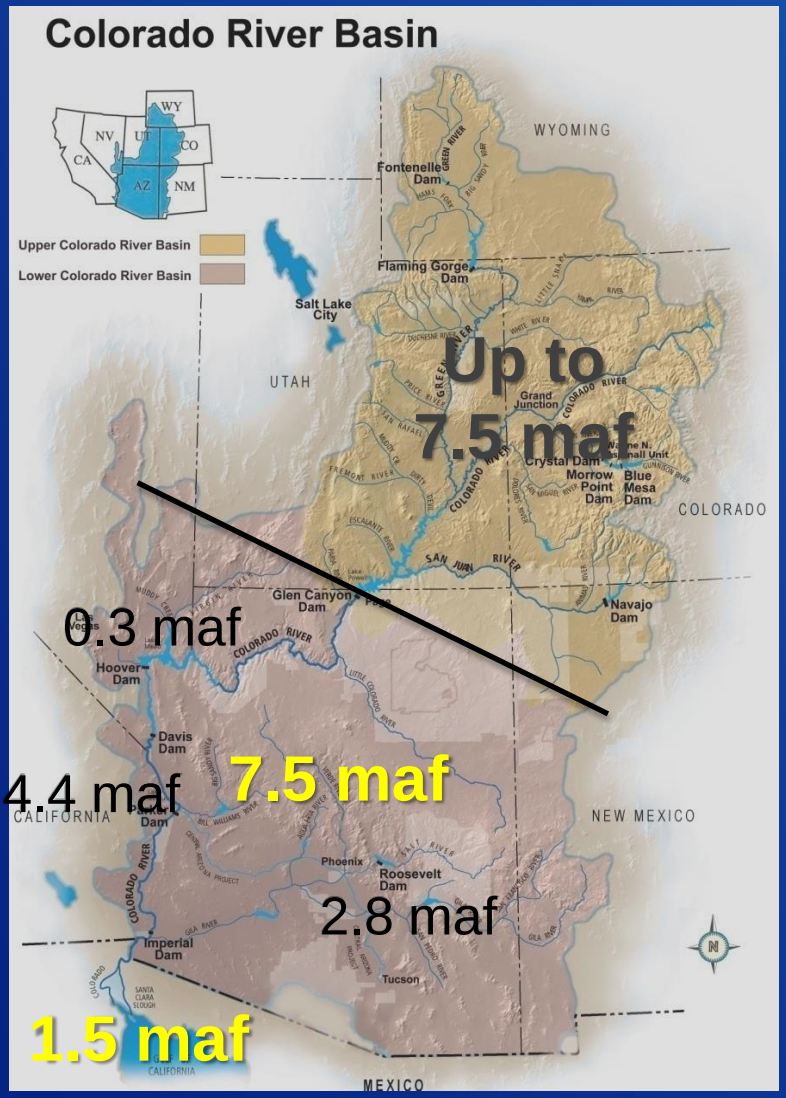
1928 Boulder Canyon Project Act, Section 6

- Authorizes… "[t]hat the dam and reservoir provided for by section 1 hereof shall be used:
  - First, for river regulation, improvement of navigation, and flood control;
  - second, for irrigation and domestic uses and satisfaction of present perfected rights in pursuance of Article VIII of said Colorado River compact; and
  - third, for power."

Secretary's Role as Water Master in the Lower Colorado Region

- Reclamation's Lower Colorado Region acts on behalf of the Secretary to carry out the Water Master role
- The Water Master role stems from the 1928 Boulder Canyon Project Act and the 2006 Consolidated Supreme Court Decree in *Arizona* v. *California*
- The Secretary performs role similar to state engineers on other river systems in the West

Lower Basin Annual Water Deliveries



- Annual water deliveries include:
  - California 4.4 maf
  - Arizona 2.8 maf
  - Nevada 0.3 maf
  - Mexico 1.5 maf
  - Reservoir regulation of Lakes Mohave and Havasu
  - System gains and losses
- Deliveries can be larger or smaller under surplus or shortage conditions, or to meet other delivery requirements

RECLAMATION

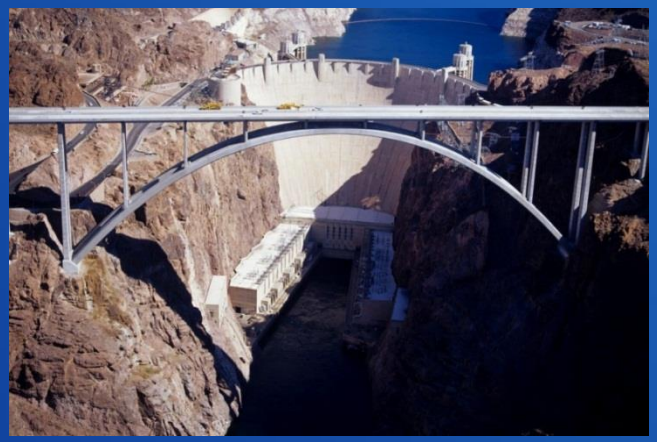
Lake Powell and Lake Mead Coordinated Operations and Agreements related to Lower Basin Water Delivery

Powell/Mead Coordinated Operations

- Lake Powell Filling Criteria, 1962
- Long-Range Operating Criteria, 1970 (minor modifications in 2005)
- Interim Surplus Guidelines, 2001
- 602(a) Storage Guideline, 2004
- Coordinated Operations Interim Guidelines, 2007

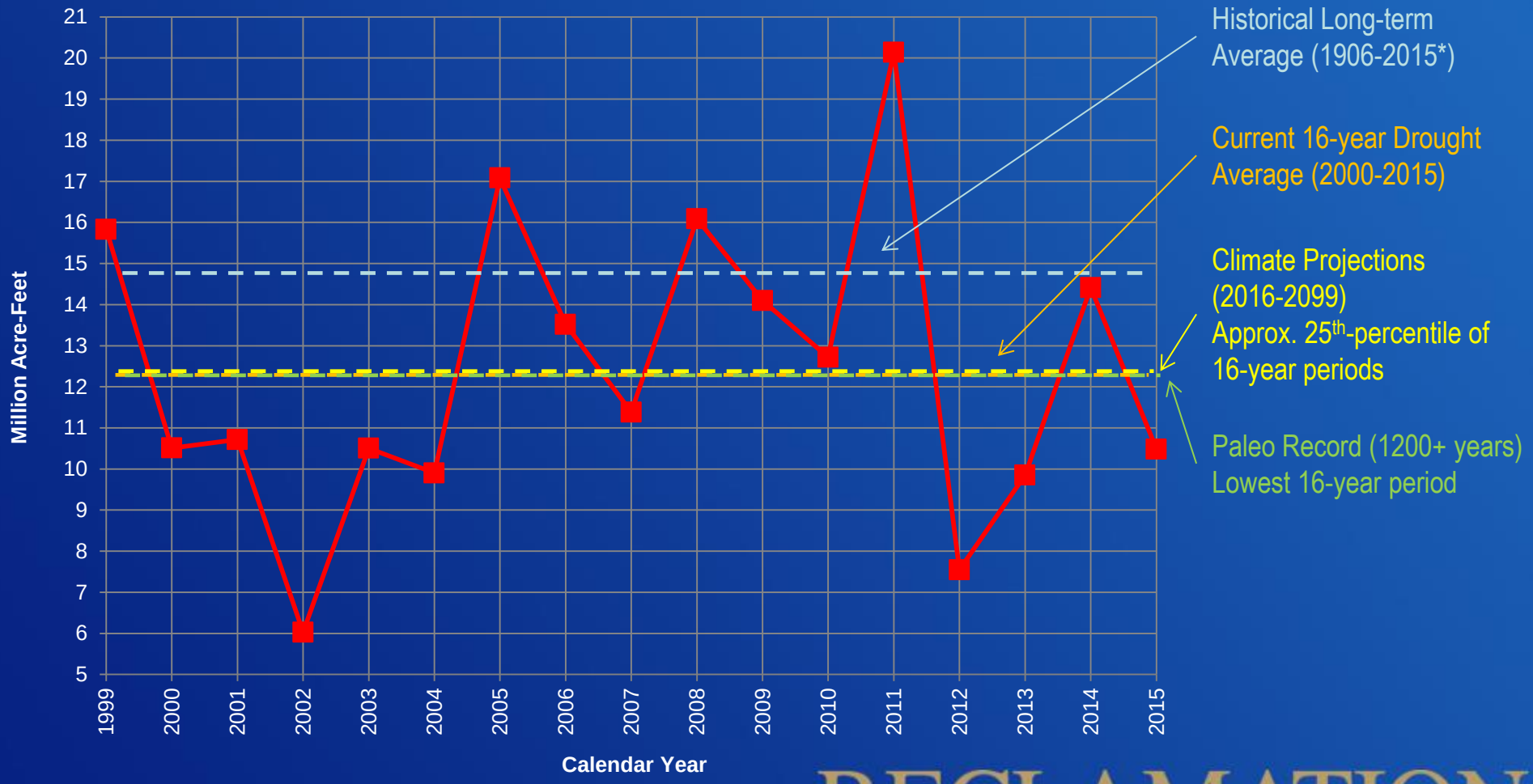
Lower Basin and Mexico Water Delivery

- Offstream Storage of Colorado River Water, 1999
- Interim Surplus Guidelines, 2001
- Colorado River Water Delivery Agreement, 2003
- Coordinated Operations Interim Guidelines, 2007
- IBWC Minute 319, 2012
- IOPP, Unused Water, and ICS procedures



Current 16-year Drought (2000-2015)

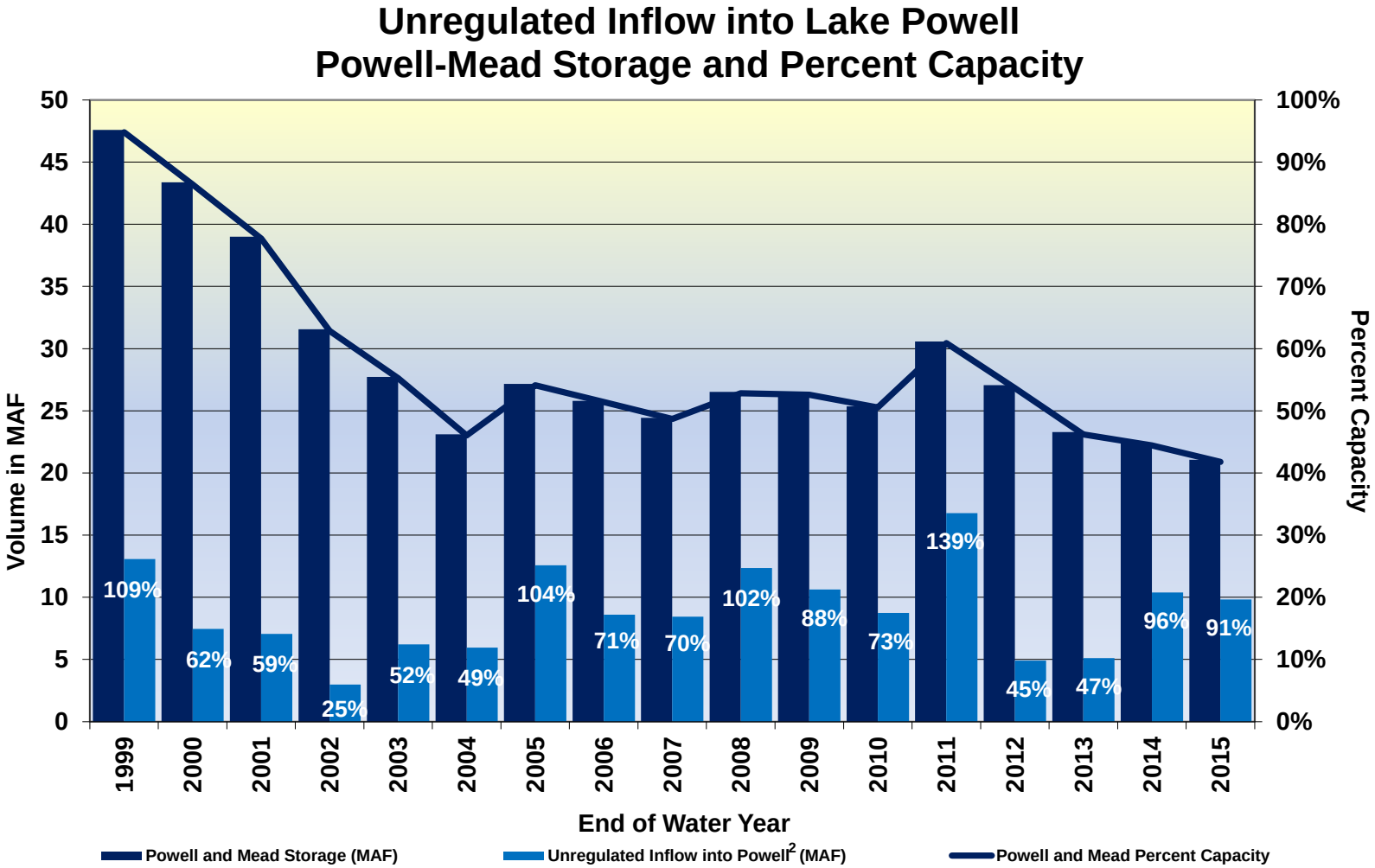
Natural Flow at Lees Ferry



*2013-2015 natural flows are provisional

RECLAMATION

State of the System (Water Years 1999-2015)[1]



[1]Values for water year 2015 are projected. Unregulated inflow is based on the latest CBRFC forecast dated July 1, 2015. Storage and percent capacity are based on the June 2015 24-Month Study.

[2]Percentages at the top of the light blue bars represent percent of average unregulated inflow into Lake Powell for a given water year. Water years 1999-2011 are based on the 30-year average from 1971 to 2000. Water years 2012-2015 are based on the 30-year average from 1981-2010.

RECLAMATION

Interim Guidelines for Operation of Lake Powell and Lake Mead

- Key provisions:
  - Operation for Lake Powell and Lake Mead is specified throughout the full range of operation
  - Strategy for shortages in the Lower Basin is specified, including a provision for additional shortages if warranted
  - Mechanism (Intentionally Created Surplus or ICS) is established to encourage efficient and flexible water use in the Lower Basin
- In place for an interim period (through 2026)
- Do not include provisions for Mexico

RECLAMATION

IBWC Minute 319

Cooperative 5-year agreement with Mexico

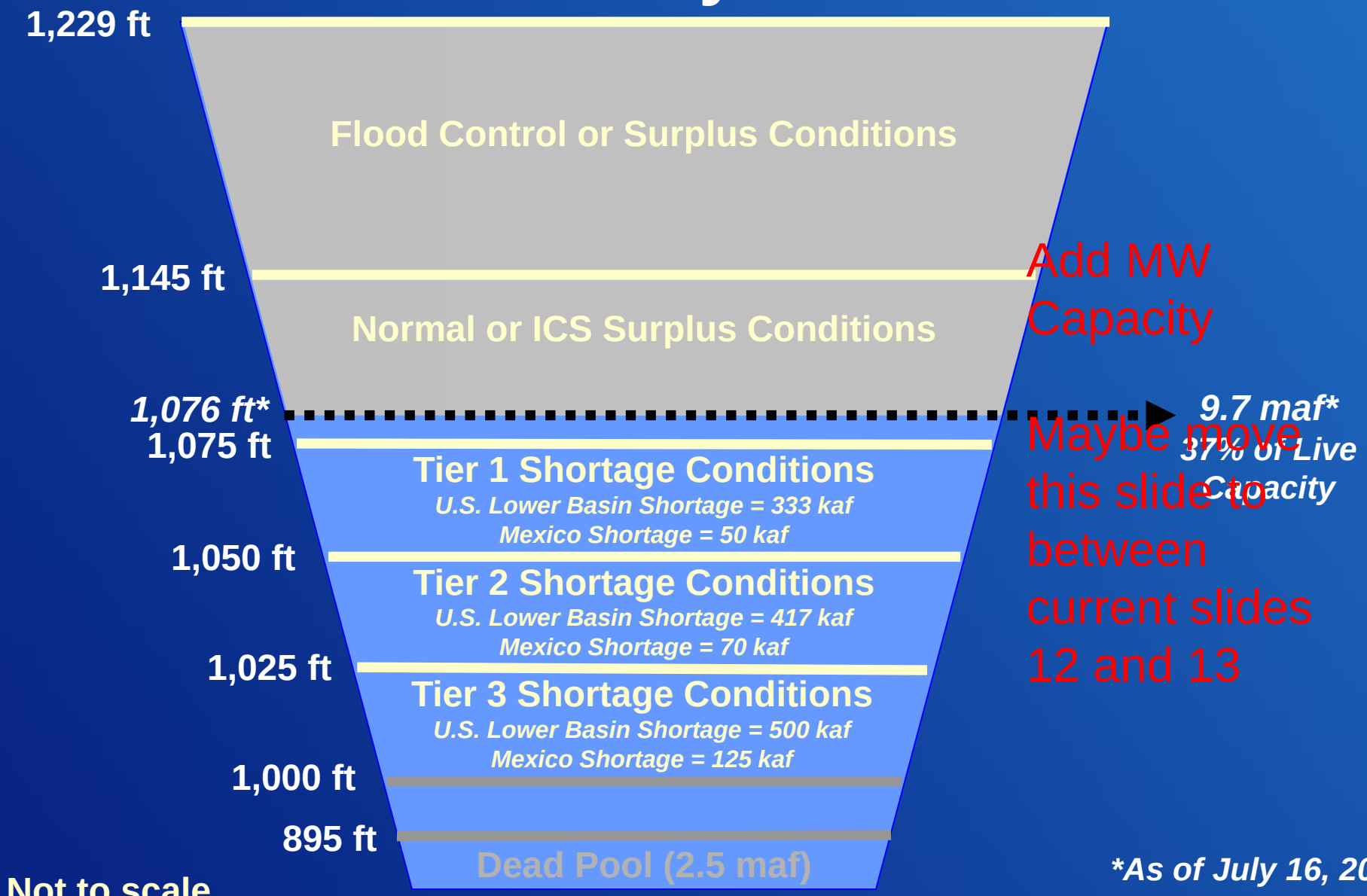
- Historic breakthrough on sharing Colorado River resources
- In place for an interim period from 2013 to 2017
- Provides for storage of Mexican conserved water in Lake Mead
- Shortage and surplus sharing with U.S. water users
- Improved infrastructure for conservation
- Water for the environment in the Colorado River Delta

Damage to canal in Mexico from earthquake, April 2010.

View of riparian area in Colorado River Delta.

RECLAMATION

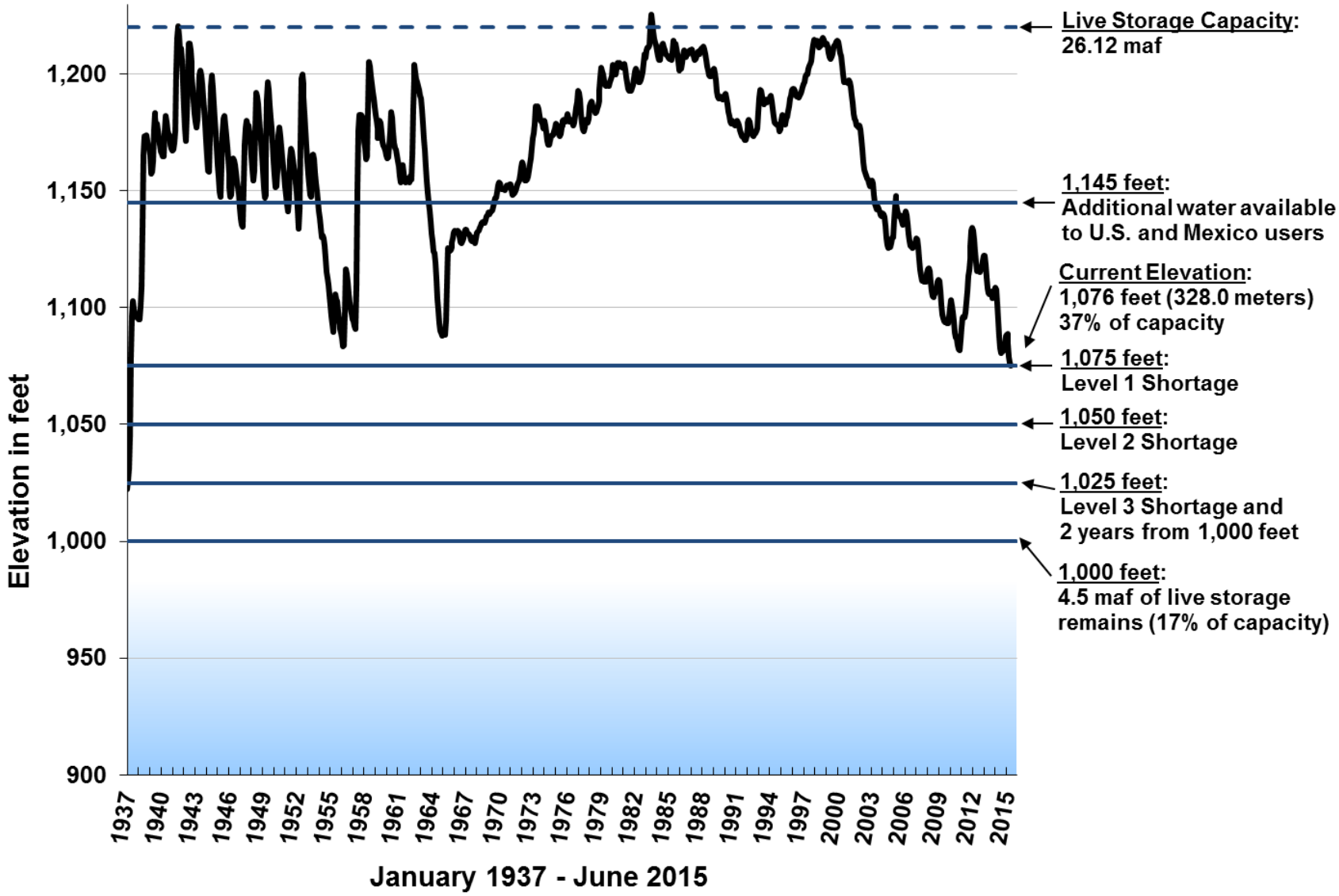
Lake Mead – Key Elevations



[1] U.S. Lower Basin shortage volumes based on the 2007 Interim Guidelines; Mexico shortage volumes based on IBWC Minute 319.

RECLAMATION

Lake Mead Historical Elevations and Critical Elevations



RECLAMATION

Drought Response Planning

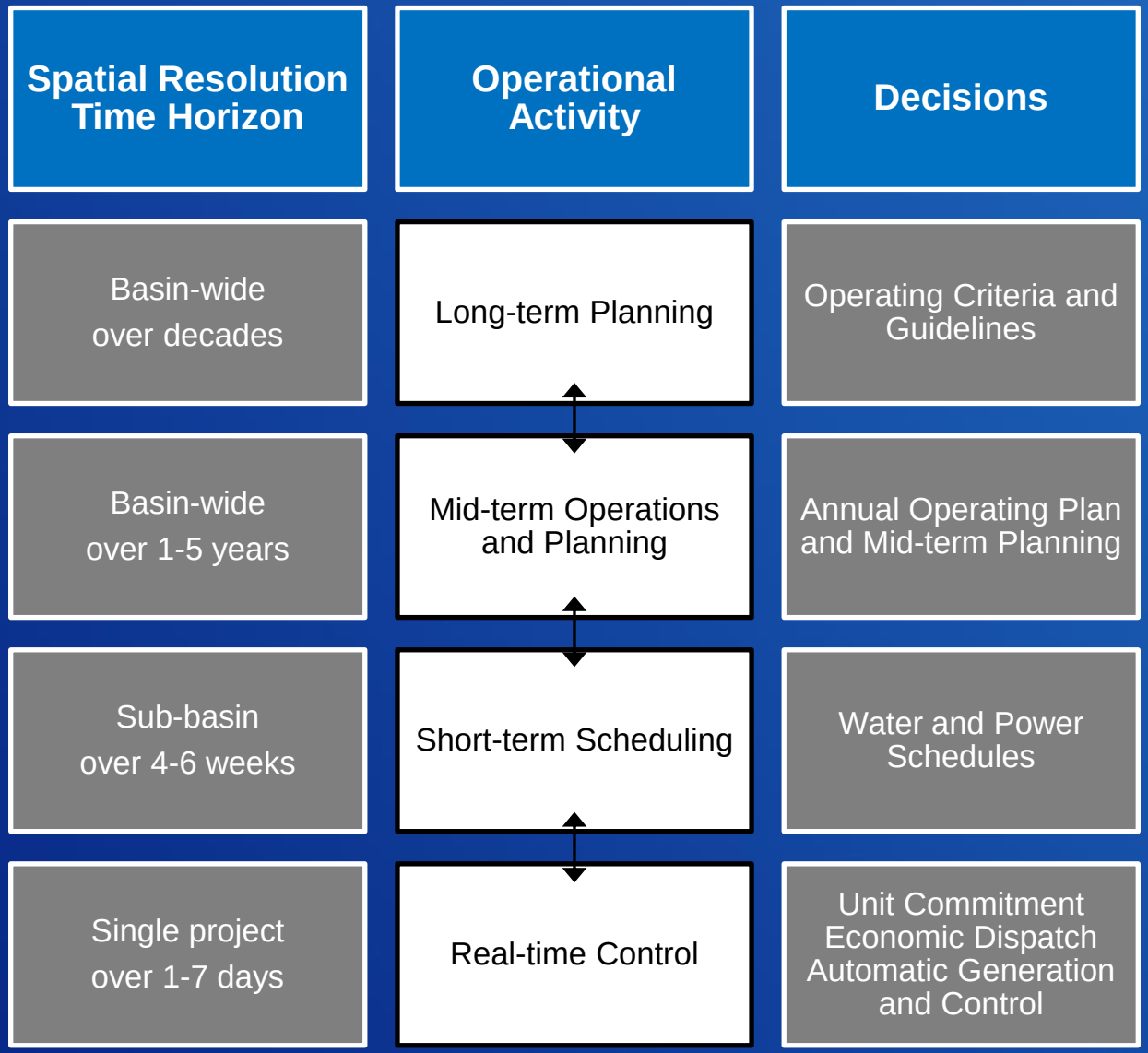
Basin-wide Pilot System Conservation Program

- Funders: Reclamation, CAWCD, SNWA, MWD, and Denver Water
- Provides $11 million for voluntary pilot projects that create system water
- Anticipate that the first implementation agreements will be signed during spring/summer of 2015

Lower Basin Agreement for Pilot Drought Response Actions

- Participants: CAWCD, MWD, SNWA, Lower Basin States, and Reclamation
- 2014-2017 Goal: Generate 740,000 acre-feet of water to benefit Lake Mead elevation
- 2014-2019 Goal: Generate 1.5 to 3.0 maf of water to benefit Lake Mead elevation

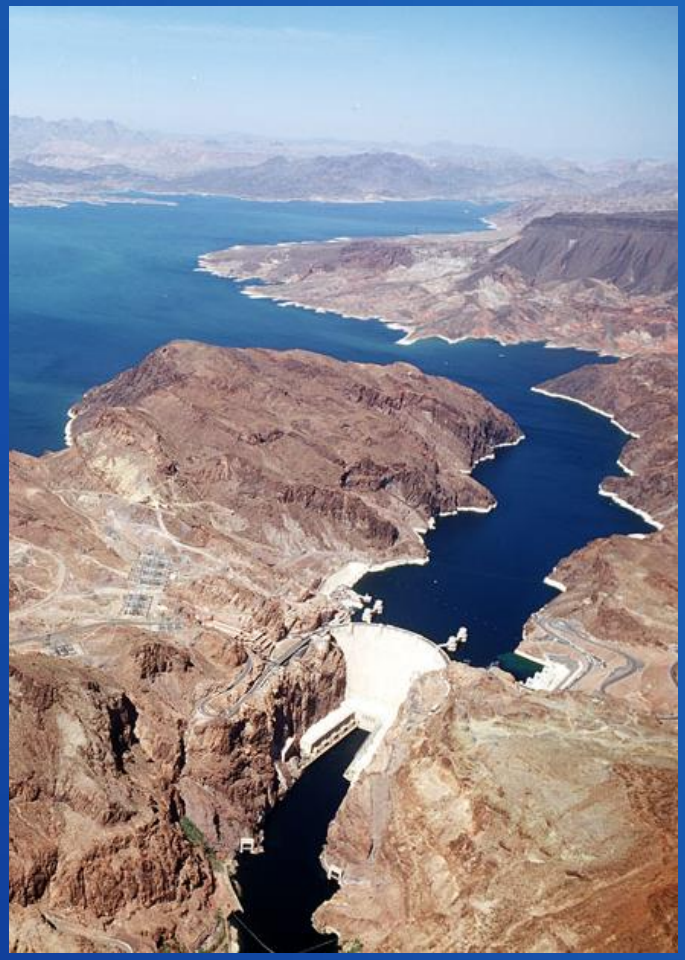
Operational Decision-making Hierarchy



RECLAMATION

Operation of Lake Mead and Hoover Dam

- Two modes of operation govern the releases from Lake Mead
  - Flood Control (releases in excess to downstream water delivery requests)
  - Meet the downstream water delivery requests
- Flood Control operations governed by U.S. Corps of Engineers regulations



Lake Mead

Hoover Dam

Lake Mohave

Davis Dam

Lake Havasu

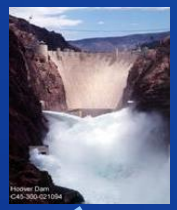
Parker Dam

Coordinating Energy Targets with Western

- Hoover Dam
  - Set monthly release volume, convert to gross energy target, and provide target to Western Area Power Administration
- Parker and Davis Dams
  - Set daily releases to meet water deliveries and elevation targets at Lakes Mohave and Havasu
  - Set hourly releases within the day to help meet peak power demands and special operations while still meeting daily water deliveries

Operation of Hoover Dam

- Hoover is a peaking powerplant
- Monthly energy targets are disaggregated into each contractor's share by Western
- Each contractor schedules its energy to meet energy demands on a real-time basis
- Monthly gross energy target is met within ± 2 percent
- Reclamation may change monthly gross energy target within the month based on system conditions



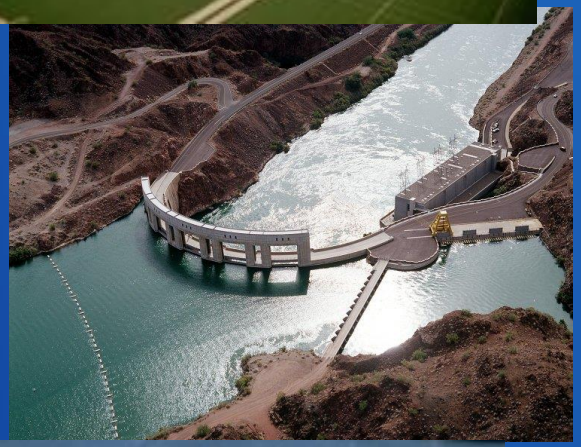
Operation of Davis and Parker Dams

- Water released from Davis Dam reaches Lake Havasu in about 1½ days
- CAP and MWD diversion schedules are coordinated with BCOO
- Yuma Area Office develops daily Parker water orders for users below Parker Dam
- Water released from Parker Dam reaches Yuma, Imperial Valley, and northern Mexico in about 3 to 4 days

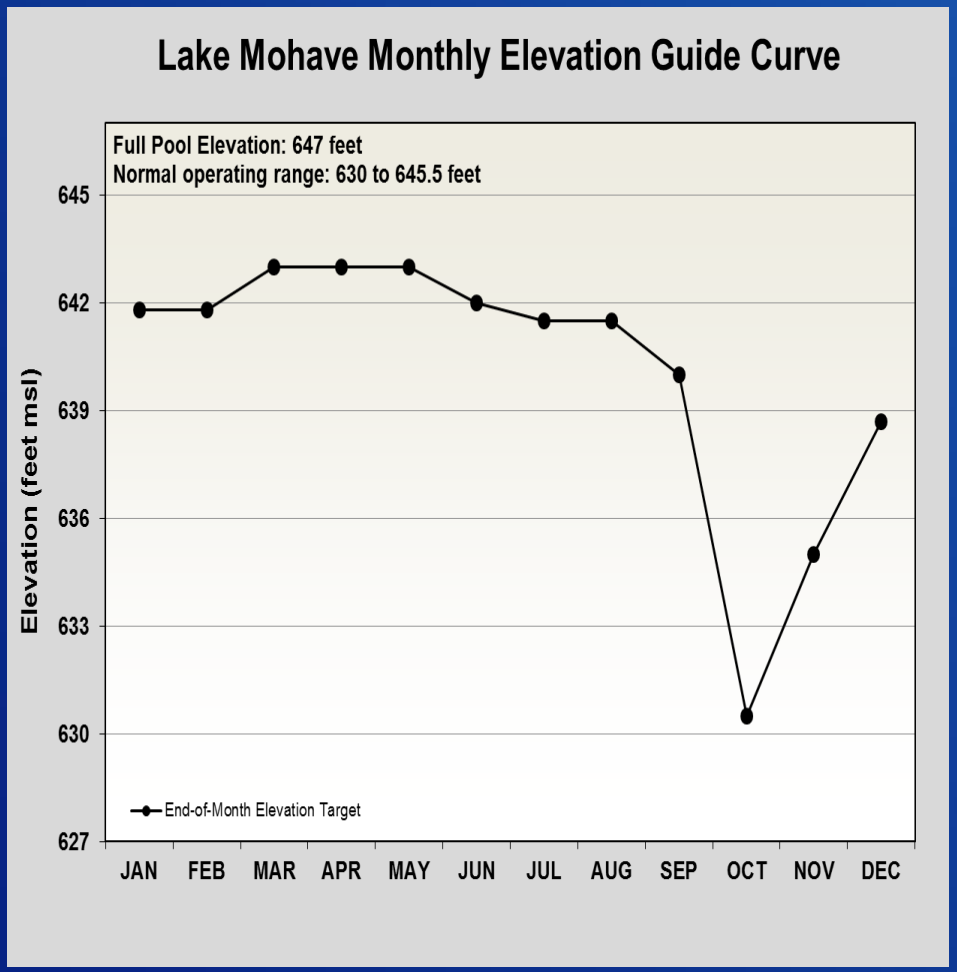
RECLAMATION

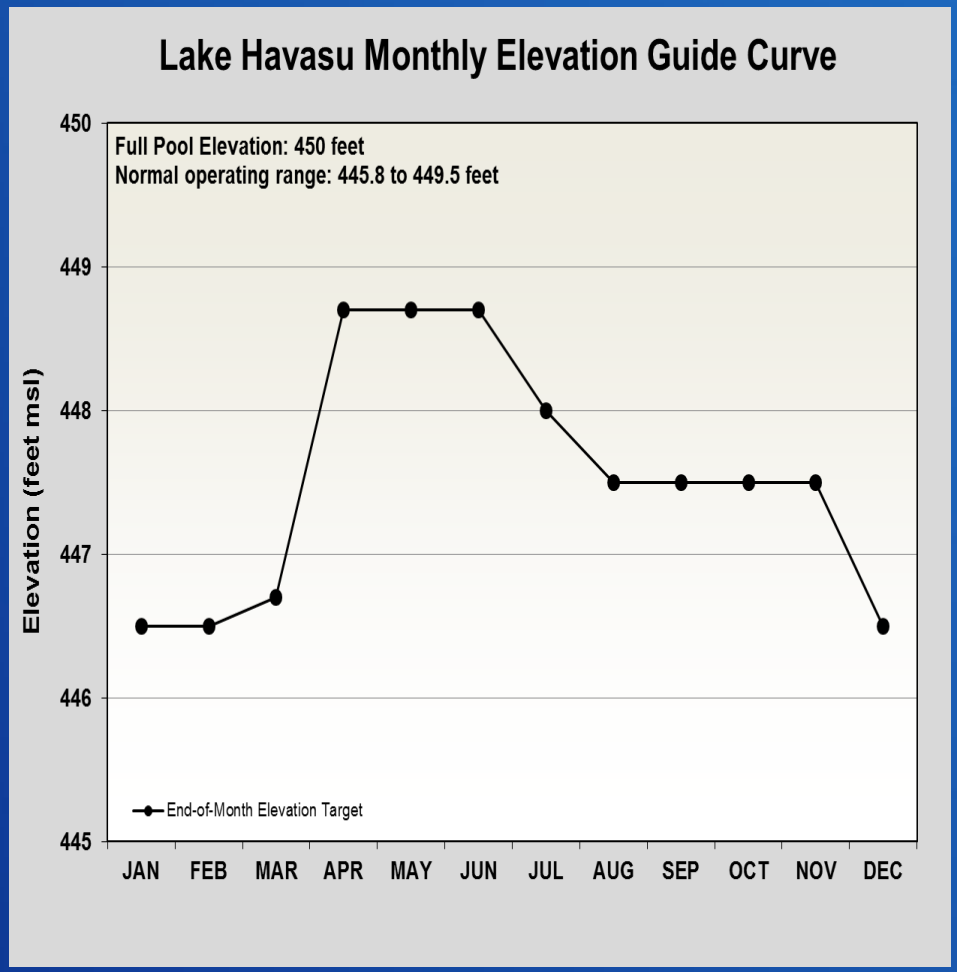
Operation of Davis and Parker Dams

- Monthly elevation targets for Lake Mohave and Lake Havasu are considered when setting Lake Mead releases
- Monthly elevation targets are based on:
  - Flood control operations
  - Water for downstream delivery
  - Environmental constraints
  - Recreational and boater safety considerations
- Releases from Davis and Parker are scheduled on an hourly basis
  - Hydropower projections are coordinated with Western



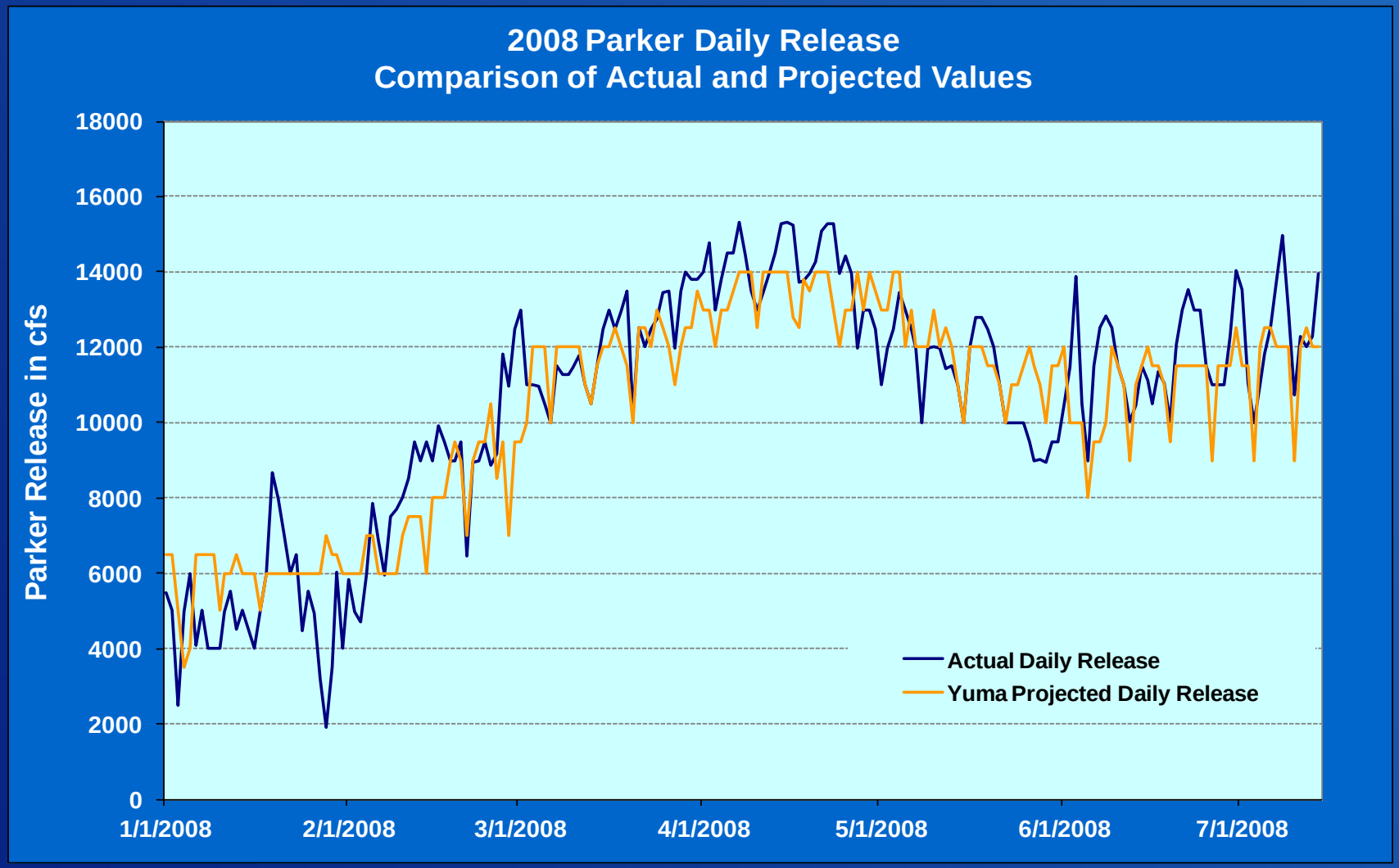
Monthly Elevation Guide Curves for Lake Mohave and Lake Havasu





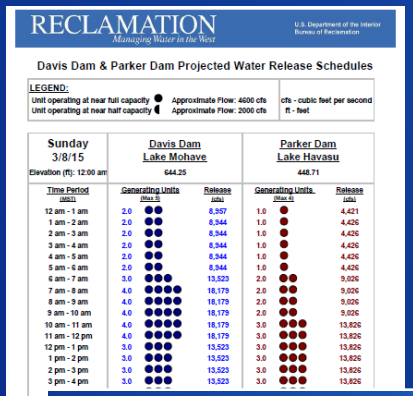
RECLAMATION

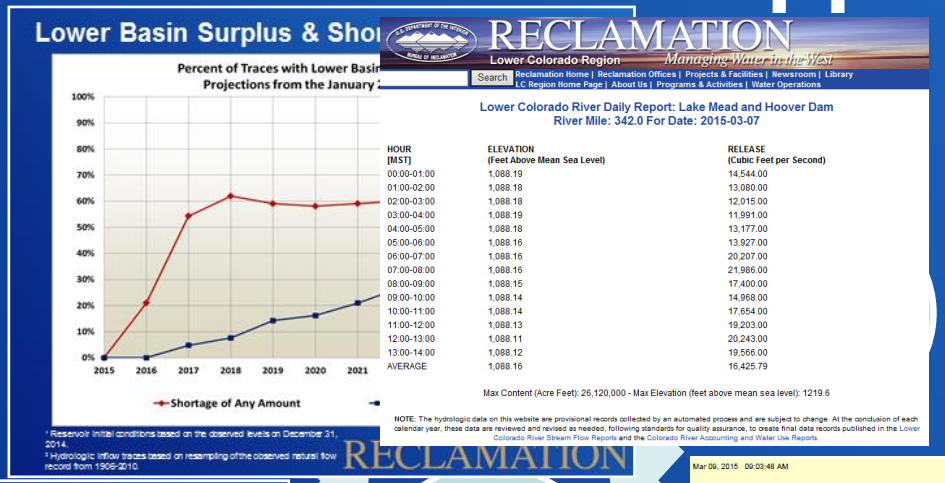
Parker Dam Daily Releases



RECLAMATION

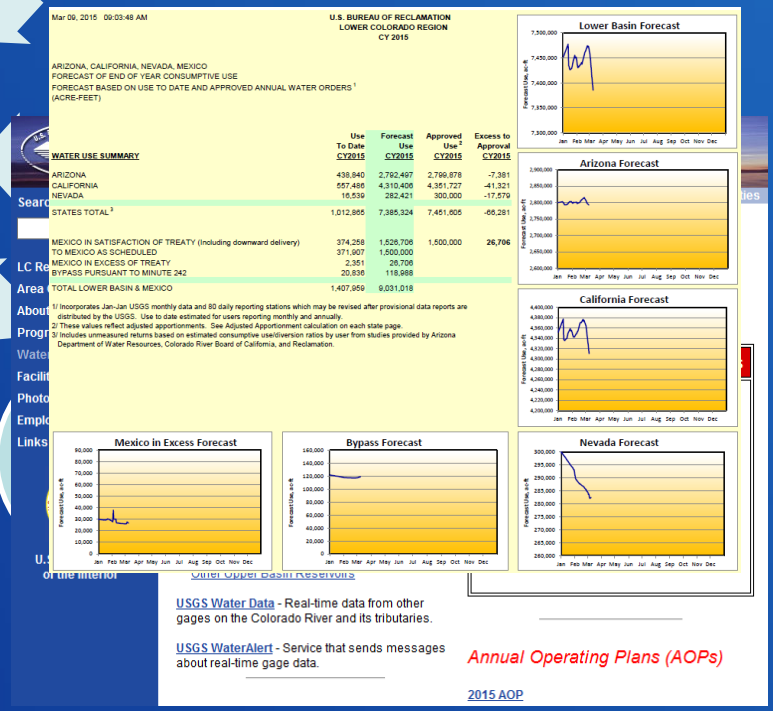
Data-centered Decision Support System





Hydrologic Database (HDB)

Disseminate Information & Knowledge



RECLAMATION

Boulder Canyon Operations Office
Water Operations Control Center

Operational Hours (Pacific Time)

Monday through Friday from 7:30 a.m. to 4:00 p.m.
Federal holidays and weekends (Saturday and Sunday) from 12:30 p.m. to 2:30 p.m.

Contact Information

Telephone: (702) 293-8373
Fax: (702) 293-8454
Email: bcoowaterops@usbr.gov
Web: http://www.usbr.gov/lc/riverops.html

Additional Contact Information

Daniel Bunk *River Operations Manager*	(702) 293-8013	dbunk@usbr.gov
Steven Hvinden *Chief, Boulder Canyon Operations Office*	(702) 293-8415	shvinden@usbr.gov
Rose Davis *Public Affairs Officer*	(702) 293-8421	jdavis@usbr.gov


For further information:
http://www.usbr.gov/lc/riverops.html
BCOOWaterOps@usbr.gov

Conner, Kelly <kconner@usbr.gov>

Fwd: K Cooper Presentation for E&OC 5/20/15

1 message

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:32 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

---------- Forwarded message ----------
From: **Cooper, Keith** <kycooper@usbr.gov>
Date: Tue, May 19, 2015 at 1:28 PM
Subject: K Cooper Presentation for E&OC 5/20/15
To: Connie Hack <chack@usbr.gov>
Cc: Mark Cook <MRCook@usbr.gov>, Brandon Hilliard <bhilliard@usbr.gov>, George Wendt <gwendt@usbr.gov>

Connie,
Please find my presentation for the Effect of Low Power Pool on Turbines at Hoover Dam.

Please let me know if you need any additional info. I'll be out of the office but available via cell 702-569-3491.

--
Thanks,

Keith Cooper
Mechanical Engineer, EIT
ICML MLT-1
(702) 494-2420
kycooper@usbr.gov

E and OC May 2015.ppt
7102K

Conner, Kelly <kconner@usbr.gov>

Fwd: Key Points - Hoover hydropower/Lake Mead water levels

2 messages

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:33 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

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Mark
---------- Forwarded message ----------
From: **Davis, Jeannette (Rose)** <jdavis@usbr.gov>
Date: Tue, May 5, 2015 at 11:48 AM
Subject: Re: Key Points - Hoover hydropower/Lake Mead water levels
To: "Cook, Mark" <mrcook@usbr.gov>

Thank you Mark!!
Rose

On Tue, May 5, 2015 at 11:46 AM, Cook, Mark <mrcook@usbr.gov> wrote:

> Rose,
> These look like good points to me. Another big accomplishment that we have done is the unit overhauls and wicket gate replacements. Through this program to date, we have reclaimed 105 MW of capacity. It is about equivalent to having added another generator at the dam! Instead of the 1573 MW available today, we would only have 1468 MW available had we not done this work.
>
> The 950 elevation designation is not official yet. The phrase I like to use is "Our minimum power pool is 1050, but we are in the process of revising it to be 950."
>
> Thanks,
> Mark
>
> On Mon, May 4, 2015 at 4:09 PM, Davis, Jeannette (Rose) <jdavis@usbr.gov> wrote:
>
> > Hi Mark,
> > I put together some messages about low water levels in Lake Mead and the effects/interaction with hydropower generation. I had some hits and some misses. Chau and Larry Carr made some edits and I'm sending this to you for your edits.
> >
> > I am hoping the language can stay fairly simple so I can understand it myself and explain it as needed.
> > Please review and make your edits?
> > I really appreciate it.
> > Rose
> > ---------- Forwarded message ----------
> > From: **Nguyen, Chau** <cnguyen@usbr.gov>
> > Date: Mon, May 4, 2015 at 4:05 PM
> > Subject: Re: Key Points - Hoover hydropower/Lake Mead water levels
> > To: "Davis, Jeannette (Rose)" <jdavis@usbr.gov>
> >
> > Rose,
> > Attached is the revised key points with comments from me, Larry and Dan Bunk.
> >
> > Chau

On Thu, Apr 30, 2015 at 12:01 PM, Davis, Jeannette (Rose) <jdavis@usbr.gov> wrote:

> Thank you so much!!
> I made that mistake with KJZZ last Friday so rest assured with your tutoring me and working with the talking points we will get it right in the future. I really appreciate you!
> Rose
>
> On Thu, Apr 30, 2015 at 11:27 AM, Nguyen, Chau <cnguyen@usbr.gov> wrote:
>
> > Rose,
> > I will review the draft talking with Larry and provide you with the corrections before you send to Mark Cook for review.
> >
> > Chau
> >
> > On Wed, Apr 29, 2015 at 10:19 AM, Davis, Jeannette (Rose) <jdavis@usbr.gov> wrote:
> >
> > > Hi Chau,
> > > Here is my first cut at some talking points for the hydro questions we are getting. Would you review and make any corrections and then we'll send them to Mark?
> > > Thanks so much,
> > > Rose
> > >
> > > --
> > > Rose Davis, MPA
> > > Public Affairs Officer
> > > Lower Colorado Region
> > > Bureau of Reclamation
> > > (o) 702-293-8421
> > > (c) 702-591-0029
> > > jdavis@usbr.gov
> > >
> > > Check us out at: http://www.usbr.gov/lc/
> >
> > --
> > Chau B. Nguyen, P.E., PMP
> > Chief, Power Office
> > Bureau of Reclamation
> > Lower Colorado Regional Office
> > (W) 702-293-8125
> > (C) 702-278-9753
>
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Check us out at: http://www.usbr.gov/lc/

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:34 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark
--------- Forwarded message ---------
From: **Cook, Mark** <mrcook@usbr.gov>
Date: Tue, May 5, 2015 at 11:46 AM
Subject: Re: Key Points - Hoover hydropower/Lake Mead water levels
[Quoted text hidden]

Conner, Kelly <kconner@usbr.gov>

Fwd: Low Lake Projections

1 message

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:36 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

---------- Forwarded message ----------
From: **Aaron Muehlberg** <aaron.muehlberg@gmail.com>
Date: Tue, Mar 17, 2015 at 3:51 PM
Subject: Low Lake Projections
To: "Cook, Mark" <mrcook@usbr.gov>, "Cooper, Keith" <kycooper@usbr.gov>

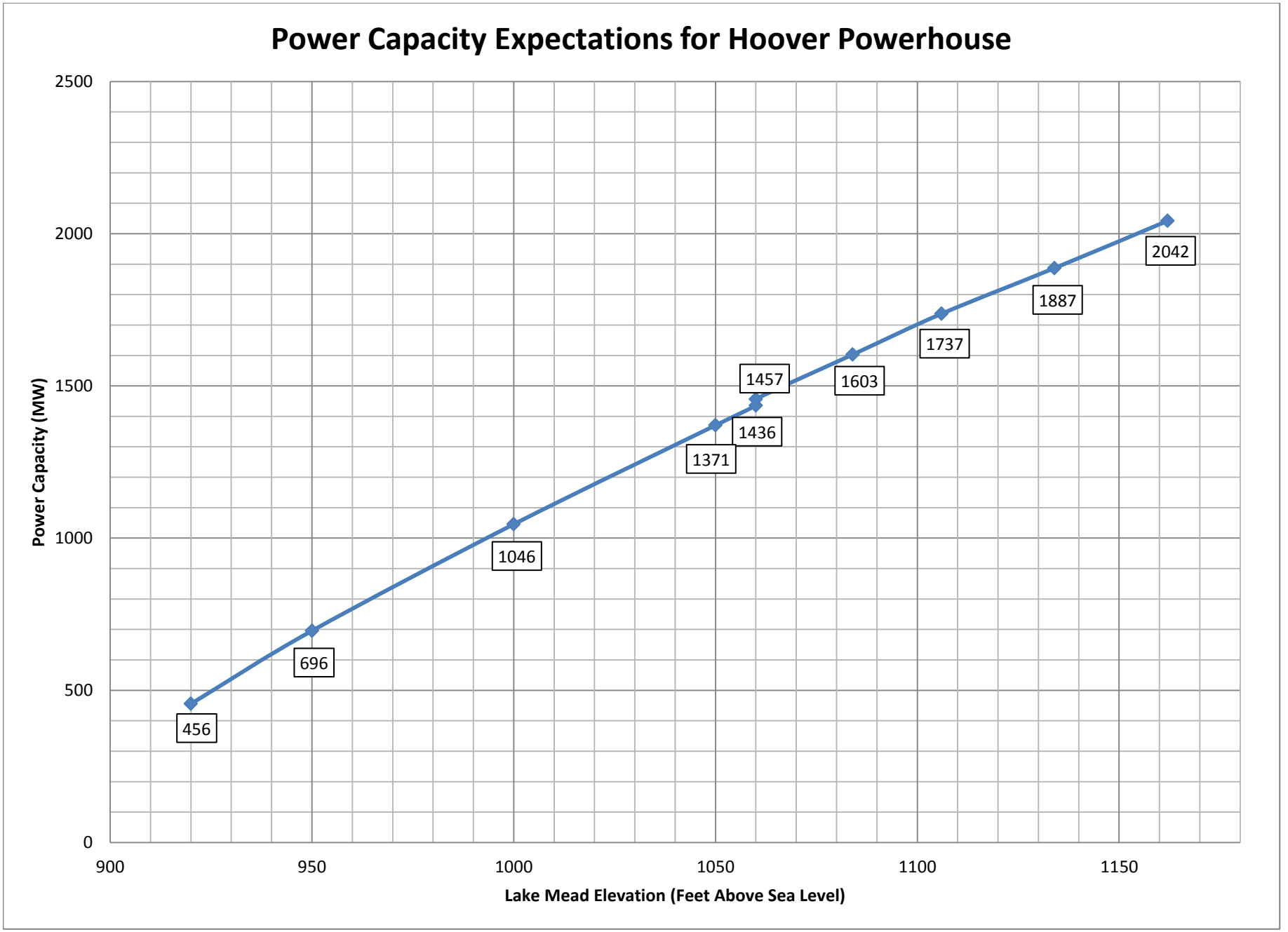
So I found my spreadsheet for projections - looks like I used as much real data as possible, then interpolated based on model test results for power output. Has a good plot also.

As far as what led to the now operation above rough zone - If I had the N1-N4 model test I think it would be more clear. That Allis design is more or less 9 of your remaining machines. I am almost certain you will find some very basic sigma/cavitation info that tells you not to run the machines at high loads with low tailbays. It will only get worse as the head drops, if I remember right, then also with your rough zone growing.

Both somewhat short answers, but hopefully it steers you in the right direction. Please call anytime with things like this. I still very much enjoy the updates and helping understand the work I did. Let me know if it does or does not help. The model test paper helps understand where the cavitation will be, and the tests will show it better. Have a good one.

-Aaron

Estimates of Low Elevation Power Outputs of Hoover_8-2013.xlsx
18K


Power Capacity Expectations for Hoover Powerhouse
Power Capacity (MW)
2500
2000
1500
1000
500
0
900
950
1000
1050
1100
1150
Lake Mead Elevation (Feet Above Sea Level)
456
696
1046
1371
1436
1457
1603
1737
1887
2042

Fwd: Assumptions for Hoover analysis in LTEMP EIS

1 message

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:25 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

Thanks,
Mark

---------- Forwarded message ----------
From: **Skordas, Robert** <rskordas@usbr.gov>
Date: Tue, Oct 27, 2015 at 1:02 PM
Subject: Fwd: Assumptions for Hoover analysis in LTEMP EIS
To: Britt Bowen <bbowen@usbr.gov>
Cc: Mark Cook <MRCook@usbr.gov>

Britt:

Can you respond? I ran out of time and Mark is out. I know we've been working to lower the Power Pool to elevation 950'. Mark should be in tomorrow morning if you don't have time or wish to consult before responding.

Thank you for the help,
Rob

---------- Forwarded message ----------
From: **Tighi, Shana** <stighi@usbr.gov>
Date: Tue, Oct 27, 2015 at 11:46 AM
Subject: Assumptions for Hoover analysis in LTEMP EIS
To: Robert Skordas <rskordas@usbr.gov>, Mark Cook <mrcook@usbr.gov>
Cc: "LaGory, Kirk E." <lagory@anl.gov>, tdveselka@anl.gov, lapoch@anl.gov, Larry Karr <lkarr@usbr.gov>

Hi Rob and Mark,

As you may be aware, UC Region is working with Argonne National Laboratory on an EIS for Glen Canyon Dam - Long Term Experimental and Management Plan (LTEMP). Based on comments they received during the cooperating agency draft review, they are adding a short analysis on potential impacts to Hoover Dam power generation.

They had to make some assumptions to perform their analysis and I thought one of you might be (or could refer me to) the appropriate contact to confirm a few basic assumptions. Tom Velseka of Argonne has been coordinating with Larry Karr on some data that provides the basis of the analysis, and I think most of it is reasonable. I just wanted to get your input a a couple of things.

1. Minimum power pool - We at BCOO have still been using 1,050 feet as the "official" minimum power pool.

Given the wide-head turbines, this has obviously lowered, but I understand that it is still somewhat undetermined what the new minimum power pool is. I have suggested to Argonne that they stick with the official number of 1,050 feet, but if you think it is more appropriate for a lower elevation to be published in an EIS, please let us know.

2. The relationship between lake elevation and capacity - If you look at the attached ppt, slide 5, you will see a curve indicating a relationship between lake elevation and Hoover capacity. Tom put this together based on the PO&M-59 reports provided by Larry Karr. This relationship is a strong basis for his analysis, and they are hoping you can provide a bit of a "sanity check" and confirm if this looks reasonable. This curve will not be published in the EIS.

They are on a *very* tight time frame. If one of you are able to respond **within the next day**, then they can revise any assumptions in time to re-run their analysis and include it in the write up for the Public Draft EIS. If not, then they will need to go with their current assumptions and revisit the analysis for the Final EIS.

I appreciate your time and attention. Please let me know if you have any questions or would like to discuss.

Shana

--
Shana Tighi
River Operations Group
Boulder Canyon Operations Office
PO BOX 61470
Boulder City, NV 89006

Office(702) 293-8572
Mobile (702) 374-1864
FAX (702) 293-8454
stighi@usbr.gov

---------- Forwarded message ----------
From: **LaGory, Kirk E.** <lagory@anl.gov>
Date: Tue, Oct 27, 2015 at 9:59 AM
Subject: FW: Oct 27 2015 Hoover Conference Call Presentation.ppt
To: "Billerbeck, Rob P." <rob_p_billerbeck@nps.gov>, "Heffernan, Beverley" <bheffernan@usbr.gov>, "Grantz, Katrina" <kgrantz@usbr.gov>, "Balsom, Janet R." <jan_balsom@nps.gov>, "Veselka, Thomas D." <tdveselka@anl.gov>, "Poch, Leslie A." <lapoch@anl.gov>, "Picel, Kurt C." <kcpicel@anl.gov>, "Tighi, Shana" <stighi@usbr.gov>

Attached is a presentation from Tom Veselka for our discussion in a few minutes.

~~~~~~~~~~~~~~~~~~~~~~~~~~

Kirk E. LaGory, Ph.D.

Ecologist and Program Manager

Rivers and Hydropower Program

Environmental Science Division

Argonne National Laboratory
~~~~~~~~~~~~~~~~~~~~~~~~~~

9700 S. Cass Ave., Building 240

Argonne, Illinois 60439

Office: 630-252-3169

Cell: 630-564-3169

Fax: 630-252-6090

~~~~~~~~~~~~~~~~~~~~~~~~~

From: Veselka, Thomas D.
Sent: Tuesday, October 27, 2015 11:58 AM
To: LaGory, Kirk E. <lagory@anl.gov>
Cc: Poch, Leslie A. <lapoch@anl.gov>
Subject: Oct 27 2015 Hoover Conference Call Presentation.ppt

Kirk,

Attached is a presentation that I quickly put together this morning for the Hoover discussion.

Please distribute.

Thanks

Oct 27 2015 Hoover Conference Call Presentation.ppt
1961K
~~~~~~~~~~~~~~~~~~~~~~~~~

GCD LTEMP EIS IMPACTS ON LAKE MEAD AND THE HOOVER DAM POWERPLANT

Presented to the
LTEMP Management Team
October 27, 2015

by

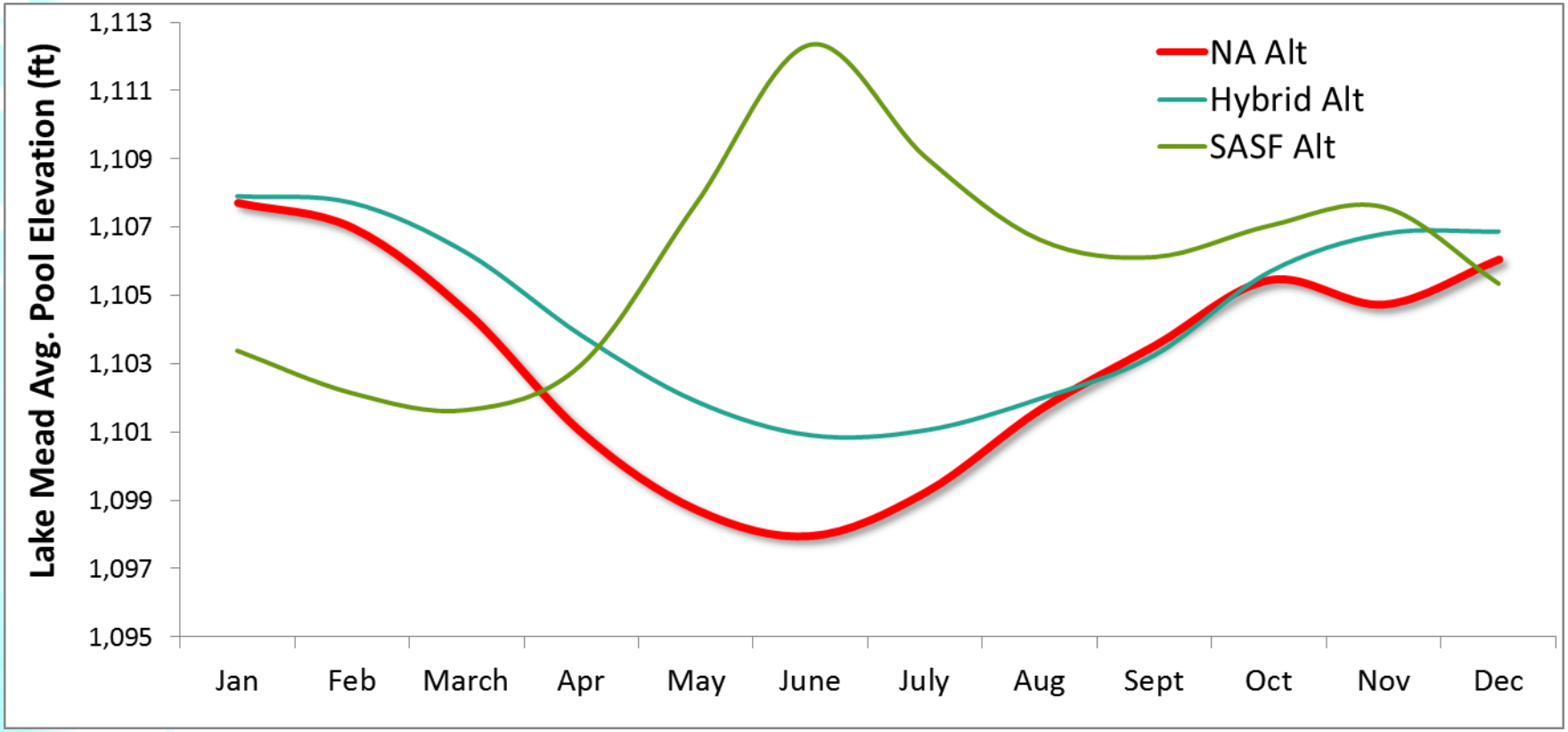
Thomas Veselka and Les Poch
Argonne National Laboratory

Argonne NATIONAL LABORATORY

Lake Mead Reservoir & Hoover Powerplant Overview

- **Lake Mead Reservoir**
  - Reservoir is full when water surface is at the top of the spillway
    - Elevation: 1,221.4 feet
    - Storage: 28,537 TAF
    - Initial conditions are very low; about 1,075 ft
  - Hoover powerplant at full reservoir
    - 17 Francis turbines and 2 Pelton Waterwheel station service units
    - Total hydropower capacity: 2,074 MW
- **Lake Powell/Glen Canyon Dam (GCD) water releases affects Lake Mead reservoir storage/elevation and therefore Hoover power output**
  - Powerplant capacity
  - Powerplant water to power conversion efficiency-- CRSS model results
- **A simplistic Argonne analysis provides "ballpark" insights into the impacts of GCD LTEMP EIS on Hoover Powerplant economics. It uses:**
  - CRSS/SBM monthly results from the 21 traces
  - Historical monthly Hoover Powerplant data from PO&M-59
  - BOR website/presentations and web news articles
  - Information and guidance from BOR (mainly Larry Karr)
  - AURORA adjusted spot market prices over the 20 year experimental period
  - Assumes almost all generation (95%) occurs during on-peak hours

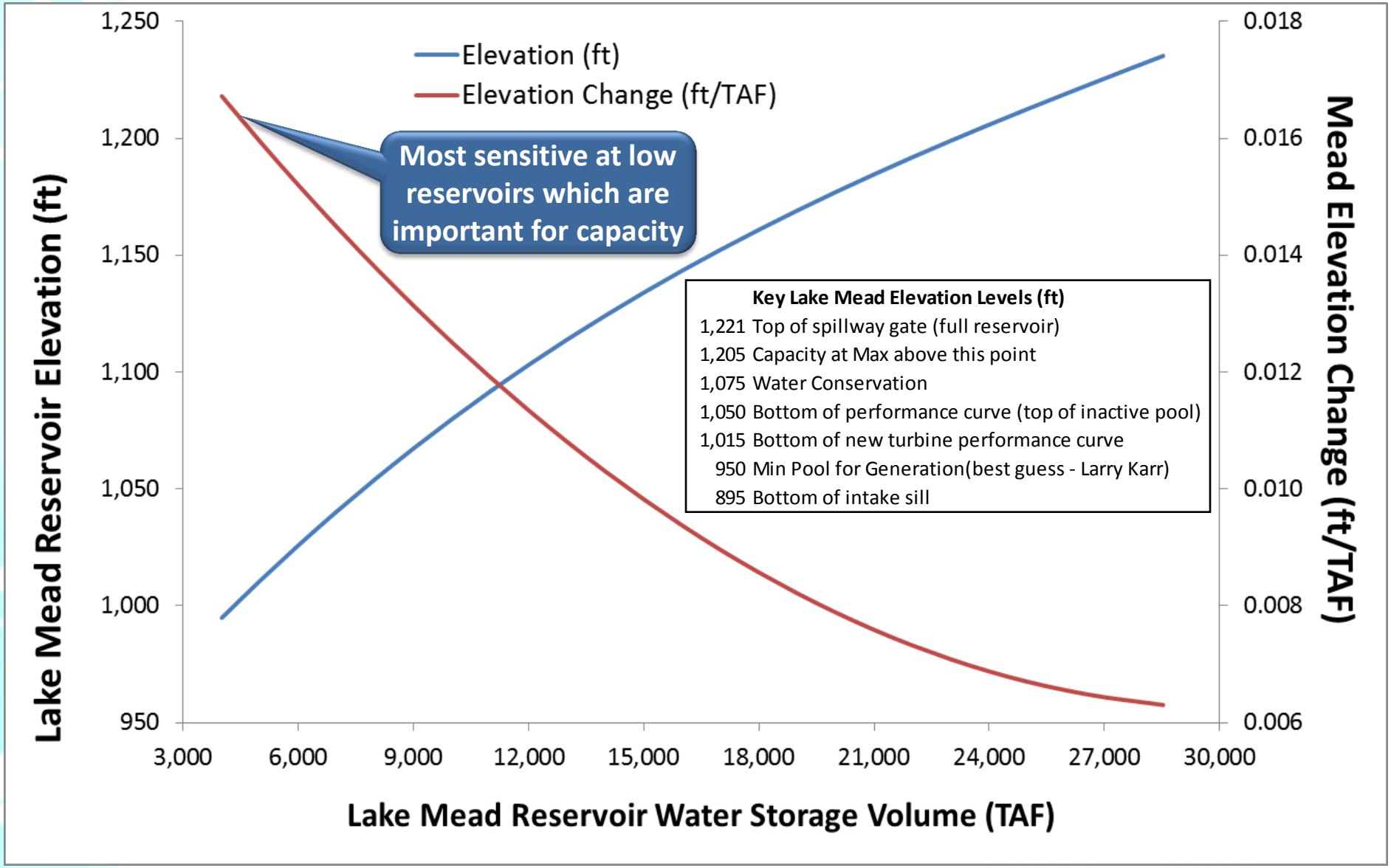
GCD Alternative Affect Lake Mead Reservoir Elevations



- **Hybrid Alternative**
  - Higher Mead elevations throughout most of the year
  - July/Aug elevations critical for capacity are slightly higher

- **SASF Alternative**
  - Except for the winter months Mead elevations are higher
  - July/Aug elevations critical for capacity is significantly higher

Mead Elevation Change Is Most Sensitive at Low Reservoir



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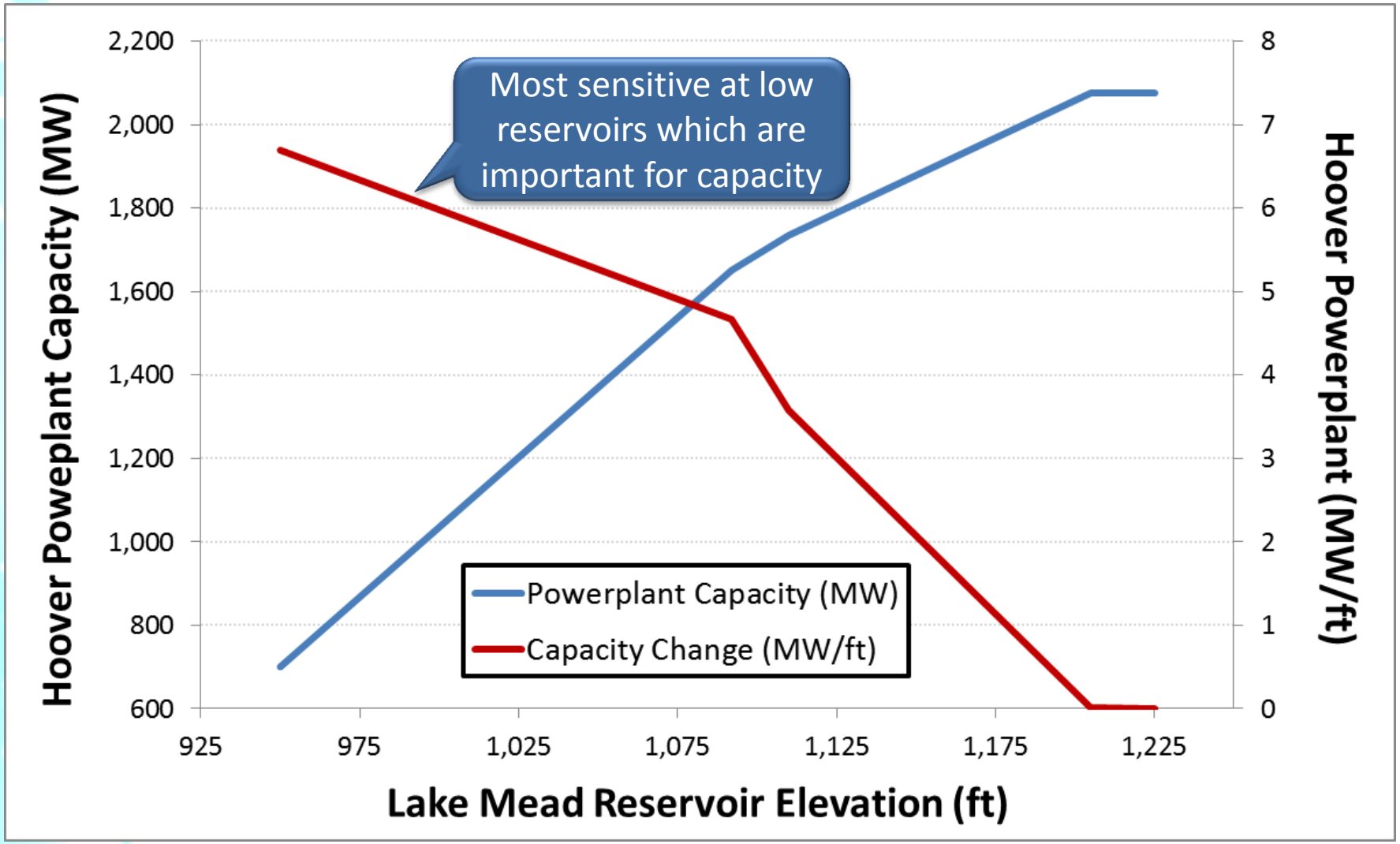
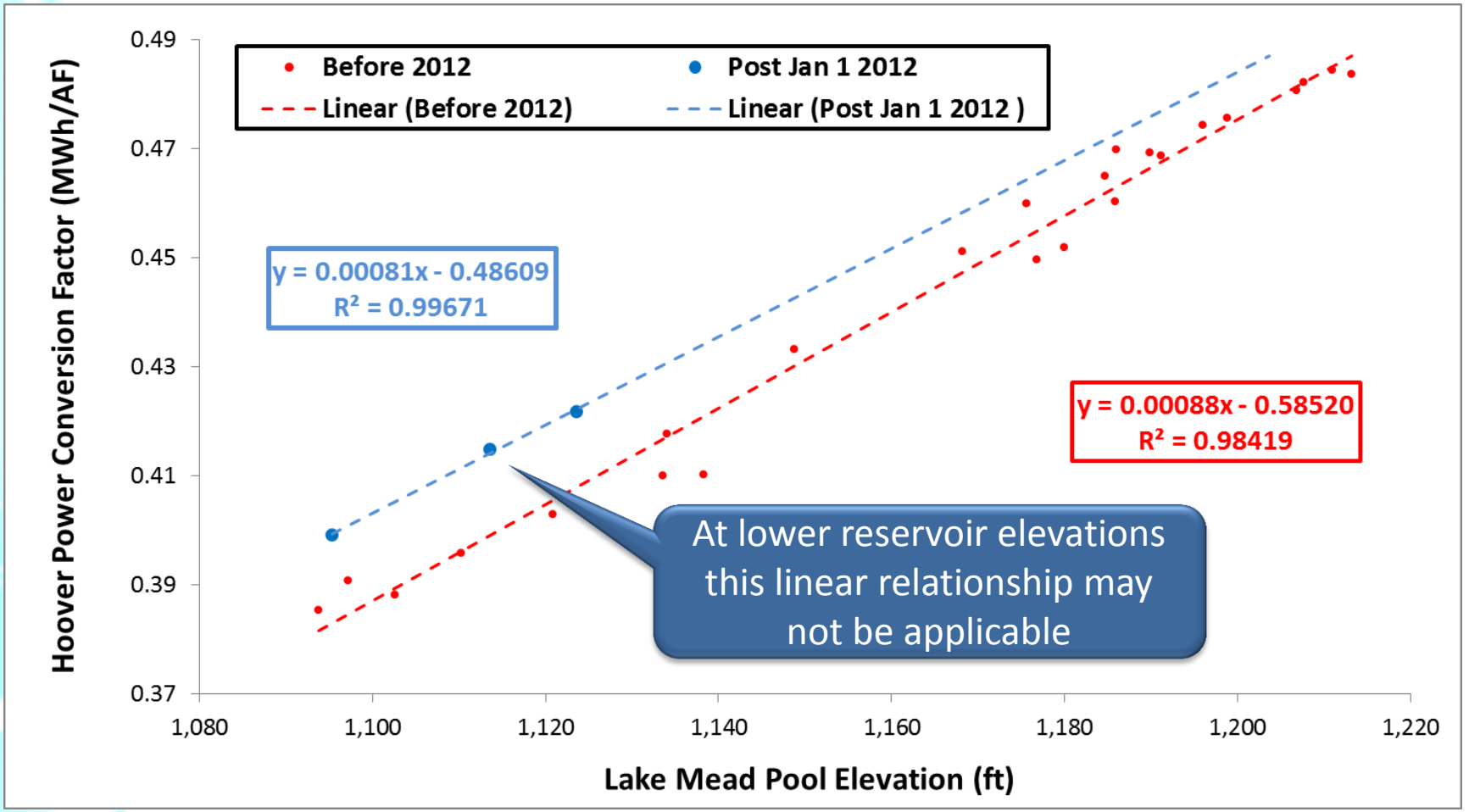
Hoover Capacity Change Is Most Sensitive at Low Reservoir



There is a compounding affect because both elevation and capacity are the most sensitive at lower reservoir elevations that is used to set firm capacity (e.g., 90% exceedance)

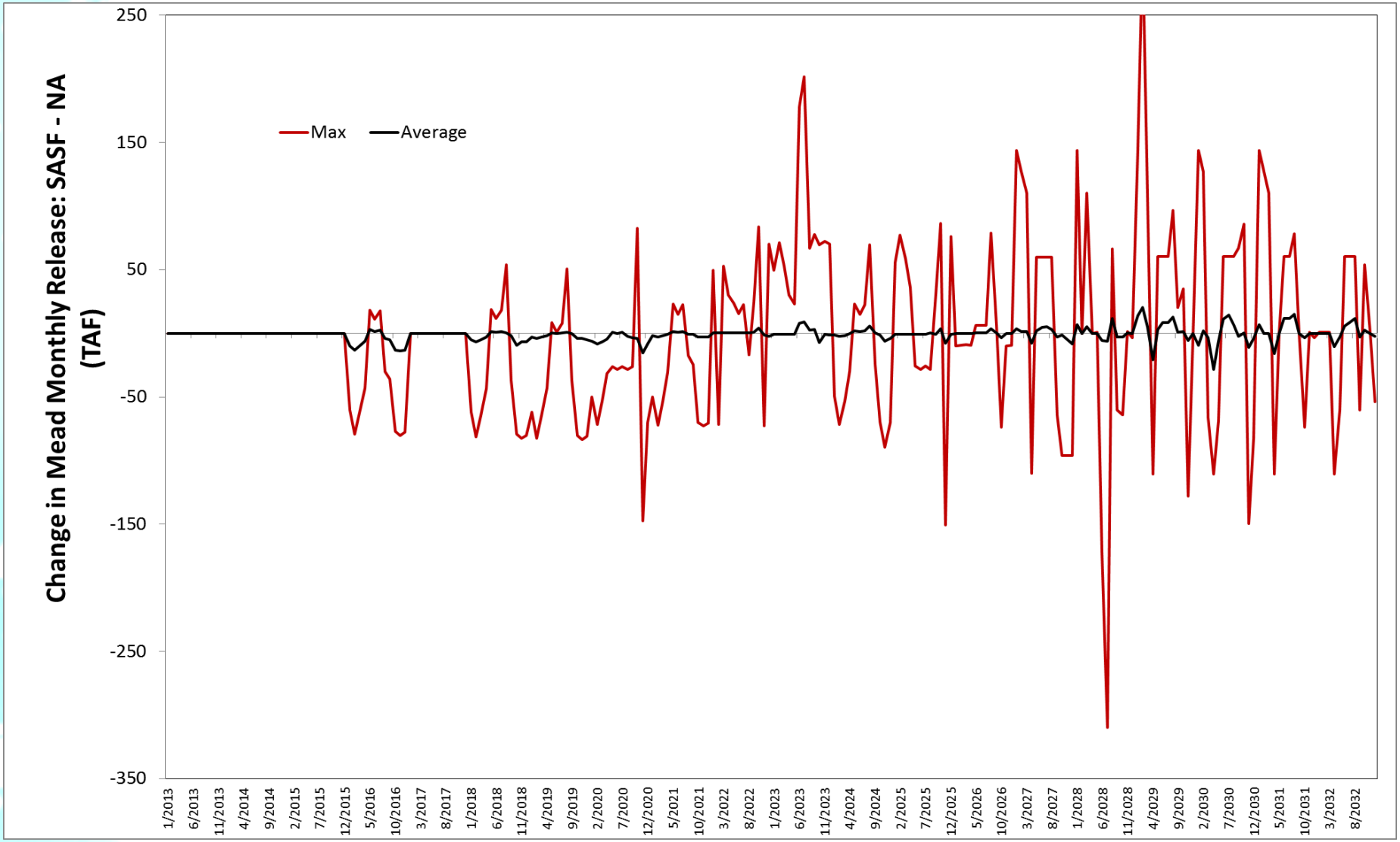
LTEMP Changes in Mead Elevation Affects Hoover Energy Production Given the Same Mead Water Release Volume



Beginning in 2012 new software was installed to optimize Hoover unit dispatch

Argonne NATIONAL LABORATORY

LTEMP Changes Mead Monthly Water Release Volumes



Rough Ballpark Economic Impacts of the Hybrid Alternative on Hoover

Major Assumptions

Aug	Peak Load Month
950	Minimum Pool Elevation for Power Production (ft)
44,000	Capacity Replacement Cost ($/MW-yr)

Exceedance Fraction	*Mead Pool Elevation (ft)*			*Hoover Capacity (MW)*				*Capacity Value Increase 10^6 $*	*Energy Value Increase 10^6 $*	*Total Increase 10^6 $*
	NA	**Hybrid**	***Change***	NA	**Hybrid**	**Change A**	***Change B***			
1.0	991.6	992.0	0.3	1,037.9	1,040.3	2.4	1.8	2.1	12.4	14.5
0.9	**1,016.9**	**1,018.0**	**1.1**	**1,217.4**	**1,225.1**	**7.7**	**6.5**	**6.7**	**12.4**	**19.2**
0.8	1,040.3	1,040.4	0.1	1,367.7	1,368.6	0.9	0.8	0.8	12.4	13.2
0.7	1,063.4	1,064.0	0.5	1,502.5	1,505.5	3.0	3.0	2.6	12.4	15.0
0.6	1,076.9	1,077.3	0.4	1,574.9	1,577.1	2.2	2.4	1.9	12.4	14.3
0.5	1,095.4	1,096.2	0.9	1,667.3	1,671.4	4.1	4.9	3.6	12.4	16.0
0.4	1,111.8	1,112.0	0.2	1,743.2	1,744.1	0.9	1.2	0.8	12.4	13.2
0.3	1,141.6	1,142.7	1.1	1,866.3	1,870.6	4.3	6.4	3.8	12.4	16.2
0.2	1,171.7	1,172.1	0.4	1,973.8	1,975.1	1.3	2.3	1.2	12.4	13.6
0.1	1,198.8	1,198.4	-0.4	2,057.4	2,056.4	-1.0	-2.0	-0.9	12.4	11.5
0.0	1,218.1	1,218.1	0.0	2,074.0	2,074.0	0.0	0.0	0.0	12.4	12.4

Rough Ballpark Economic Impacts of the Hybrid Alternative on Hoover

Major Assumptions

Jul	Peak Load Month
950	Minimum Pool Elevation for Power Production (ft)
44,000	Capacity Replacement Cost ($/MW-yr)

Exceedance Fraction	*Mead Pool Elevation (ft)*			*Hoover Capacity (MW)*				*Capacity Value Increase 10^6 $*	*Energy Value Increase 10^6 $*	*Total Increase 10^6 $*
	NA	**Hybrid**	*Change*	NA	**Hybrid**	**Change A**	*Change B*			
1.0	991.1	994.7	3.6	1,034.0	1,060.5	26.4	20.3	23.3	12.4	35.7
0.9	**1,015.0**	**1,018.6**	**3.6**	**1,204.5**	**1,228.6**	**24.1**	**20.4**	**21.2**	**12.4**	**33.7**
0.8	1,038.3	1,042.1	3.8	1,355.8	1,379.0	23.2	21.6	20.5	12.4	32.9
0.7	1,061.8	1,064.5	2.7	1,493.3	1,508.5	15.2	15.7	13.4	12.4	25.8
0.6	1,075.0	1,077.2	2.2	1,565.0	1,576.4	11.4	12.4	10.0	12.4	22.5
0.5	1,093.3	1,096.0	2.7	1,657.4	1,670.2	12.9	15.3	11.3	12.4	23.7
0.4	1,108.7	1,110.5	1.8	1,729.1	1,737.1	8.0	10.1	7.0	12.4	19.4
0.3	1,137.3	1,139.0	1.7	1,849.5	1,856.2	6.7	9.8	5.9	12.4	18.4
0.2	1,170.7	1,171.0	0.3	1,970.4	1,971.5	1.1	1.9	1.0	12.4	13.4
0.1	1,195.7	1,196.6	0.8	2,048.5	2,050.9	2.4	4.7	2.1	12.4	14.5
0.0	1,217.3	1,217.3	0.0	2,074.0	2,074.0	0.0	0.0	0.0	12.4	12.4

Rough Ballpark Economic Impacts of the Hybrid Alternative on Hoover

Major Assumptions

Jul	Peak Load Month
950	Minimum Pool Elevation for Power Production (ft)
44,000	Capacity Replacement Cost ($/MW-yr)

Exceedance Fraction	*Mead Pool Elevation (ft)*			*Hoover Capacity (MW)*				*Capacity Value Increase 10^6 $*	*Energy Value Increase 10^6 $*	*Total Increase 10^6 $*
	NA	**Hybrid**	*Change*	NA	**Hybrid**	**Change A**	*Change B*			
1.0	991.1	994.7	3.6	1,034.0	1,060.5	26.4	20.3	23.3	12.4	35.7
0.9	**1,015.0**	**1,018.6**	**3.6**	**1,204.5**	**1,228.6**	**24.1**	**20.4**	**21.2**	**12.4**	**33.7**
0.8	1,038.3	1,042.1	3.8	1,355.8	1,379.0	23.2	21.6	20.5	12.4	32.9
0.7	1,061.8	1,064.5	2.7	1,493.3	1,508.5	15.2	15.7	13.4	12.4	25.8
0.6	1,075.0	1,077.2	2.2	1,565.0	1,576.4	11.4	12.4	10.0	12.4	22.5
0.5	1,093.3	1,096.0	2.7	1,657.4	1,670.2	12.9	15.3	11.3	12.4	23.7
0.4	1,108.7	1,110.5	1.8	1,729.1	1,737.1	8.0	10.1	7.0	12.4	19.4
0.3	1,137.3	1,139.0	1.7	1,849.5	1,856.2	6.7	9.8	5.9	12.4	18.4
0.2	1,170.7	1,171.0	0.3	1,970.4	1,971.5	1.1	1.9	1.0	12.4	13.4
0.1	1,195.7	1,196.6	0.8	2,048.5	2,050.9	2.4	4.7	2.1	12.4	14.5
0.0	1,217.3	1,217.3	0.0	2,074.0	2,074.0	0.0	0.0	0.0	12.4	12.4

Rough Ballpark Economic Impacts of the Hybrid Alternative on Hoover

Major Assumptions

Aug	Peak Load Month
1,050	Minimum Pool Elevation for Power Production (ft)
44,000	Capacity Replacement Cost ($/MW-yr)

Exceedance Fraction	*Mead Pool Elevation (ft)*			*Hoover Capacity (MW)*				*Capacity Value Increase 10^6 $*	*Energy Value Increase 10^6 $*	*Total Increase 10^6 $*
	NA	**Hybrid**	*Change*	NA	**Hybrid**	**Change A**	*Change B*			
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.0	31.0
0.9	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**31.0**	**31.0**
0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.0	31.0
0.7	1,063.4	1,064.0	0.5	1,502.5	1,505.5	3.0	3.0	2.6	31.0	33.6
0.6	1,076.9	1,077.3	0.4	1,574.9	1,577.1	2.2	2.4	1.9	31.0	33.0
0.5	1,095.4	1,096.2	0.9	1,667.3	1,671.4	4.1	4.9	3.6	31.0	34.6
0.4	1,111.8	1,112.0	0.2	1,743.2	1,744.1	0.9	1.2	0.8	31.0	31.8
0.3	1,141.6	1,142.7	1.1	1,866.3	1,870.6	4.3	6.4	3.8	31.0	34.8
0.2	1,171.7	1,172.1	0.4	1,973.8	1,975.1	1.3	2.3	1.2	31.0	32.2
0.1	1,198.8	1,198.4	-0.4	2,057.4	2,056.4	-1.0	-2.0	-0.9	31.0	30.1
0.0	1,218.1	1,218.1	0.0	2,074.0	2,074.0	0.0	0.0	0.0	31.0	31.0

Rough Ballpark Economic Impacts of the SASF Alternative on Hoover

Major Assumptions

Aug	Peak Load Month
950	Minimum Pool Elevation for Power Production (ft)
44,000	Capacity Replacement Cost ($/MW-yr)

Exceedance Fraction	*Mead Pool Elevation (ft)*			*Hoover Capacity (MW)*				*Capacity Value Increase 10^6 $*	*Energy Value Increase 10^6 $*	*Total Increase 10^6 $*
	NA	SASF	*Change*	NA	SASF	Change A	*Change B*			
1.0	991.6	995.2	3.5	1,037.9	1,064.0	26.1	20.0	23.0	24.4	47.4
0.9	**1,016.9**	**1,023.4**	**6.5**	**1,217.4**	**1,260.5**	**43.1**	**36.9**	**37.9**	**24.4**	**62.3**
0.8	1,040.3	1,050.3	10.0	1,367.7	1,427.9	60.2	57.3	53.0	24.4	77.4
0.7	1,063.4	1,073.5	10.1	1,502.5	1,557.3	54.8	57.7	48.2	24.4	72.6
0.6	1,076.9	1,083.2	6.3	1,574.9	1,607.2	32.3	35.9	28.5	24.4	52.9
0.5	1,095.4	1,100.1	4.7	1,667.3	1,689.8	22.5	27.1	19.8	24.4	44.2
0.4	1,111.8	1,114.5	2.7	1,743.2	1,754.9	11.7	15.1	10.3	24.4	34.7
0.3	1,141.6	1,145.2	3.6	1,866.3	1,879.8	13.5	20.3	11.9	24.4	36.3
0.2	1,171.7	1,173.6	1.8	1,973.8	1,979.8	6.1	10.5	5.3	24.4	29.7
0.1	1,198.8	1,199.9	1.1	2,057.4	2,060.7	3.3	6.5	2.9	24.4	27.3
0.0	1,218.1	1,218.1	0.0	2,074.0	2,074.0	0.0	0.0	0.0	24.4	24.4

Rough Ballpark Economic Impacts of the SASF Alternative on Hoover

Major Assumptions

Jul	Peak Load Month
950	Minimum Pool Elevation for Power Production (ft)
44,000	Capacity Replacement Cost ($/MW-yr)

Exceedance Fraction	*Mead Pool Elevation (ft)*			*Hoover Capacity (MW)*				*Capacity Value Increase 10^6 $*	*Energy Value Increase 10^6 $*	*Total Increase 10^6 $*
	NA	SASF	*Change*	NA	SASF	Change A	*Change B*			
1.0	991.1	1,003.1	12.0	1,034.0	1,121.9	87.8	68.5	77.3	24.4	101.7
0.9	**1,015.0**	**1,029.5**	**14.5**	**1,204.5**	**1,300.2**	**95.7**	**82.6**	**84.2**	**24.4**	**108.6**
0.8	1,038.3	1,054.3	16.0	1,355.8	1,451.2	95.4	91.2	84.0	24.4	108.4
0.7	1,061.8	1,078.1	16.4	1,493.3	1,581.3	88.0	93.3	77.5	24.4	101.9
0.6	1,075.0	1,087.9	12.9	1,565.0	1,631.0	66.0	73.7	58.1	24.4	82.5
0.5	1,093.3	1,102.8	9.4	1,657.4	1,702.1	44.7	53.9	39.3	24.4	63.7
0.4	1,108.7	1,116.5	7.8	1,729.1	1,763.6	34.5	44.5	30.4	24.4	54.8
0.3	1,137.3	1,145.0	7.7	1,849.5	1,879.3	29.8	44.1	26.2	24.4	50.6
0.2	1,170.7	1,175.5	4.8	1,970.4	1,986.1	15.7	27.3	13.8	24.4	38.2
0.1	1,195.7	1,199.3	3.5	2,048.5	2,058.8	10.3	20.2	9.1	24.4	33.5
0.0	1,217.3	1,217.3	0.0	2,074.0	2,074.0	0.0	0.0	0.0	24.4	24.4

Rough Ballpark Economic Impacts of the SASF Alternative on Hoover

Major Assumptions

Aug	Peak Load Month
1,050	Minimum Pool Elevation for Power Production (ft)
44,000	Capacity Replacement Cost ($/MW-yr)

Exceedance Fraction	*Mead Pool Elevation (ft)*			*Hoover Capacity (MW)*				*Capacity Value Increase 10^6 $*	*Energy Value Increase 10^6 $*	*Total Increase 10^6 $*
	NA	SASF	*Change*	NA	SASF	Change A	*Change B*			
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	132.0	132.0
0.9	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**132.0**	**132.0**
0.8	0.0	1,050.7	1,050.7	0.0	1,430.1	1,430.1	5,988.9	1,258.5	132.0	1,390.5
0.7	1,063.4	1,073.5	10.1	1,502.5	1,557.3	54.8	57.7	48.2	132.0	180.1
0.6	1,076.9	1,083.2	6.3	1,574.9	1,607.2	32.3	35.9	28.5	132.0	160.4
0.5	1,095.4	1,100.1	4.7	1,667.3	1,689.8	22.5	27.1	19.8	132.0	151.7
0.4	1,111.8	1,114.5	2.7	1,743.2	1,754.9	11.7	15.1	10.3	132.0	142.2
0.3	1,141.6	1,145.2	3.6	1,866.3	1,879.8	13.5	20.3	11.9	132.0	143.9
0.2	1,171.7	1,173.6	1.8	1,973.8	1,979.8	6.1	10.5	5.3	132.0	137.3
0.1	1,198.8	1,199.9	1.1	2,057.4	2,060.7	3.3	6.5	2.9	132.0	134.8
0.0	1,218.1	1,218.1	0.0	2,074.0	2,074.0	0.0	0.0	0.0	132.0	132.0

Conner, Kelly <kconner@usbr.gov>

Fwd: FYI

1 message

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:34 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark
---------- Forwarded message ----------
From: **Cook, Mark** <mrcook@usbr.gov>
Date: Tue, May 5, 2015 at 10:37 AM
Subject: FYI
To: Keith Cooper <kycooper@usbr.gov>

Thanks,
Mark

Hoover_Generating_Elevation_Breif.doc
34K

BUREAU OF RECLAMATION

BRIEFING FOR: Terrance J. Fulp, Ph.D., Regional Director **DATE:** May 5, 2015
David M. Palumbo, P.E., Deputy Regional Director

PURPOSE OF PAPER: Currently Hoover Dam has a stated minimum power pool elevation of 1050. This briefing paper outlines the possibility of lowering that to 950.

BACKGROUND: Historically Reclamation published that the low generating reservoir was at elevation 1083. During the current extended drought it became apparent that Lake Mead elevation may drop below that. Therefore sometime in 2003 and 2004 Reclamation began publishing that the new minimum elevation pool was 1050. The oldest document that could be located with the new elevation of 1050 was dated August 6, 2004 and stated that up-rated turbines at Hoover enabled the minimum power pool to be lowered to 1050. However it implied this was due to up-rated turbines that were replaced in beginning in the early 1980's even though the minimum pool elevation of 1083 was used in many documents all the way up to 2003. No official memorandum could be located that lowered the minimum power pool from 1083 to 1050.

Projecting further lowering of the Reservoir in 2012 Reclamation began switching out the original turbines with a low head turbines designed to operate at lower heads with higher efficiencies. As of 2014 units A8, A1, and N8 have been replaced with low head turbines. In the next 2 years units N6 and N5 will also be replaced with low head turbines. This will bring a total number of low head turbines to 5. The low head turbines efficiency curves rate the turbines to 1000 feet.

An analysis of how Hoover Dam Power Plants will operate under different heads was performed by Aaron Mulburg, Mechanical Engineer at Hoover Dam. At elevation 1050 the units without low head turbines can operate but we expect little regulation ability and cavitation damage will occur when operated in the rough zones. The new low head turbines will have regulation ability and minimal rough zones. Total plant capacity will be 1371 MW.

At elevation 1000 the units without low head turbines will operate but with minimal regulation and increased potential for cavitation. The new low head turbines will operate but with larger rough zones. Total plant capacity will be 1046 MW.

At elevation 950 the units without low head turbines will operate but will likely have cavitation damage at any load. The new low head turbines will continue to operate but the rough zones will increase. Total plant capacity will be only 696 MW.

CURRENT STATUS: Reclamation stakeholders have expressed interest in the minimum power pool being lowered due to possibility of Lake Mead continuing to drop.

Lower Colorado Dams office in confident that both the low head turbines and the original turbines would continue to generate electricity at elevations at or above 950 feet, however the plant's capacity and ability to regulate would decrease and potential damage to the units would increase.

Conner, Kelly <kconner@usbr.gov>

Fwd: Minimum Power Pool

2 messages

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:13 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

---------- Forwarded message ----------
From: **Cook, Mark** <mrcook@usbr.gov>
Date: Mon, May 23, 2016 at 4:01 PM
Subject: Fwd: Minimum Power Pool
To: Robert Skordas <RSkordas@usbr.gov>

Rob,
This is what I found on the minimum power pool recent history.

Thanks,
Mark

---------- Forwarded message ----------
From: **Cook, Mark** <mrcook@usbr.gov>
Date: Mon, Jun 29, 2015 at 3:48 PM
Subject: Re: Minimum Power Pool
To: "Skordas, Robert" <rskordas@usbr.gov>

I think where we are at on this is we had the briefing with Keith, so now we need to brief Terry so that he can give the nod to BCOO to produce the official document.

Thanks,
Mark

On Thu, Jun 25, 2015 at 7:22 AM, Skordas, Robert <rskordas@usbr.gov> wrote:

> Mark:
>
> Do we have an official document declaring the Minimum Power Pool at 950? I know you have been working on something. We need to share it with Western once it is complete.
>
> Thank you,
> Rob
>
> Rob Skordas
> Area Manager LCDO
> Bureau of Reclamation, Hoover Dam
> PO Box 60400
> Boulder City, NV 89006-0400
> (702) 494-2301 Office
> (702) 525-3257 Cell

RECLAMATION
Managing Water in the West

2 attachments

Hoover_Generating_Elevation_Brief 150316.doc
34K

E and OC May 2015.ppt
7102K

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:14 AM
To: Kelly Conner <kconner@usbr.gov>

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> *Rob Skordas*
> Area Manager LCDO
> Bureau of Reclamation, Hoover Dam
> PO Box 60400
> Boulder City, NV 89006-0400
> (702) 494-2301 Office
> (702) 525-3257 Cell

RECLAMATION
Managing Water in the West

BUREAU OF RECLAMATION

BRIEFING FOR: Terrance J. Fulp, Ph.D., Regional Director **DATE:** March 16, 2015
David M. Palumbo, P.E., Deputy Regional Director

PURPOSE OF PAPER: Currently Hoover Dam has a stated minimum power pool elevation of 1050. This briefing paper outlines the possibility of lowering that to 950.

BACKGROUND: Historically Reclamation published that the low generating reservoir was at elevation 1083. During the current extended drought it became apparent that Lake Mead elevation may drop below that. Therefore sometime in 2003 and 2004 Reclamation began publishing that the new minimum elevation pool was 1050. The oldest document that could be located with the new elevation of 1050 was dated August 6, 2004 and stated that up-rated turbines at Hoover enabled the minimum power pool to be lowered to 1050. However it implied this was due to up-rated turbines that were replaced in beginning in the early 1980's even though the minimum pool elevation of 1083 was used in many documents all the way up to 2003. No official memorandum could be located that lowered the minimum power pool from 1083 to 1050.

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An analysis of how Hoover Dam Power Plants will operate under different heads was performed by Aaron Muehlberg, Mechanical Engineer at Hoover Dam. At elevation 1050 the units without low head turbines can operate but we expect little regulation ability and cavitation damage will occur when operated in the rough zones. The new low head turbines will have regulation ability and minimal rough zones. Total plant capacity will be 1371 MW.

At elevation 1000 the units without low head turbines will operate but with minimal regulation and increased potential for cavitation. The new low head turbines will operate but with larger rough zones. Total plant capacity will be 1046 MW.

At elevation 950 the units without low head turbines will operate but will likely have cavitation damage at any load. The new low head turbines will continue to operate but the rough zones will increase. Total plant capacity will be only 696 MW.

CURRENT STATUS: Reclamation stakeholders have expressed interest in the minimum power pool being lowered due to possibility of Lake Mead continuing to drop.

Lower Colorado Dams office in confident that both the low head turbines and the original turbines would continue to generate electricity at elevations at or above 950 feet, however the plant's capacity and ability to regulate would decrease and potential damage to the units would increase.

RECLAMATION

Managing Water in the West

Effect of Low Power Pool on Turbines at Hoover Dam

5/20/2015

Keith Cooper

U.S. Department of the Interior
Bureau of Reclamation

Summary

As Lake Mead's elevation continues to decline, concerns have been raised with regard to the continued operation of the production generators at Hoover Dam.

- **As the effective head declines out of the design range for the turbines, increased cavitation and vibration damage can be expected.**
- **Continued operation out of design range will result in additional required maintenance, repair and monitoring to control and prevent significant damage.**
- **Quantification/Estimation of damage is difficult and will require the use of modeling equipment available to turbine designers.**

Turbine Design

- **Design Inception**
  - **Parameters are identified to maximize customer return based on operational constraints that exist**
  - **A best fit is identified when an operational range is determined which establishes the design parameter**

- **Design goals of turbines**
  - **Stability within design range**
    - **Minimizing pressure pulsations and cavitation**
  - **Benefit within design range**
    - **Maximizing power, efficiency**

Pressure Pulsations

- Pressure imbalance in the draft tube that cause high vibration, thrust loading and power/gate swings due to part load vortices.
- The cavitation column is a result of large rotational component due to decrease of flow from optimum flow rate
- Rough zones are identified and this range is avoided with operational programs
- New wide-head runners have minimized rough zones but still exist as inherent to Francis Runners

Cavitation

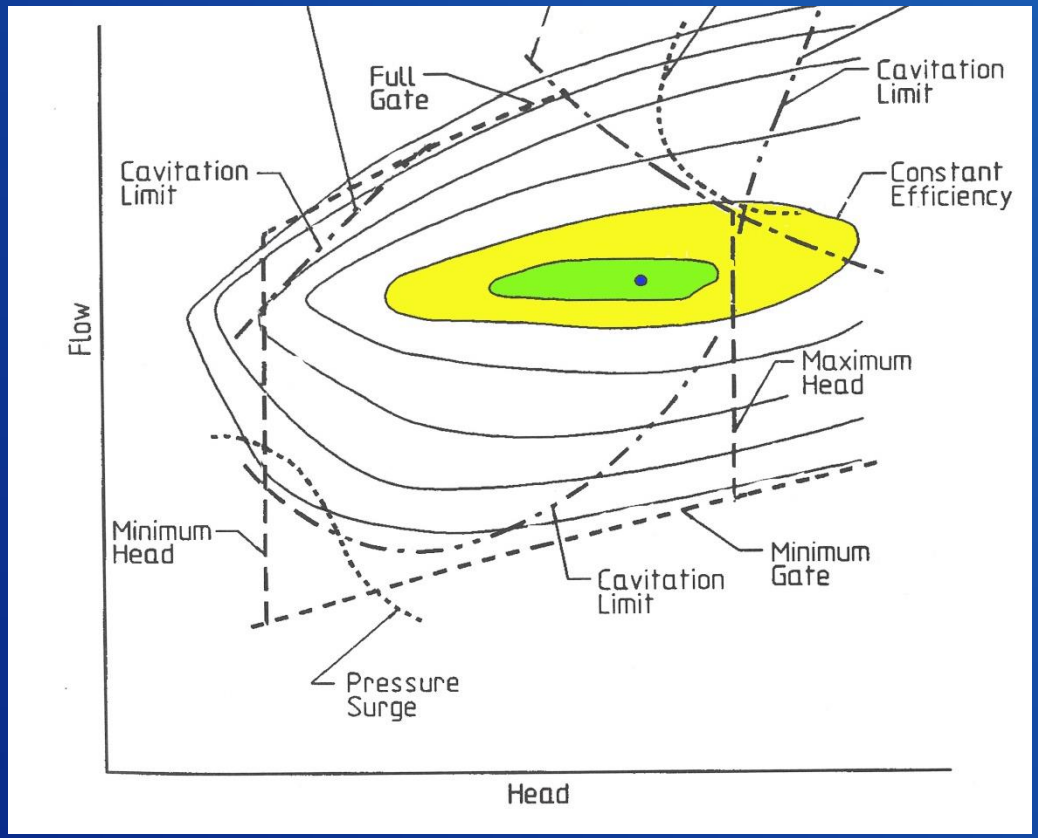
Formation of bubbles as the pressure falls low enough for flow to vaporize. As pressure increases, the vapor bubbles will collapse and if near a surface will do so with enough intensity to remove/pit stainless steel.

As the surface is damaged rough surfaces are left behind propagating damage.

RECLAMATION

Hill Chart

Design chart for turbines to show characteristic behavior based on calculations. Breakdown will immediately follow.

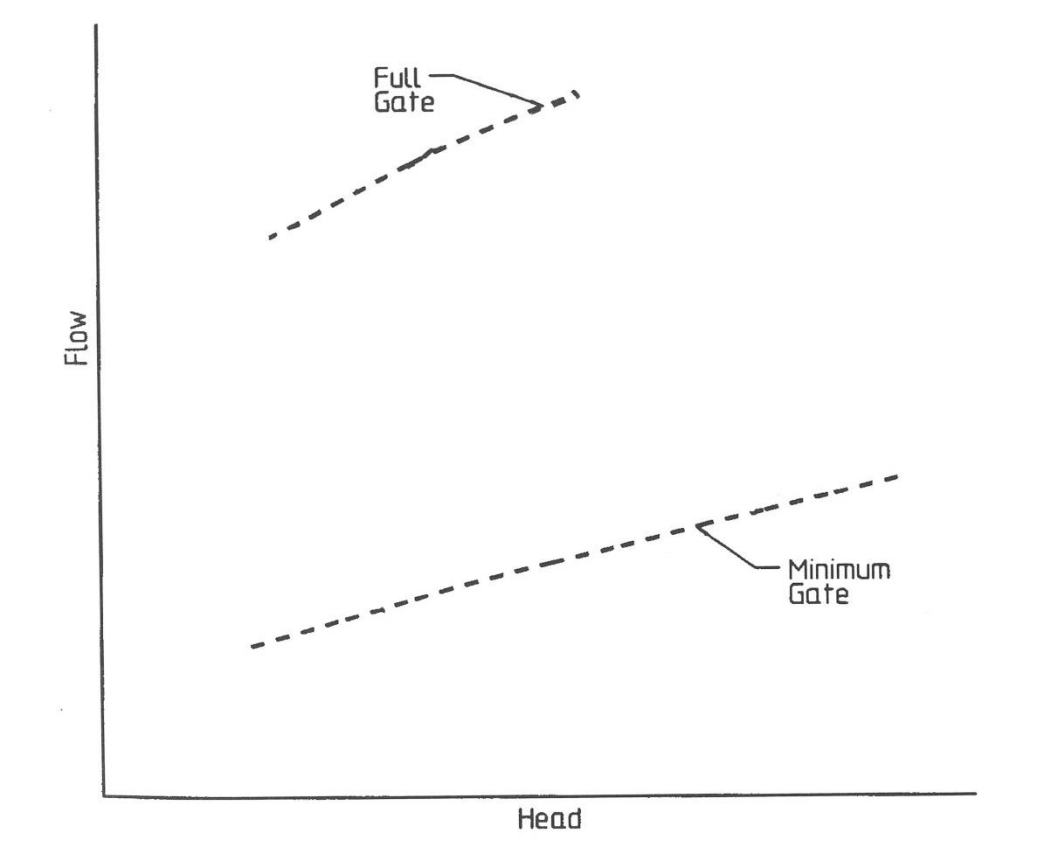


Guide to Hydropower Mechanical Design, ASME, 1996

RECLAMATION

Hill Chart- Axes and Gate Limits

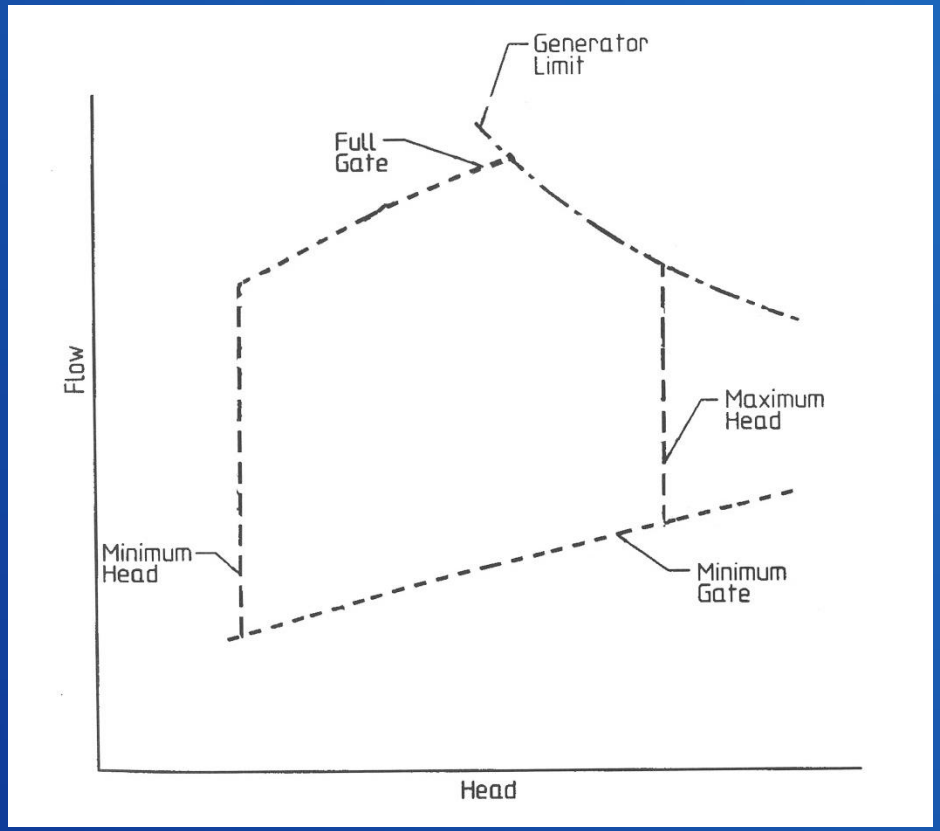
- As head increases, so does the flow at the same gate position allowing for maximum flow/power
- As head decreases, maximum flow/power also decreases.



RECLAMATION

Hill Chart- Head Limits

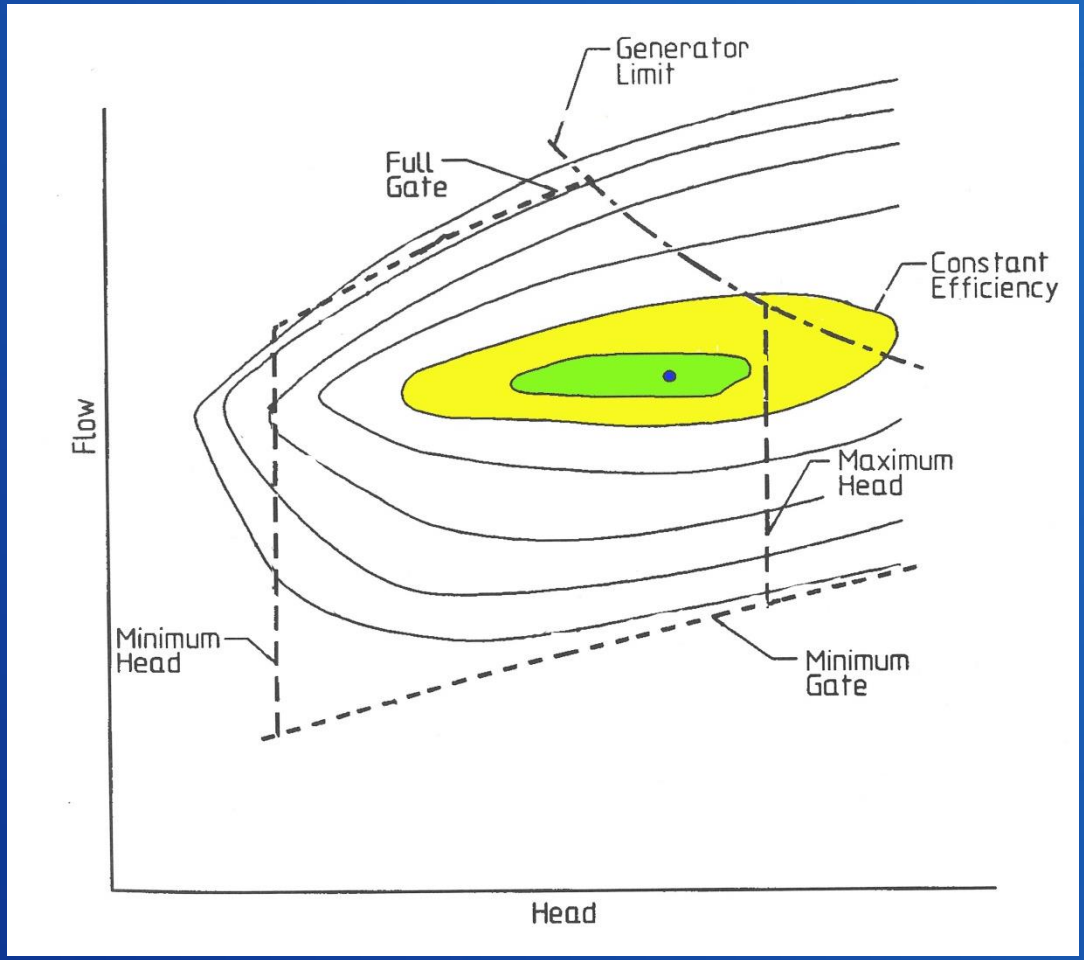
- Maximum and minimum head for the application are determined here.
- Notice that at maximum head, the full gate opening is not identified due to restriction that will come in the following slides.
- Now it's easier to see the design range of this generic turbine blocked in by the minimum and maximum gate and head



RECLAMATION

Hill Chart Efficiency Rings

- Each Circular ring encompasses an area of constant efficiency, 94% for example
- The highest efficiency is the blue dot
- Slightly lower efficiency is the green, then then yellow

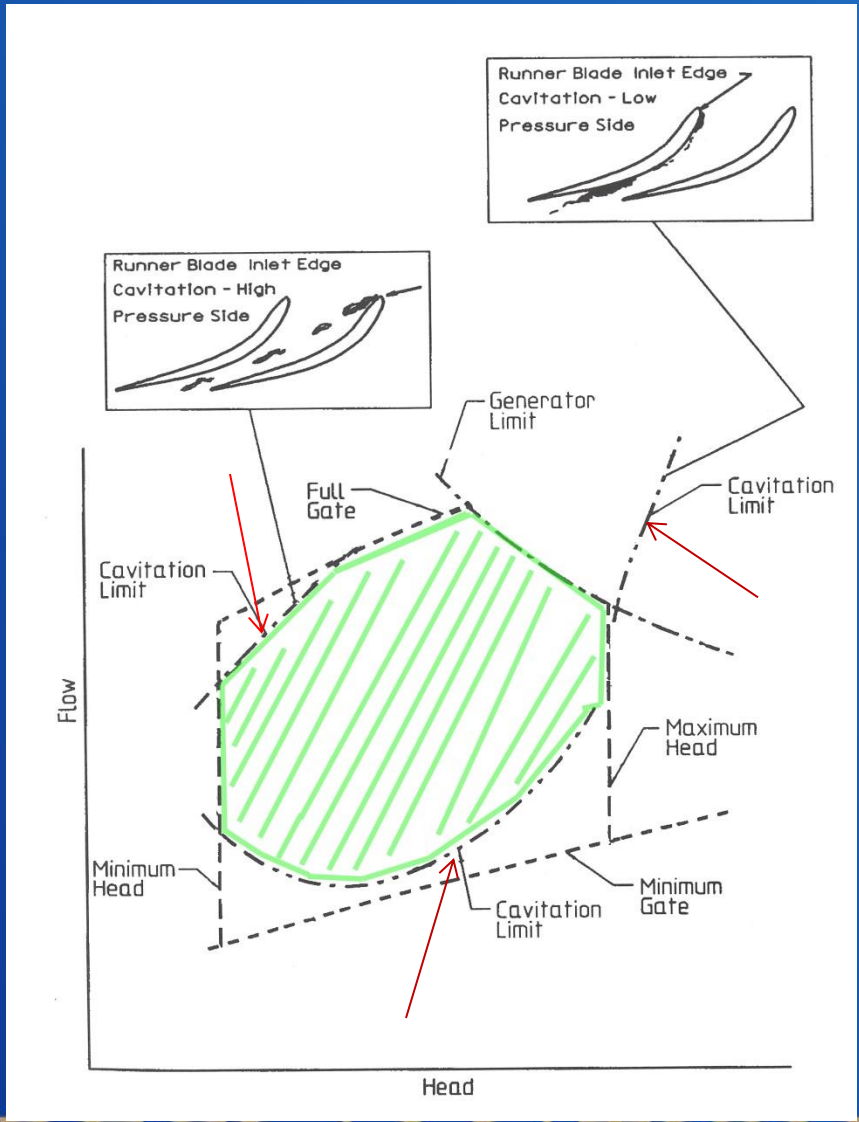


RECLAMATION

Hill Chart- Cavitation Lines

There are 3 different points for cavitation limit, all cavitation lines depicted by red arrows;

- **At low head, full gate must be restricted to prevent inlet, pressure side cavitation**
- **At High head gate restrictions must also be applied to prevent inlet suction side cavitation.**
- **At low gate note the minimum operating zone limited by cavitation.**

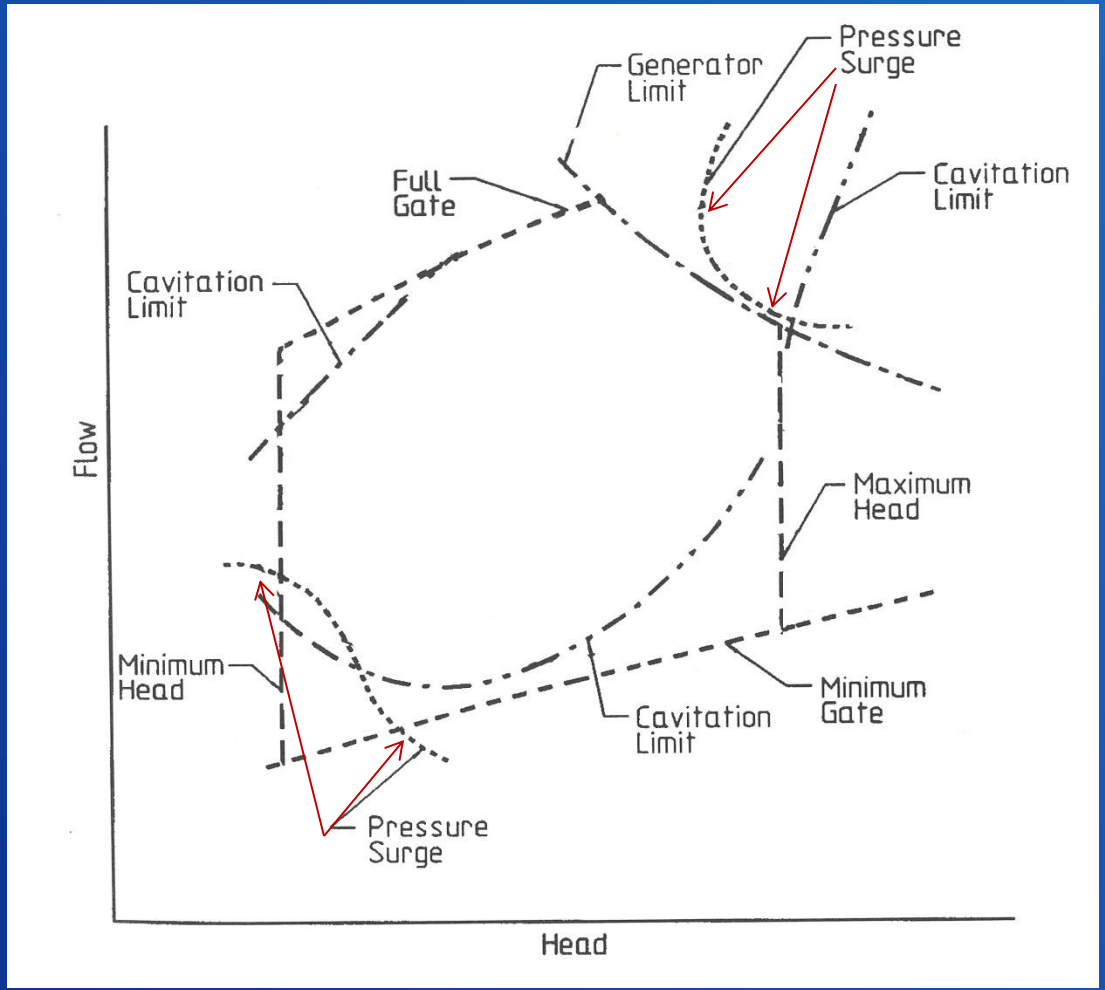


RECLAMATION

Hill Chart Pressure Surge

All surge lines depicted by red arrows

- **Further reducing the upper and lower limits of operation are the pressure surges identified on this Hill Chart**
- **Again this is not identical for all Francis Turbines but is typical for Hoover Units**

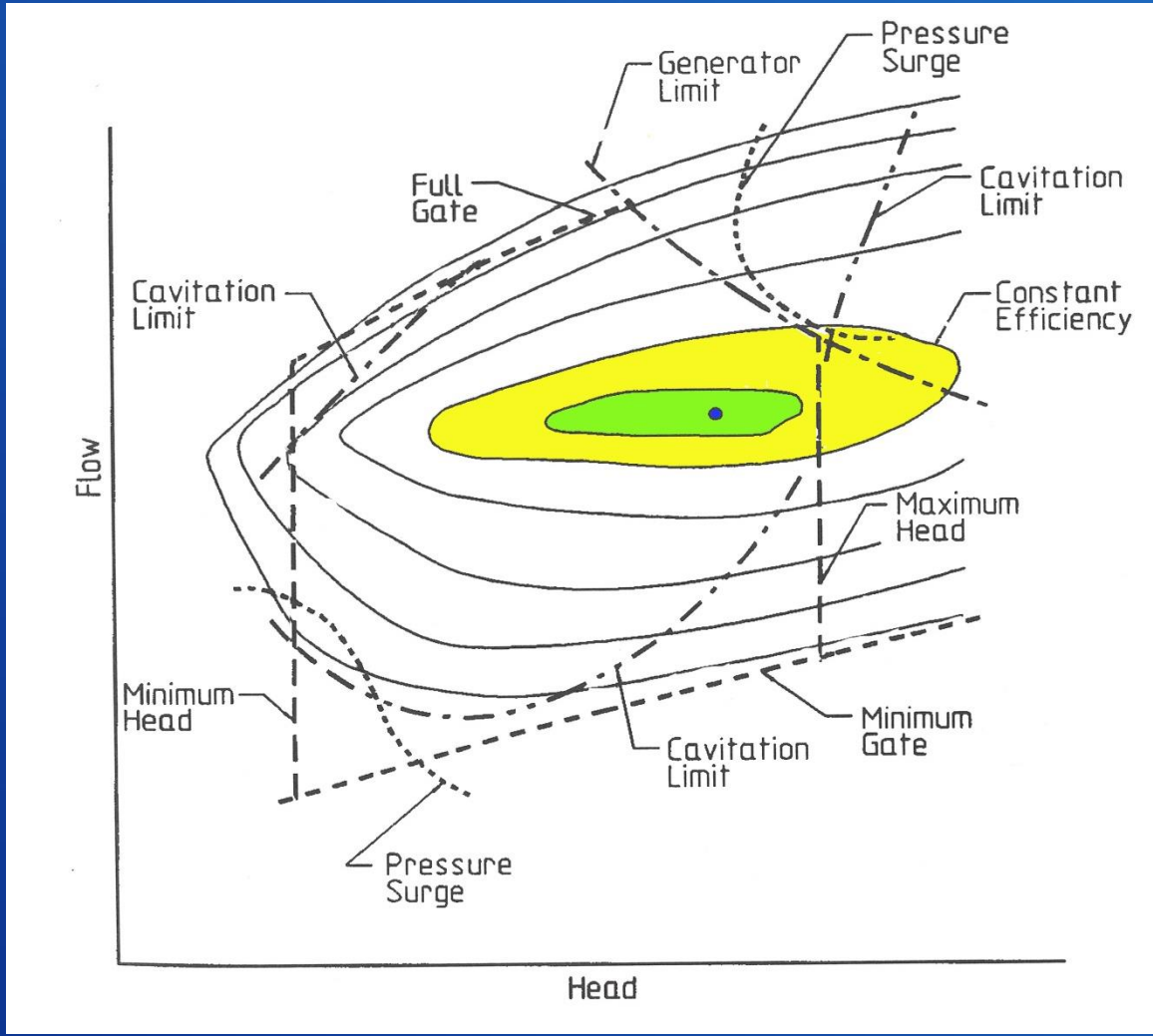


RECLAMATION

Hill Chart Summarization Low Head

At outer limit;

- **Upper gate opening will be limited due to cavitation**
- **Lower Gate limits will be restricted due to cavitation and pressure surge**
- **Peak efficiencies are not attainable as designed.**
- **Operational area will diminish with power capacity,**



RECLAMATION

Current Status at Hoover

Hoover's production generation includes 17 units at the end of 2016 will include;

- **(4.5) Wide Head Turbines with extended design head range between 350'-575' or approximately 1000'-1225' forebay elevation**
- **(11.5) Turbines designed for approximate heads between 400'-580' or 1050'-1225' forebay elevation**
- **As Lake Level declines operational conditions will require less use of the higher head turbines to minimize repair and preserve equipment**

Constraint Expectation – 1050 ft

- **All units will have decreased power capability and efficiency**
- **11.5 units can operate, but we expect little to no regulation ability at the high efficiency top end**
  - **With low tail water submersions, cavitation damage will occur when operated above the rough zone**
- **4.5 units will have regulation ability, but will have minimal rough zones**

- **Estimated Plant Capacity: 1371 MW**

Muehlberg 2014,
E&OC 2013

RECLAMATION

Constraint Expectation- 1000 ft

- **All units will have decreased power capability and efficiency**
- **11.5 units can operate, with minimal operational regulation below the rough zones**
  - **Cavitation damage is expected at high loads all tail water elevations**
- **4.5 units will have regulation ability at the top end, but with larger rough zones**

- **Estimated Plant Capacity: 1046 MW**

Muehlberg 2014,
E&OC 2013

RECLAMATION

Constraint Expectations – 950 ft

- **All units will have decreased power capability and efficiency**
- **11.5 units may be able to run, but with cavitation or vibration damage at any load**
- **4.5 units will have minimal regulation ability at the top end due to rough zones increasing and capacity decreasing**
  - **With low tail water submersions, none of the units will be operated at full load**

- **Estimated Plant Capacity: 696 MW**

Muehlberg 2014,
E&OC 2013

Extraordinary Maintenance

As head continues to decline and we choose to operate out of design range the need for additional outages will increase for;

- **Annual Unit Inspections**
- **Monitoring**
- **Cavitation Repair**
  - **Difficult access will require removal of turbine.**

This will result in additional maintenance costs.

Scroll Case Access with Turbine Installed

Questions?

RECLAMATION

Conner, Kelly <kconner@usbr.gov>

Fwd: Hoover power talking points

2 messages

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:23 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

---------- Forwarded message ----------
From: **Cook, Mark** <mrcook@usbr.gov>
Date: Wed, Nov 4, 2015 at 9:25 AM
Subject: Fwd: Hoover power talking points
To: Robert Vallely <rvallely@usbr.gov>
Cc: Mark Cook <mrcook@usbr.gov>

Hi Bob,

This is Josh Chavez forwarding you an email from Mark's inbox.

Will you please review the below request from Doug Hendrix and respond? Or, if you would prefer, pass the information on to me and I can respond to Doug. Whichever way works best for you.

Thank you,

Josh

---------- Forwarded message ----------
From: **Hendrix, Douglas** <dhendrix@usbr.gov>
Date: Wed, Nov 4, 2015 at 9:14 AM
Subject: Fwd: Hoover power talking points
To: Mark Cook <mrcook@usbr.gov>, Ron Smith <rsmith@usbr.gov>

Greetings Mark and Ron,

Could you review the text highlighted in green font regarding power plant output efficiency due to declining lake levels...Rose will be using these talking points tomorrow in an interview with a French news station...

Best regards,

Doug Hendrix
Public Affairs Specialist
Lower Colorado Regional Office
PH: (702) 293-8391

---------- Forwarded message ----------
From: **Davis, Jeannette (Rose)** <jdavis@usbr.gov>

Date: Wed, Nov 4, 2015 at 8:47 AM
Subject: Hoover power talking points
To: Douglas Hendrix <dhendrix@usbr.gov>

Hi Doug,
I'll need these for tomorrow's interview with the French tv folks. Could you see if you can get them confirmed/updated through either Mark Cook at Hoover or perhaps Ron Smith in the Power office. I'm pretty sure our output has dropped further.
Thank you,
Rose

--
Rose Davis, MPA
Public Affairs Officer
Lower Colorado Region
Bureau of Reclamation
(o) 702-293-8421
(c) 702-591-0029
jdavis@usbr.gov

Check us out at: http://www.usbr.gov/lc/

For Review - Hoover power Lake Mead Nov (1).docx
26K

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:23 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark

[Quoted text hidden]

For Review - Hoover power Lake Mead Nov (1).docx
26K

Hoover Dam Hydropower Generation at Lower Lake Mead Levels
Key Points
Updated July 16, 2015

Hydropower Generation

- Operational capacity and energy generation at Hoover Dam decrease with lower water levels at Lake Mead due to a decrease in the difference between the lake elevation and the downstream river elevation. This difference between the lake level and downstream river level is referred to as "head". The greater the head, the more gravitational energy the water has as it passes through the generating turbines in the dam.
    - Hoover Dam's full plant capacity is 2074 MW. The dam can generate power at its full plant capacity when Lake Mead is at elevation 1,164 feet or higher.
    - The operational capacity, or "de-rated" capacity, is the amount of capacity available including any limitations (such as decreased head).
    - At elevation 1,080 feet, the operational capacity has decreased from the full plant capacity of 2074 MW to approximately 1573 MW, or about a 24% decrease due to the lower lake elevation (less head).
    - As a general rule of thumb, a one-foot drop in Lake Mead's elevation equates to the loss of between 5 and 6 megawatts.
    - 5 MW can meet the needs of approximately 1,000 homes annually.

- Water released from Lake Mead through the Hoover Dam powerplant meets the requirements for flood control, navigation, and/or downstream water deliveries.
    - Hoover power is marketed as contingent capacity and associated energy within these requirements.
    - Neither Reclamation nor Western is obligated to offset any capacity or energy not available.
    - Each Hoover contractor receives their pro rata share of the available capacity and energy.

- Working with our Hoover power contractors, Reclamation has studied the benefits of "wide-head" turbines and has moved forward with replacing five of the 17 generating turbines at Hoover Dam.
    - Replacing an existing turbine with a "wide-head" turbine that can operate at a much wider range of water levels allows Hoover to generate electricity more efficiently at lower Lake Mead levels.
    - With the ability to operate more efficiently at a wider range of lake levels, including lower lake levels, some of the limitations of the existing turbines are offset.
    - To date, four turbines have been replaced with wide-head turbines.
    - An additional wide-head turbine is planned for installation in 2016.
    - Reclamation will continue to work with the power contractors to monitor the effects of the drought to determine the necessity of other turbine replacements.

- Another action taken at Hoover to reduce the reduction of power incurred by lower levels at Lake Mead is the unit overhauls and wicket gate replacements. Through this program to date, we have reclaimed 105 MW of capacity. It is about equivalent to having added another generator at the dam! Instead of the 1573 MW available today, we would only have 1468 MW available had we not done this work.

- Based on the design of the generating turbines, continued decrease in head results in an inability to generate power even though water can physically pass through the turbine
    - The water level where that occurs is often referred to as "minimum power pool".
    - Our minimum power pool is 1050, but we are in the process of revising it to be 950 feet.
    - Below an elevation of 950 feet, water can still flow through the dam but Hoover generators may not be able to operate.

Quick Facts:

- The amount of electricity generated by a hydropower facility depends on three factors: 1) the turbine generating capacity; 2) the turbine discharge flow (the volume of water passing through the turbine in a given amount of time), and 3) the site head (the height of the water source or vertical distance between the highest point of water source and the turbine).
- Western Area Power Administration (Western) currently markets Hoover's capacity and energy to 15 power contractors until September 30, 2017. Each power contractor has a percentage of the contracted contingent capacity and associated energy.
- Western Area Power Administration (Western) currently markets Hoover's capacity (what it could generate) and its energy (what it does generate) to 15 power contractors until September 30, 2017.
    - Reductions in the capacity and energy due to Lake Mead's decrease in water elevation are shared proportionally by the contractors based on their contracted share through Western.
    - Because Hoover power is marketed as contingent capacity and associated energy, Reclamation and Western are not obligated to guarantee the contracted amount of capacity and energy production at Hoover Dam.
    - Neither Reclamation nor Western is obligated to purchase or supply any alternate sources of power to meet the contracted share of capacity and energy produced.
    - The power contractors will determine what alternate sources of energy they will acquire.
- Discussions with Western and the power contractors for Hoover power allocation for post-2017 and electric service contract. The new BCP contracts are developed in accordance with the provisions of the Hoover Power Allocation Act of 2011 and Western's Conformed Criteria dated June 14, 2012 (77 FR 35671). When completed, the new contract has 50 year term (effective October 1, 2017)

Conner, Kelly <kconner@usbr.gov>

Fwd: Colorado River Board Meeting Preparations

1 message

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:29 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark
---------- Forwarded message ----------
From: **Palumbo, David** <dpalumbo@usbr.gov>
Date: Tue, Aug 4, 2015 at 6:58 AM
Subject: Colorado River Board Meeting Preparations
To: Daniel Bunk <DBunk@usbr.gov>, Mark Cook <mrcook@usbr.gov>, Steve Hvinden <shvinden@usbr.gov>, Robert Skordas <rskordas@usbr.gov>

Hi All:

In preparation for the Colorado River Board of California meeting that Mark and perhaps Dan will present at next Wednesday (8/12) at 10:00 am (Holiday Inn Ontario Airport, 2155 East Convention Center Way, Ontario, CA 91764, United States), I have put as a placeholder a meeting for this Thursday (8/6) at 3:30 pm in BCOO (If this day/time does not work for you, please just let me know.).

I spoke with Tanya yesterday and we talked about targeting 20 to 30 minutes focusing on the hydropower aspects of the presentation we gave her a couple of weeks back. We also talked about having a bit of the river operations presentation to set the context.

Although I have not made any recommendations on slides to eliminate, I have attached the last version of the PPT I had with some notes based on our discussion with Tanya when she was here as well as my discussion with her yesterday. Below is a summary of my notes:

Slide 9: More details on Contractors

Slide 10: Information on BCP Post 2017/Power Contractors (I will get this information)

Slide 11: Notation regarding Efficiency Coefficient

Slide 13: Value of Hoover and Impacts to Revenue and Costs (Tanya was also interested in impacts to the Basin Fund for Salinity Control Work)

Slide 41: Add MW capacity at Key Levels and Perhaps Move Slide

I am open on how you all would like to proceed, and I very much and sincerely appreciate your help.

Thanks a lot,

David
702-622-4064 (c)

Overview of Hoover Hydropower and Lower CR Operations_Briefing for CRBC_071715_v3.5.pptx


10504K

RECLAMATION

Managing Water in the West

Overview of Hoover Dam Hydropower and Lower Colorado River Basin Reservoir Operations: Drought Impacts and Reponses

Briefing for the Colorado River Board of California
July 17, 2015

U.S. Department of the Interior
Bureau of Reclamation

Presentation Outline

Part 1:

- Hoover Dam and Hydropower
- Drought Impact Responses

Part 2:

- Overview of the Basin
- Law of the River and Operational Framework
- Lower Colorado River Water Operations
- Drought Response Planning

RECLAMATION

Managing Water in the West

Part 1:

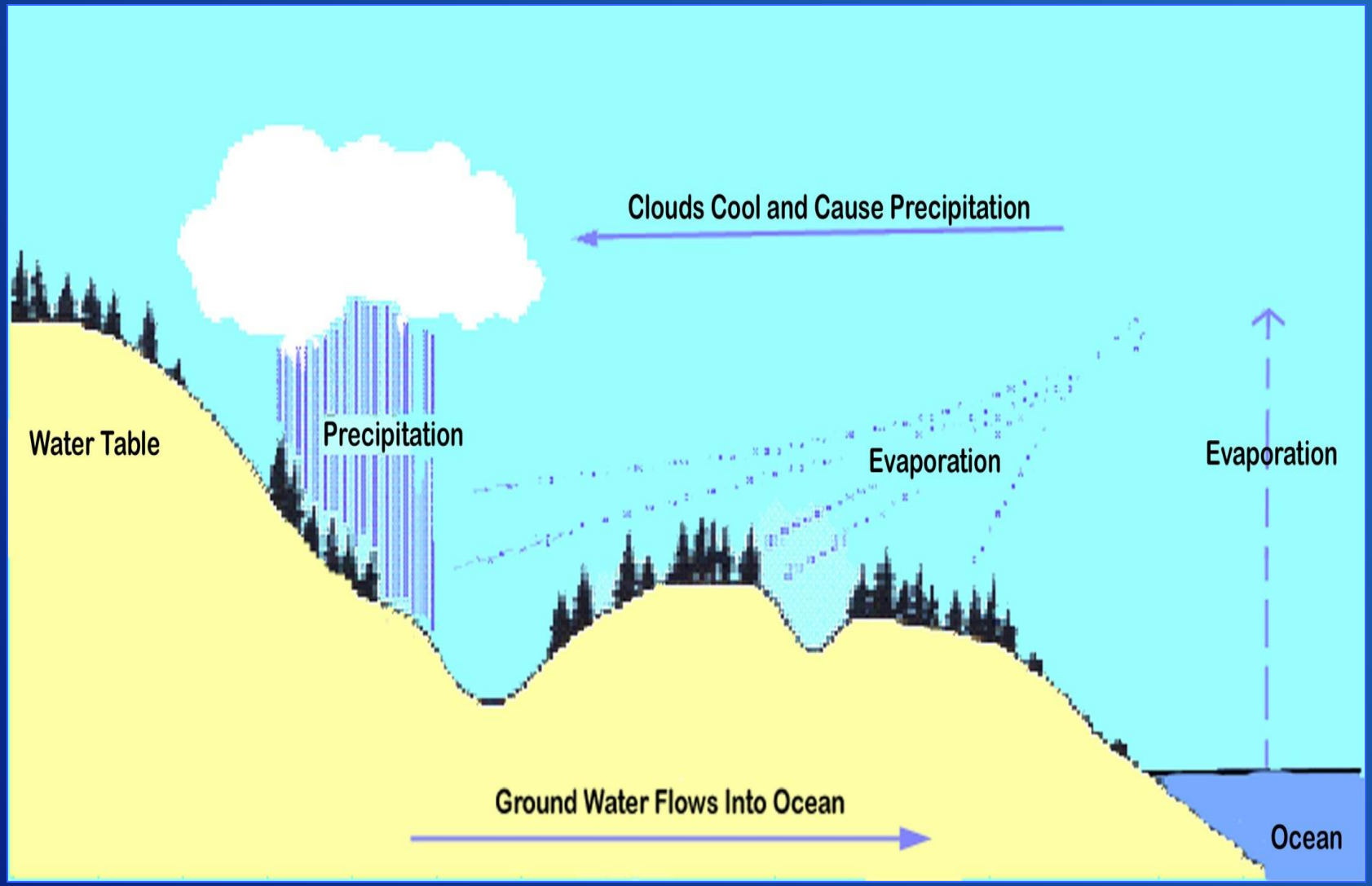
Hoover Dam, Hydropower, and Drought Impact Responses

U.S. Department of the Interior
Bureau of Reclamation

Project Purposes

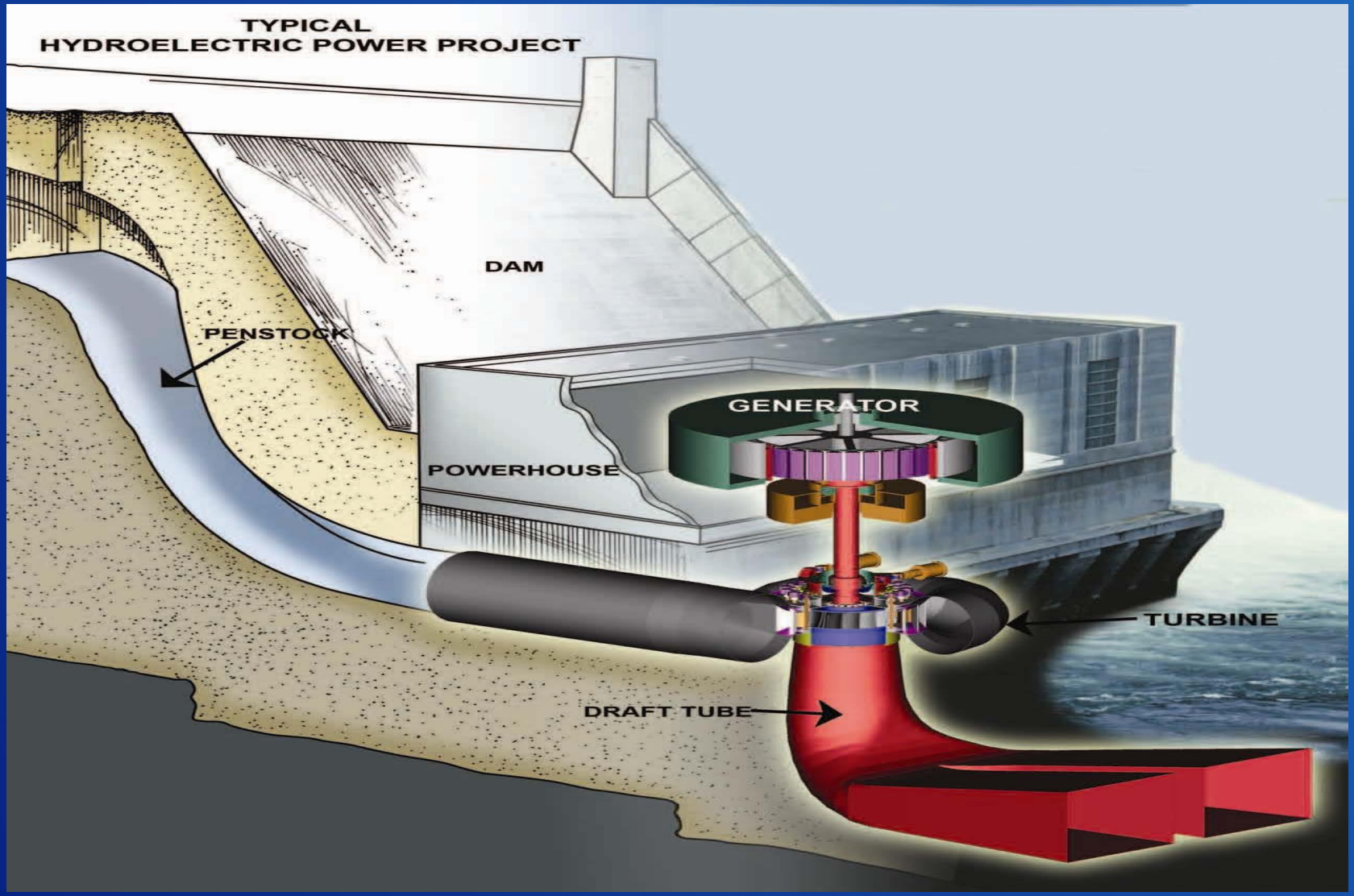
- Flood Control
- Storage of Water to meet downstream deliveries
- Recreation
- Fish & Wildlife
- Power Generation/Capacity and Ancillary Services such as:
  - Voltage control
  - System restoration
  - Blackstart power

Nature's Water Cycle



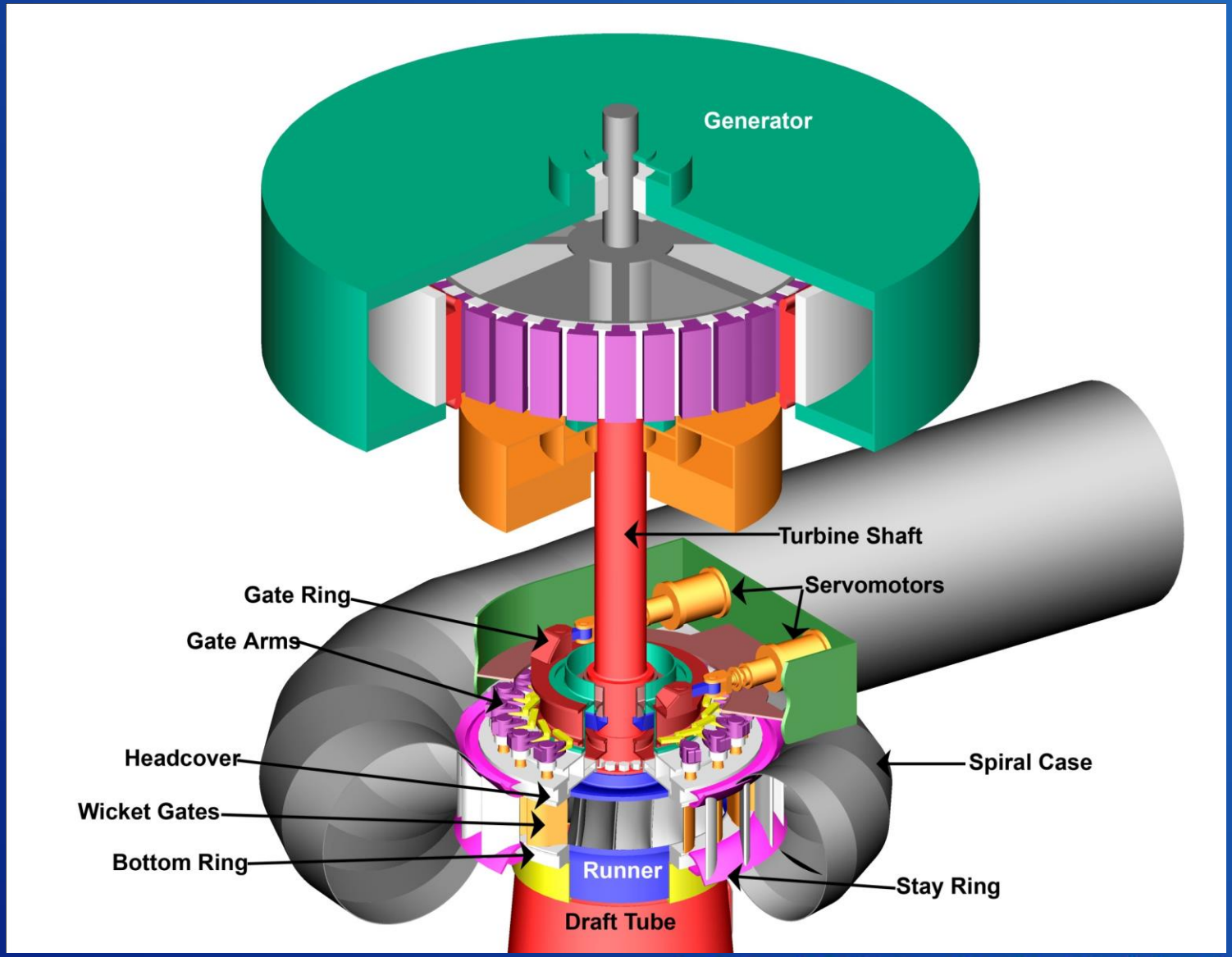
RECLAMATION

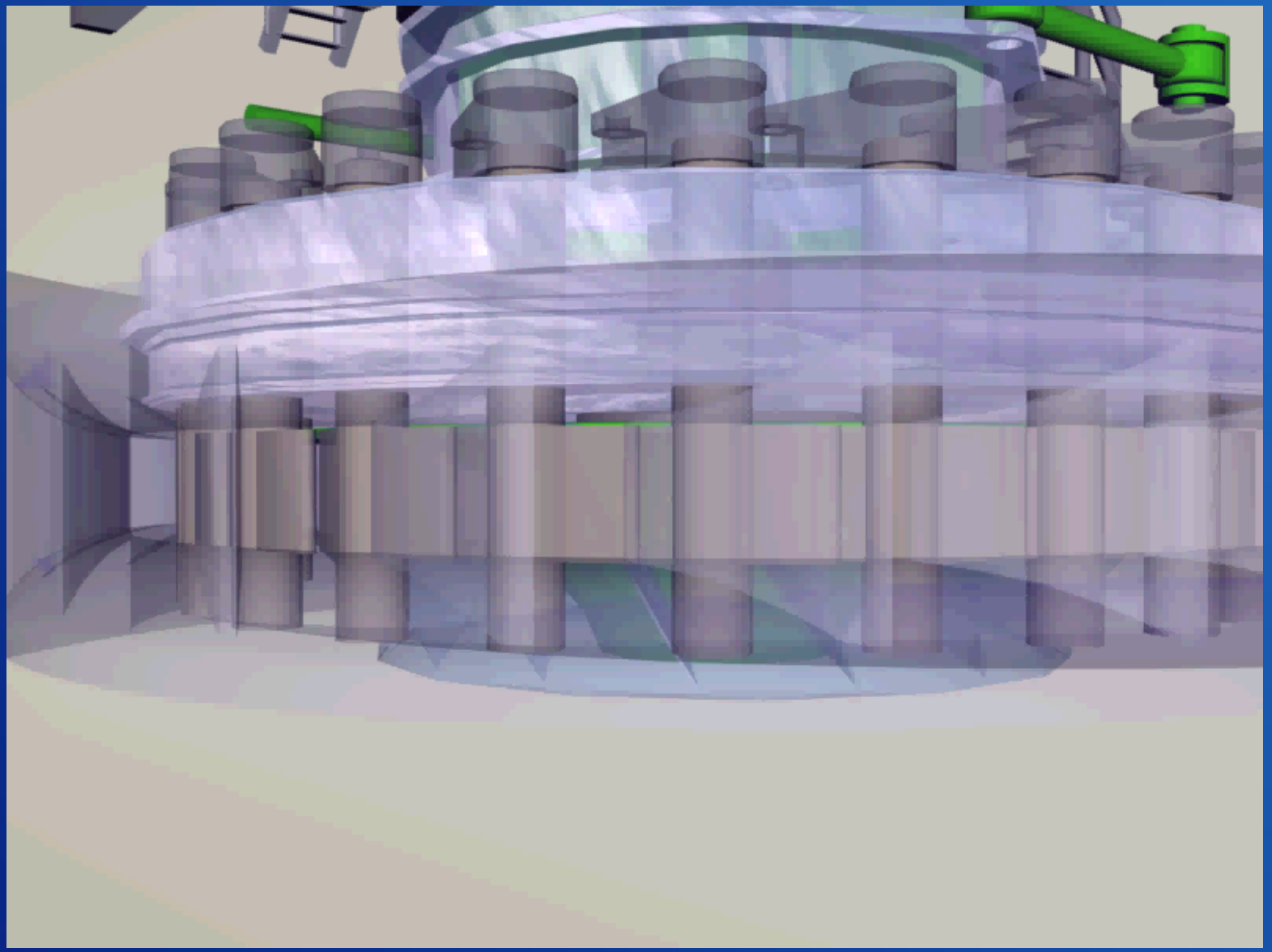
Hydropower Fundamentals



RECLAMATION

Typical Francis Turbine Generator

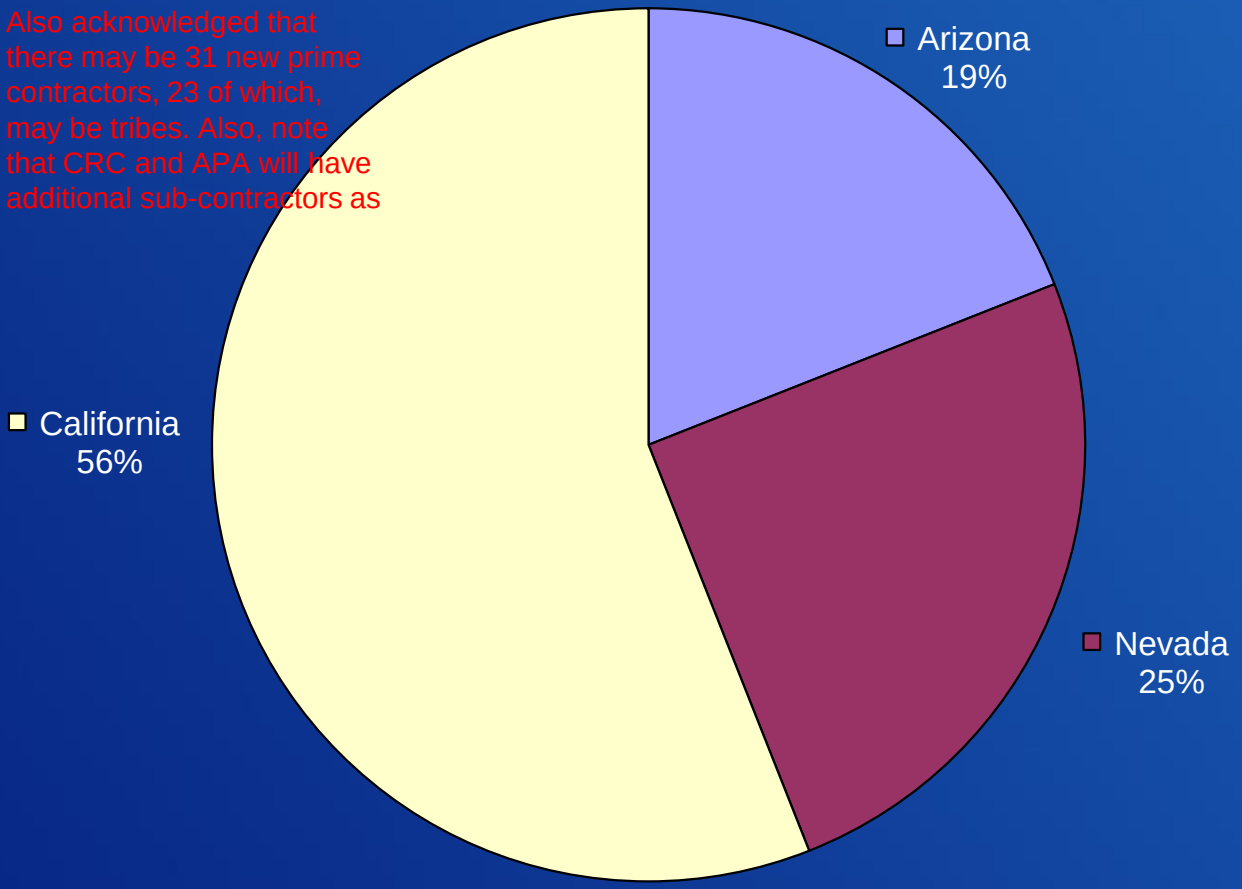




Power Allocations

Add breakdown to include prime entities for Schedules A & B

Also acknowledged that there may be 31 new prime contractors, 23 of which, may be tribes. Also, note that CRC and APA will have additional sub-contractors as



RECLAMATION

Boulder Canyon Project - Post 2017

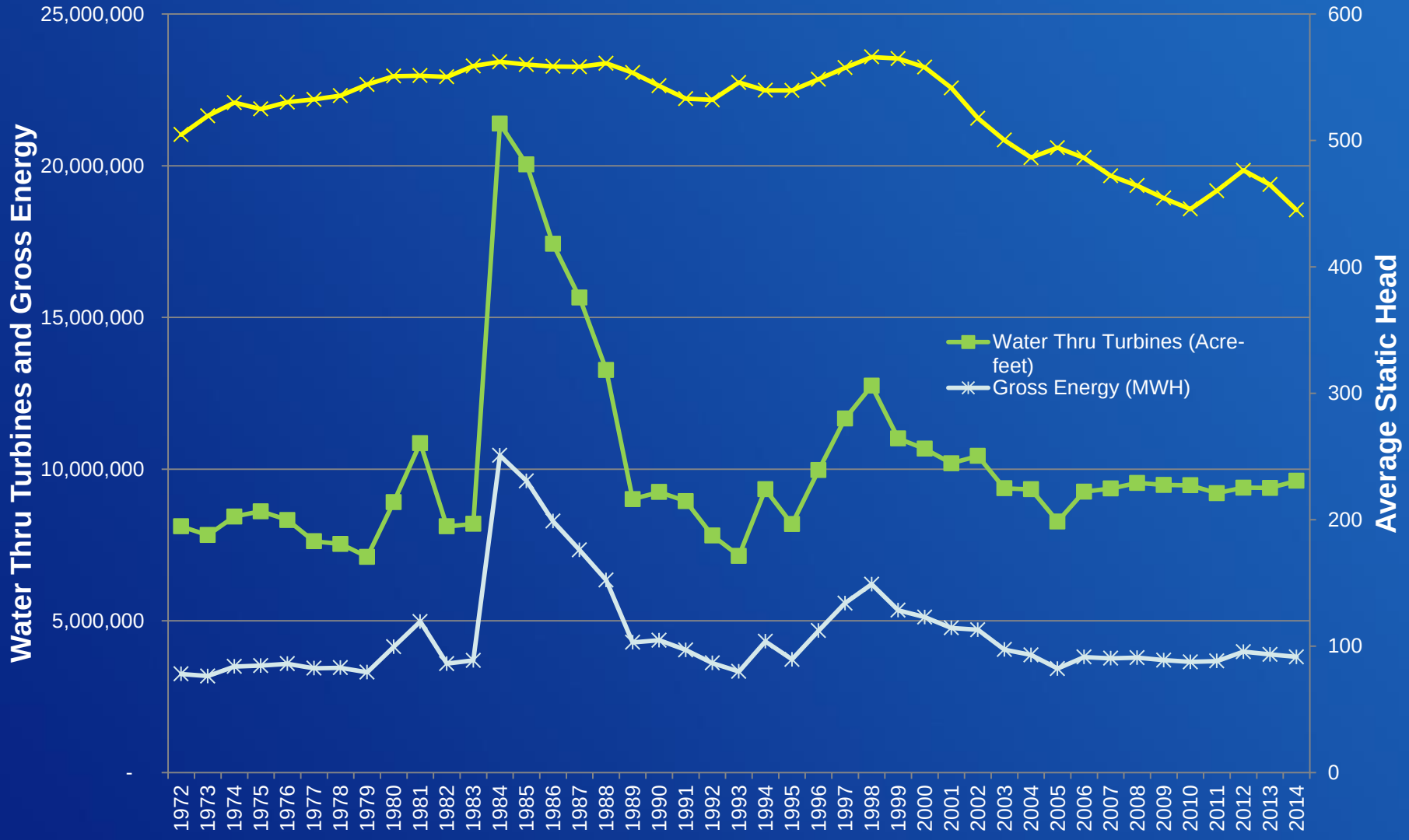
- XXX of 1934
  - 50 Years (1937 – 1987)
  - Schedule A (XXX MW)
- Hoover Power Plant Act of 1984
  - 30 Years (1987 – 2017)
  - Schedules B & C (XXX MW)
- Hoover Power Allocation Act of 2011
  - 50 Years (2017 – 2067)
  - Schedule D (XXX MW)

Pressure, Flow, Power Relationship

$$Power(MW) = \frac{Flow(CFS) \times NetHead(Feet)}{11819}$$

Add term for efficiency coefficient

Recent History



RECLAMATION

Impacts of Lower Lake Elevations

- **Loss of total generation capacity**
- **Loss of regulation capacity**
- **Decreased energy supplied to the customers**
- **Increased rough zones**
- **Increased Maintenance (cavitation) concerns**

Add Value of Hoover as peaking plant and Dynamic Signal Information.

Also, verbally mention impacts to costs and revenues for Basin Fund

Cavitation

Formation of bubbles as the pressure falls low enough for flow to vaporize. As pressure increases, the vapor bubbles will collapse and if near a surface will do so with enough intensity to remove/pit stainless steel.

As the surface is damaged rough surfaces are left behind propagating damage.

RECLAMATION

Efficiency and Capacity Improvements at Hoover Dam

- Major Overhauls of Turbine Components
- Stainless Steel Wicket Gates
- Opening Existing Wicket Gates beyond 100%
- Unit Controls Modernization
- Wide Head Range Turbine

Turbine Overhaul Work

- Purpose of this work is to restore the machinery to a more efficient operating condition

- Major Overhauls of Turbine Components
  - Installation of new seal rings improves the efficiency of turbine energy conversion.

  - Installation of new wicket gates prevent water leakage when units are shut down by restoring gate tolerances.

Stainless Steel Wicket Gates and Over stroking Wicket Gates

- **Benefits result from the 105 MW of capacity added at lower lake levels as of January 2015.**

- **Additional 9 MW are scheduled over the next 2 years**

Unit Controls Modernization Benefits

- A major role of Hoover is providing Regulation, Ramping, and Reserves to the power grid
  - Regulation and Ramping refer to Hoover's ability to change loads quickly
  - Reserves refer to Hoover's non-spin and spin capacity

- UCM improves efficiency while units are providing regulation for the power system.
  - Faster operating mode transitions such as starting and stopping a unit
  - Faster changing from condense mode to generate mode
  - Faster transition/loading through the unit rough zones
  - Faster load-following response.

- UCM improves maximum capacity available to the market

UNIT CONTROLS MODERNIZATION (UCM)
Local Control Panels

PRIOR TO CHANGES
Relays for unit control, solid state relay protection, analogue meters, pistol grip manual controls, and "window" type annunciator for alarms.

AFTER CHANGES
Programmable logic controller for unit control, digital relay protection, touch screen for manual control, monitoring, and alarms.

RECLAMATION

Wide Head Turbines

- **5 Turbines Total**
  - **4 Full Size**
  - **1 Half Size**

RECLAMATION

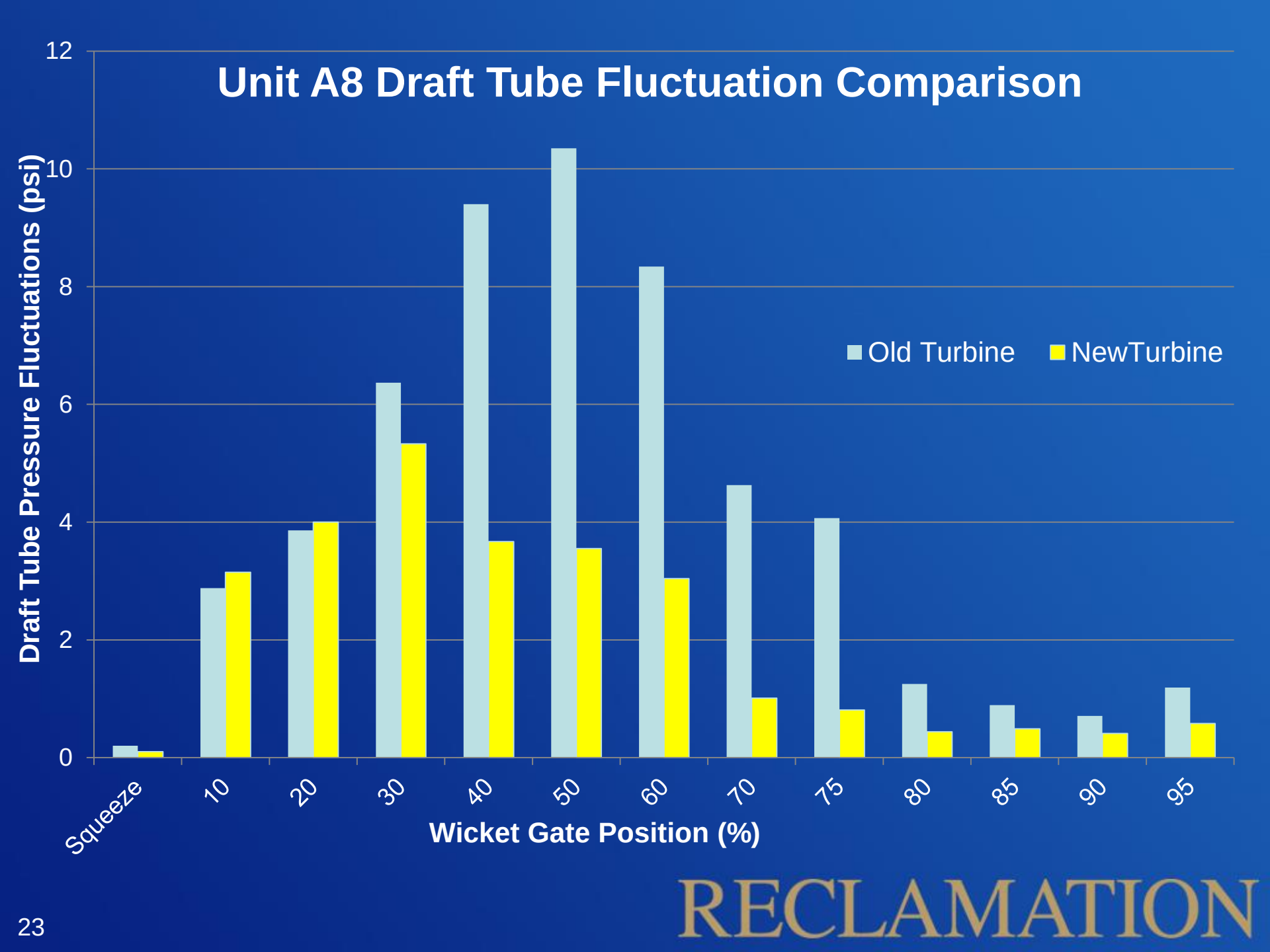
A8 Turbine

- Old Turbine had High Vibration, No AGC Capability
- New Turbine has Full Range of Operation Capability
  - No roughening air required
- Half Size Allows for More Efficient Plant Loading

RECLAMATION

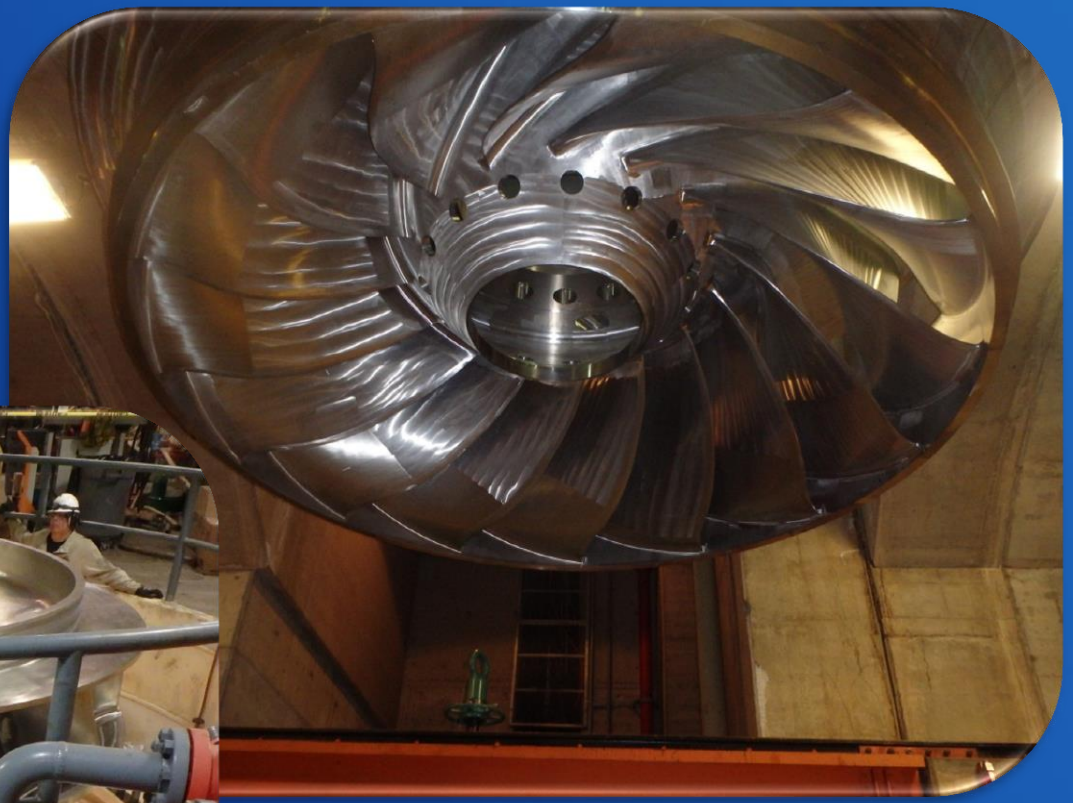
Unit A8 Unit Efficiency History

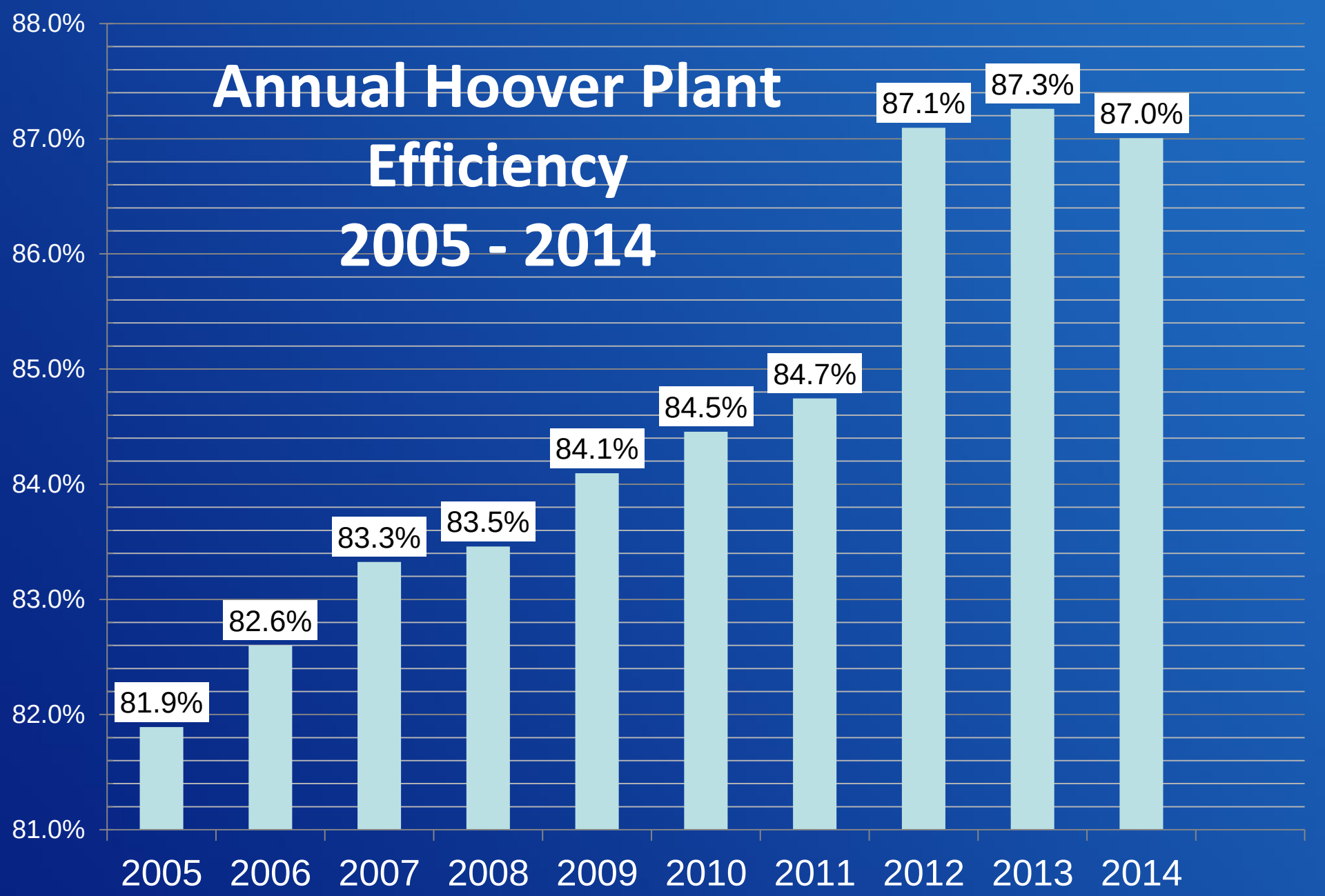
RECLAMATION



RECLAMATION

A1 Turbine Installation





RECLAMATION

Constraint Expectation – 1050 ft

Add 1075

- All units will have decreased power capability and efficiency
- 11.5 units can operate, but we expect little to no regulation ability at the high efficiency top end
  - With low tail water submersions, cavitation damage will occur when operated above the rough zone
- 4.5 units will have regulation ability, but will have minimal rough zones

- Estimated Plant Capacity: 1371 MW

Constraint Expectation- 1000 ft

- All units will have decreased power capability and efficiency
- 11.5 units can operate, with minimal operational regulation below the rough zones
  - Cavitation damage is expected at high loads all tail water elevations
- 4.5 units will have regulation ability at the top end, but with larger rough zones

- Estimated Plant Capacity: 1046 MW

Constraint Expectations – 950 ft

- All units will have decreased power capability and efficiency
- 11.5 units may be able to run, but with cavitation or vibration damage at any load
- 4.5 units will have minimal regulation ability at the top end due to rough zones increasing and capacity decreasing
  - With low tail water submersions, none of the units will be operated at full load

- Estimated Plant Capacity: 696 MW

RECLAMATION

Managing Water in the West

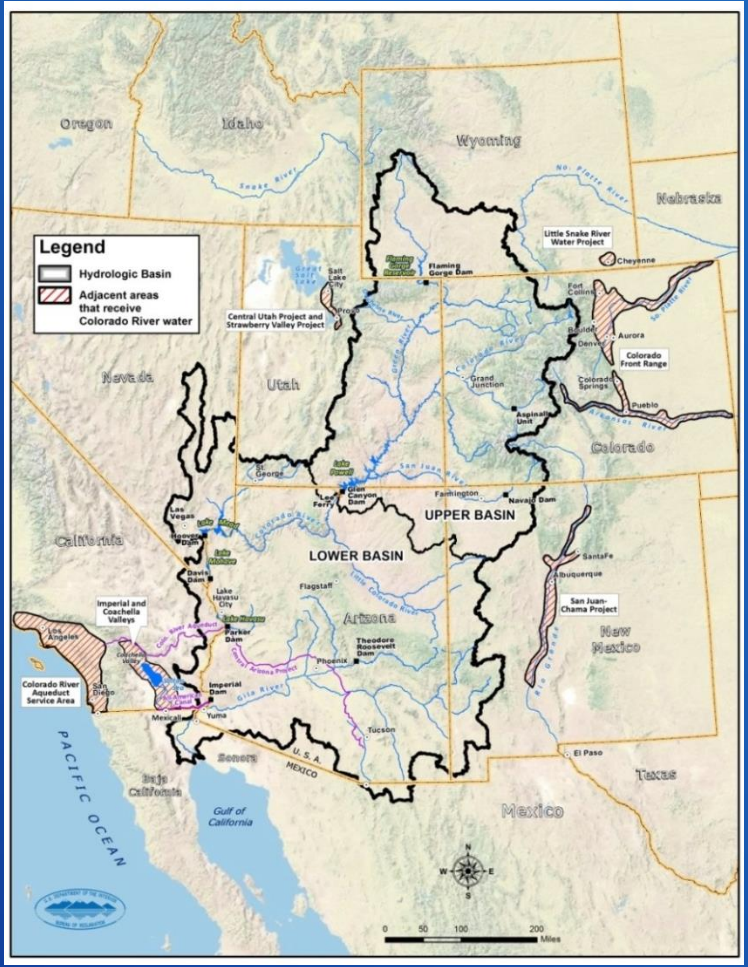
Part 2:

Operational Framework, Reservoir Operations, and Drought Response Planning

U.S. Department of the Interior
Bureau of Reclamation

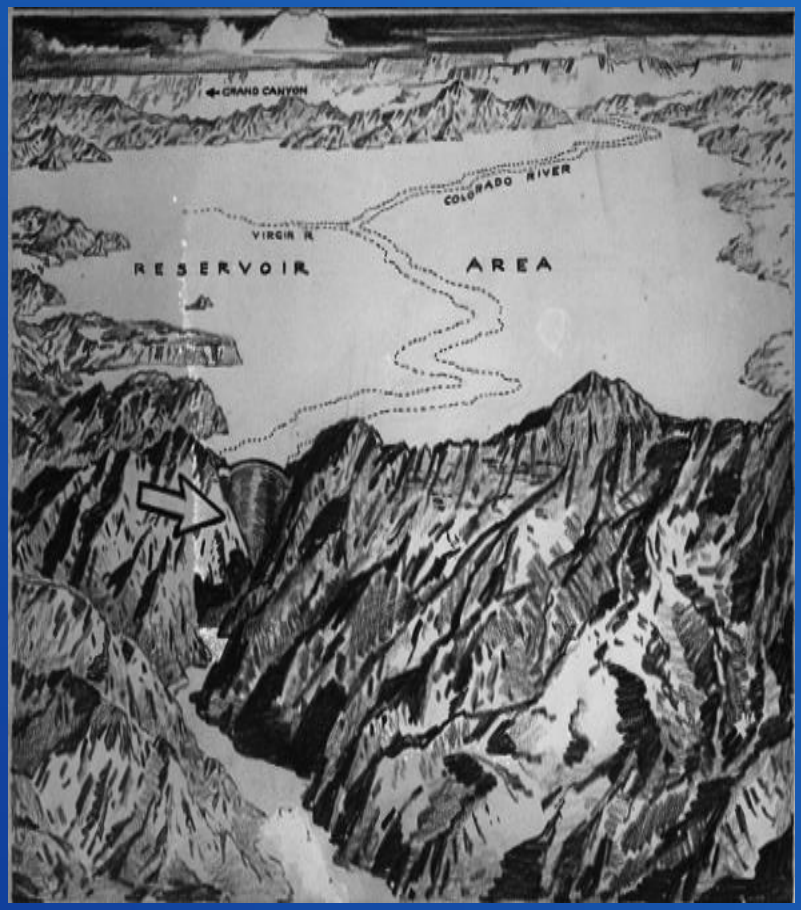
Overview of the Colorado River System

- 16.5 million acre-feet (maf) allocated annually
  - 7.5 maf each to Upper and Lower Basins
  - 1.5 maf to Mexico
- 13.0 to 14.5 maf of consumptive use annually
- 16 maf of average annual “natural flow”
  - 14.8 maf in the Upper Basin and 1.3 maf in the Lower Basin
- Inflows are highly variable year to year
- 60 maf of storage (4 times the annual inflow)
- Operations and water deliveries governed by the “Law of the River”



Colorado River Basin "Law of the River"

- Colorado River Compact, 1922
- Boulder Canyon Project Act, 1928
- US-Mexico Water Treaty, 1944
- Upper Colorado River Basin Compact, 1948
- Colorado River Storage Project Act, 1956
- Consolidated Supreme Court Decree, Arizona v. California, 1964 (and following)
- Colorado River Basin Salinity Control Act, 1974 (and following)
- Colorado River Basin Project Act, 1968



Sketch of proposed Boulder Canyon dam site and reservoir, circa 1921

RECLAMATION

Key Provisions in the 1928 Boulder Canyon Project Act

- Ratified the 1922 Compact
- Authorized the construction of Hoover Dam, including dam and reservoir priorities for water use, and related irrigation facilities in the lower Basin
- Authorized and directed the Secretary of the Interior to function as the sole contracting authority for Colorado River water use in the Lower Basin
- Apportioned the Lower Basin's 7.5 maf among the states of Arizona, California, and Nevada

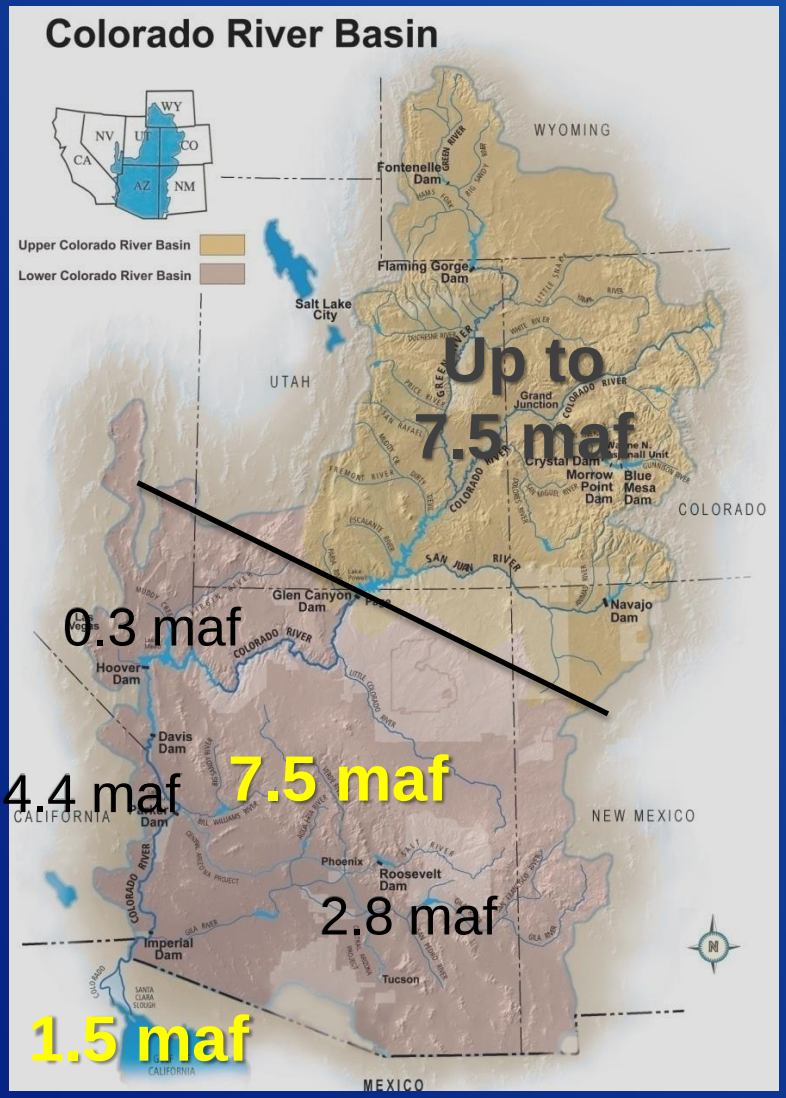
1928 Boulder Canyon Project Act, Section 6

- Authorizes… "[t]hat the dam and reservoir provided for by section 1 hereof shall be used:
  - First, for river regulation, improvement of navigation, and flood control;
  - second, for irrigation and domestic uses and satisfaction of present perfected rights in pursuance of Article VIII of said Colorado River compact; and
  - third, for power."

Secretary's Role as Water Master in the Lower Colorado Region

- Reclamation's Lower Colorado Region acts on behalf of the Secretary to carry out the Water Master role
- The Water Master role stems from the 1928 Boulder Canyon Project Act and the 2006 Consolidated Supreme Court Decree in *Arizona* v. *California*
- The Secretary performs role similar to state engineers on other river systems in the West

Lower Basin Annual Water Deliveries



- Annual water deliveries include:
  - California 4.4 maf
  - Arizona 2.8 maf
  - Nevada 0.3 maf
  - Mexico 1.5 maf
  - Reservoir regulation of Lakes Mohave and Havasu
  - System gains and losses
- Deliveries can be larger or smaller under surplus or shortage conditions, or to meet other delivery requirements

RECLAMATION

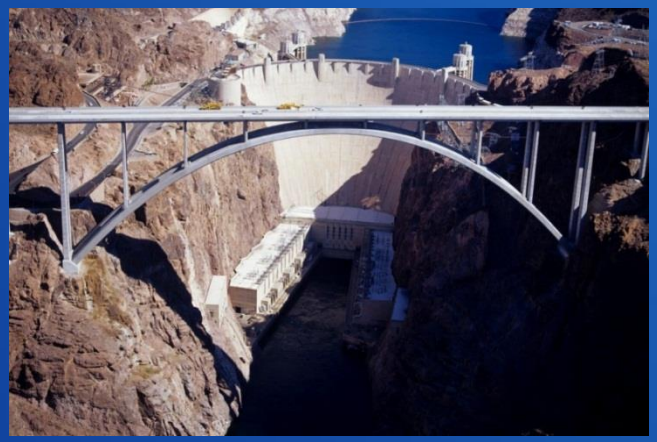
Lake Powell and Lake Mead Coordinated Operations and Agreements related to Lower Basin Water Delivery

Powell/Mead Coordinated Operations

- Lake Powell Filling Criteria, 1962
- Long-Range Operating Criteria, 1970 (minor modifications in 2005)
- Interim Surplus Guidelines, 2001
- 602(a) Storage Guideline, 2004
- Coordinated Operations Interim Guidelines, 2007

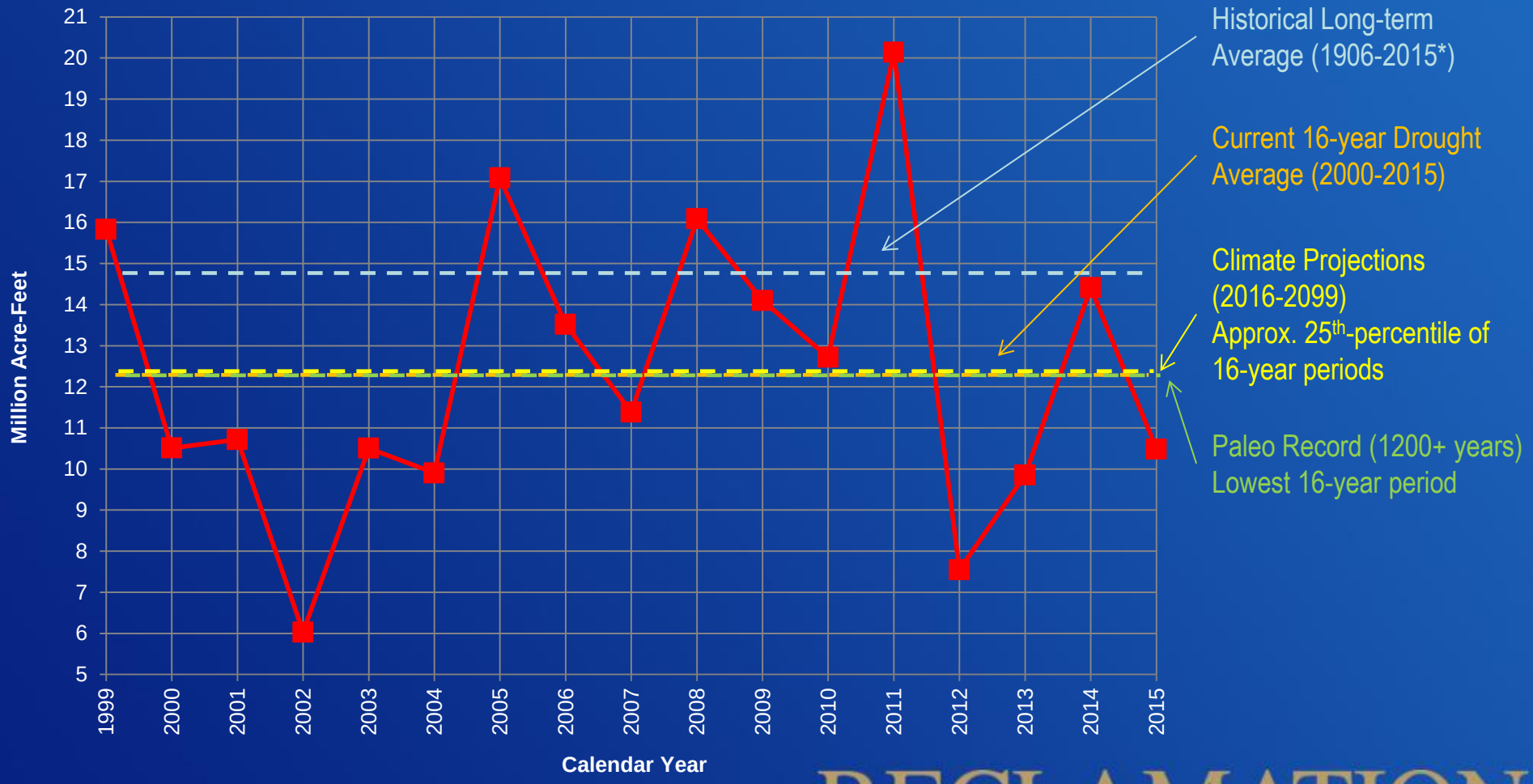
Lower Basin and Mexico Water Delivery

- Offstream Storage of Colorado River Water, 1999
- Interim Surplus Guidelines, 2001
- Colorado River Water Delivery Agreement, 2003
- Coordinated Operations Interim Guidelines, 2007
- IBWC Minute 319, 2012
- IOPP, Unused Water, and ICS procedures



Current 16-year Drought (2000-2015)

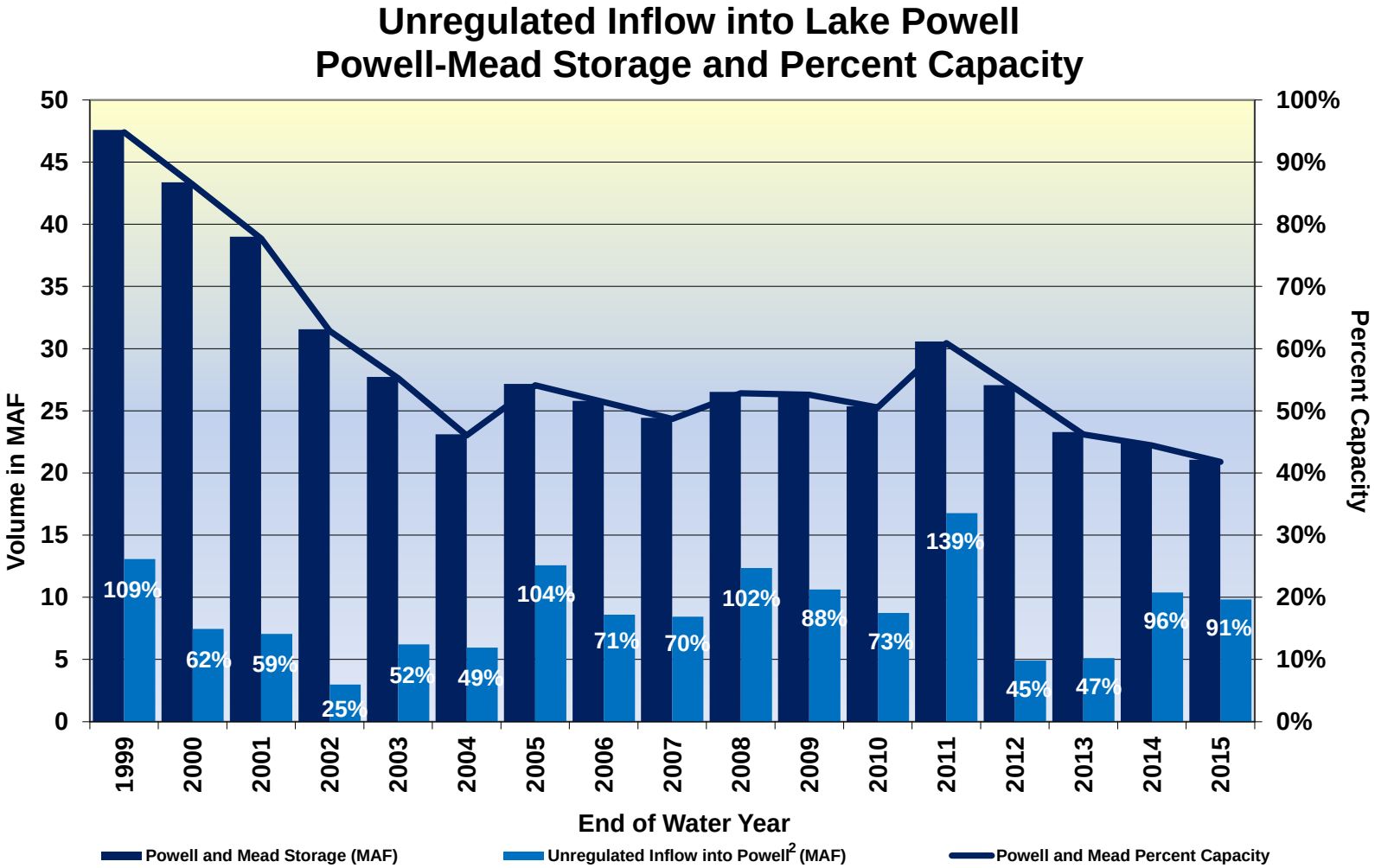
Natural Flow at Lees Ferry



*2013-2015 natural flows are provisional

RECLAMATION

State of the System (Water Years 1999-2015)[1]



[1]Values for water year 2015 are projected. Unregulated inflow is based on the latest CBRFC forecast dated July 1, 2015. Storage and percent capacity are based on the June 2015 24-Month Study.

[2]Percentages at the top of the light blue bars represent percent of average unregulated inflow into Lake Powell for a given water year. Water years 1999-2011 are based on the 30-year average from 1971 to 2000. Water years 2012-2015 are based on the 30-year average from 1981-2010.

RECLAMATION

Interim Guidelines for Operation of Lake Powell and Lake Mead

- Key provisions:
  - Operation for Lake Powell and Lake Mead is specified throughout the full range of operation
  - Strategy for shortages in the Lower Basin is specified, including a provision for additional shortages if warranted
  - Mechanism (Intentionally Created Surplus or ICS) is established to encourage efficient and flexible water use in the Lower Basin
- In place for an interim period (through 2026)
- Do not include provisions for Mexico

RECLAMATION

IBWC Minute 319

Cooperative 5-year agreement with Mexico

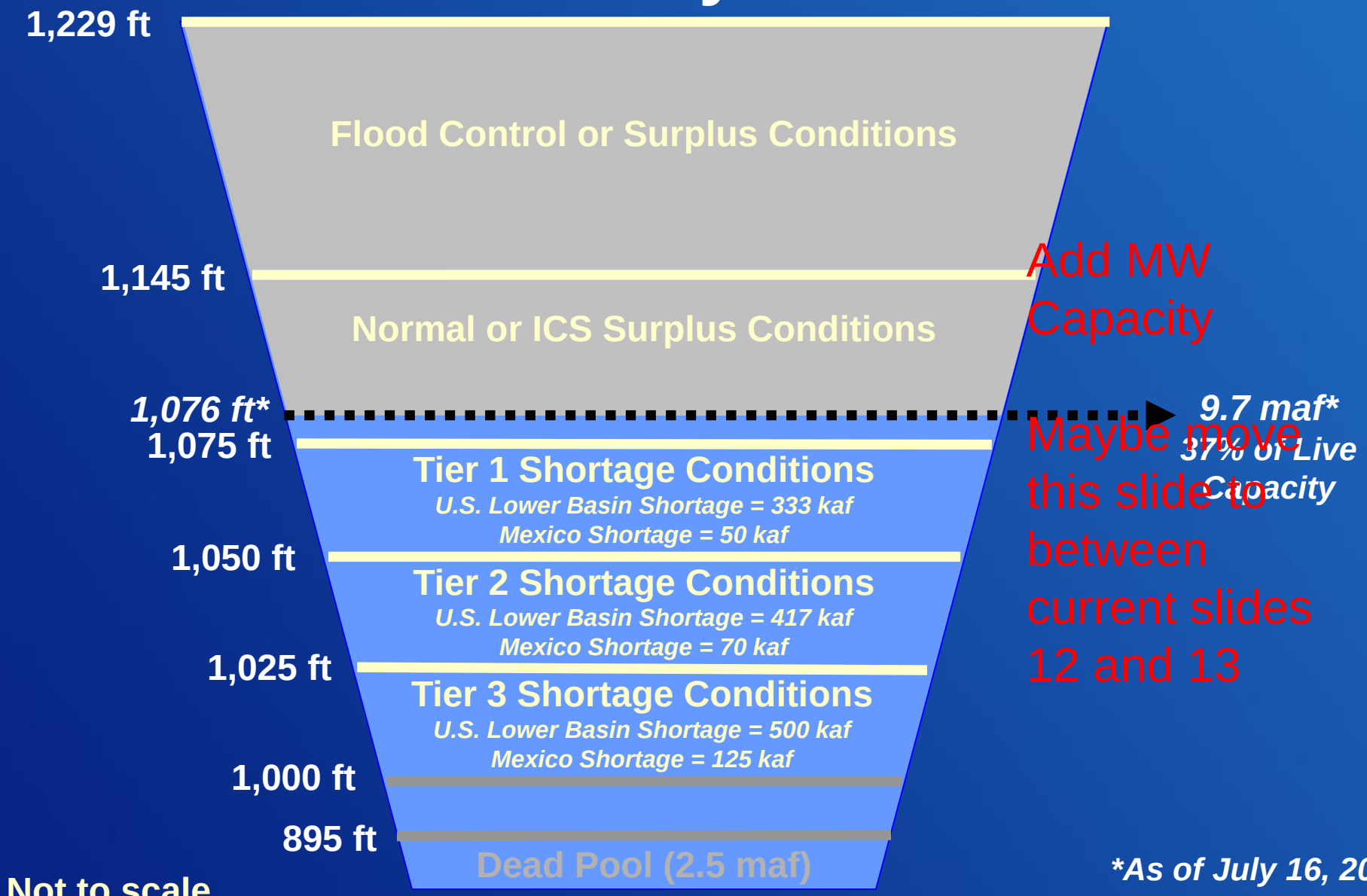
- Historic breakthrough on sharing Colorado River resources
- In place for an interim period from 2013 to 2017
- Provides for storage of Mexican conserved water in Lake Mead
- Shortage and surplus sharing with U.S. water users
- Improved infrastructure for conservation
- Water for the environment in the Colorado River Delta

Damage to canal in Mexico from earthquake, April 2010.

View of riparian area in Colorado River Delta.

RECLAMATION

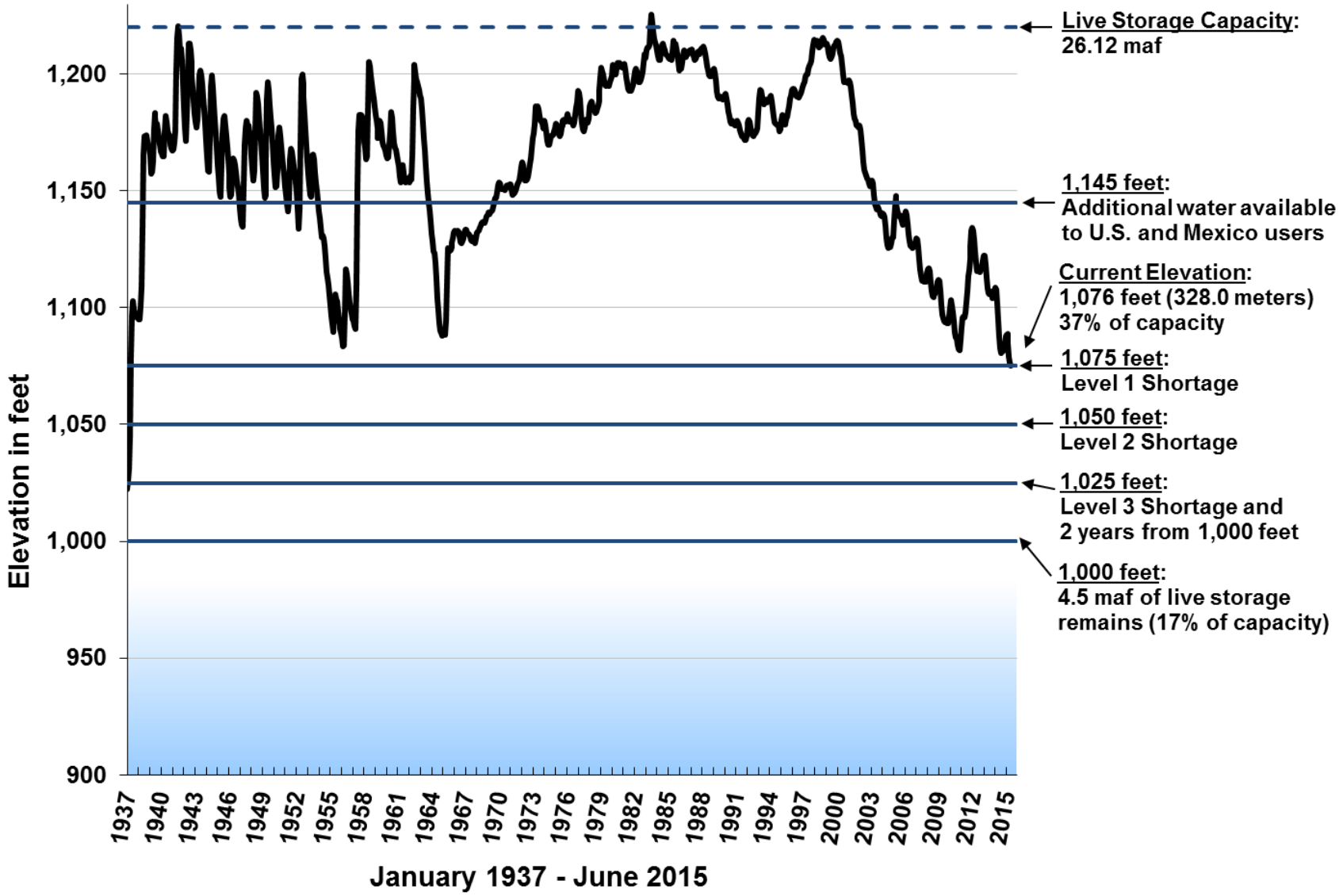
Lake Mead – Key Elevations



[1] U.S. Lower Basin shortage volumes based on the 2007 Interim Guidelines; Mexico shortage volumes based on IBWC Minute 319.

RECLAMATION

Lake Mead Historical Elevations and Critical Elevations



RECLAMATION

Drought Response Planning

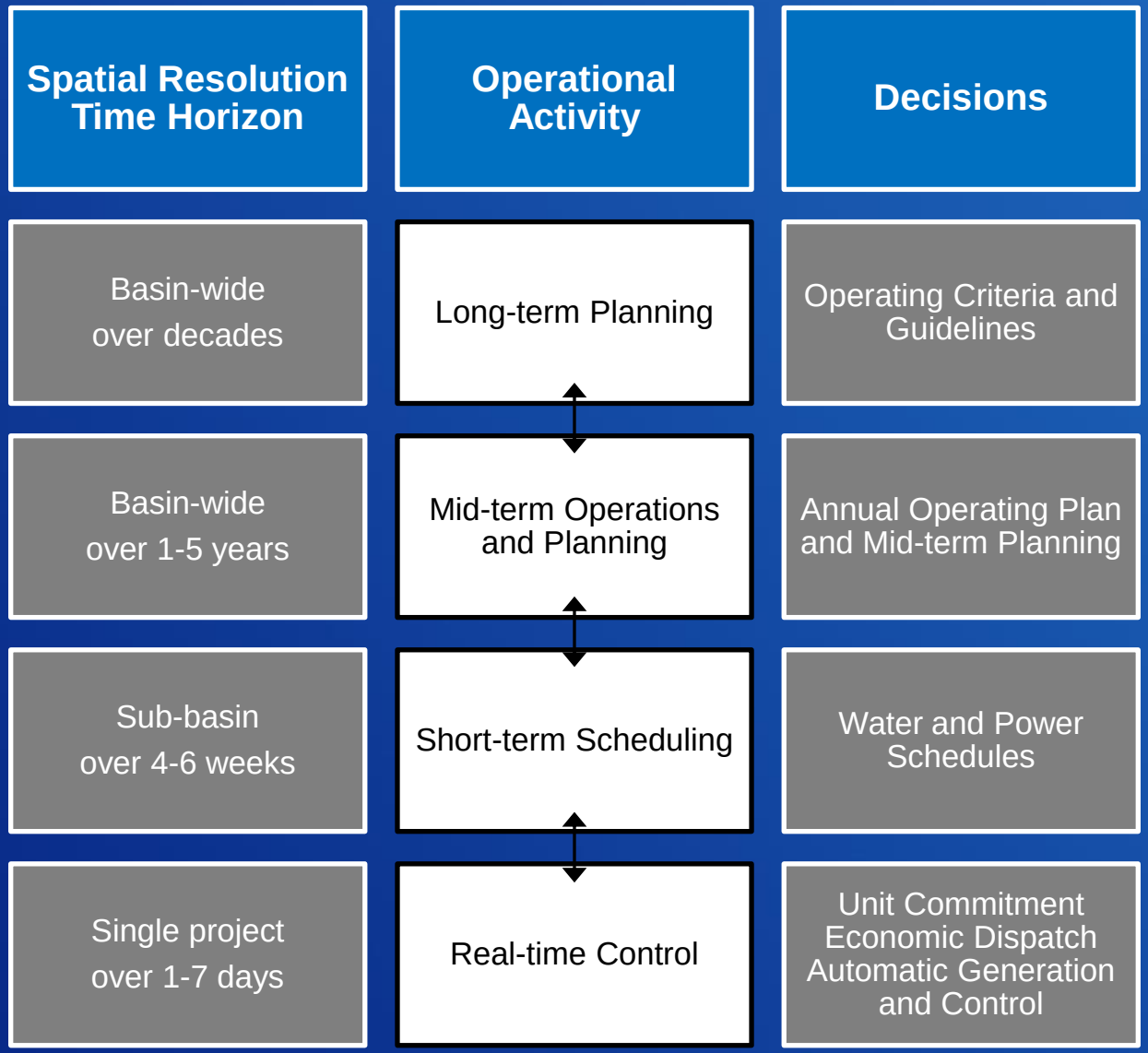
Basin-wide Pilot System Conservation Program

- Funders: Reclamation, CAWCD, SNWA, MWD, and Denver Water
- Provides $11 million for voluntary pilot projects that create system water
- Anticipate that the first implementation agreements will be signed during spring/summer of 2015

Lower Basin Agreement for Pilot Drought Response Actions

- Participants: CAWCD, MWD, SNWA, Lower Basin States, and Reclamation
- 2014-2017 Goal: Generate 740,000 acre-feet of water to benefit Lake Mead elevation
- 2014-2019 Goal: Generate 1.5 to 3.0 maf of water to benefit Lake Mead elevation

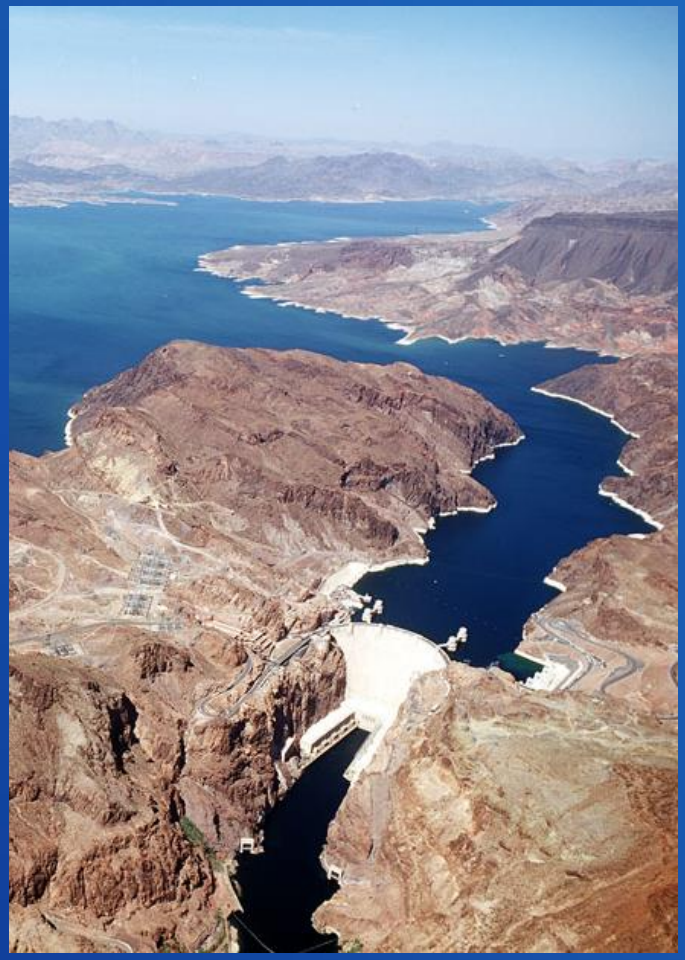
Operational Decision-making Hierarchy



RECLAMATION

Operation of Lake Mead and Hoover Dam

- Two modes of operation govern the releases from Lake Mead
  - Flood Control (releases in excess to downstream water delivery requests)
  - Meet the downstream water delivery requests
- Flood Control operations governed by U.S. Corps of Engineers regulations



Lake Mead

Hoover Dam

Lake Mohave

Davis Dam

Lake Havasu

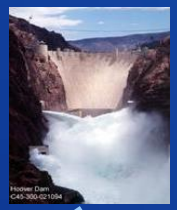
Parker Dam

Coordinating Energy Targets with Western

- Hoover Dam
  - Set monthly release volume, convert to gross energy target, and provide target to Western Area Power Administration
- Parker and Davis Dams
  - Set daily releases to meet water deliveries and elevation targets at Lakes Mohave and Havasu
  - Set hourly releases within the day to help meet peak power demands and special operations while still meeting daily water deliveries

Operation of Hoover Dam

- Hoover is a peaking powerplant
- Monthly energy targets are disaggregated into each contractor's share by Western
- Each contractor schedules its energy to meet energy demands on a real-time basis
- Monthly gross energy target is met within ± 2 percent
- Reclamation may change monthly gross energy target within the month based on system conditions



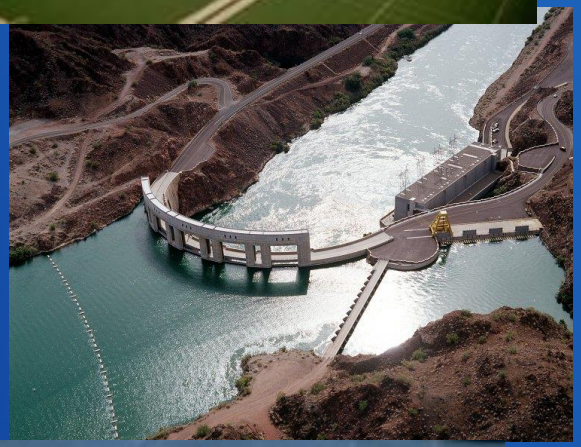
Operation of Davis and Parker Dams

- Water released from Davis Dam reaches Lake Havasu in about 1½ days
- CAP and MWD diversion schedules are coordinated with BCOO
- Yuma Area Office develops daily Parker water orders for users below Parker Dam
- Water released from Parker Dam reaches Yuma, Imperial Valley, and northern Mexico in about 3 to 4 days

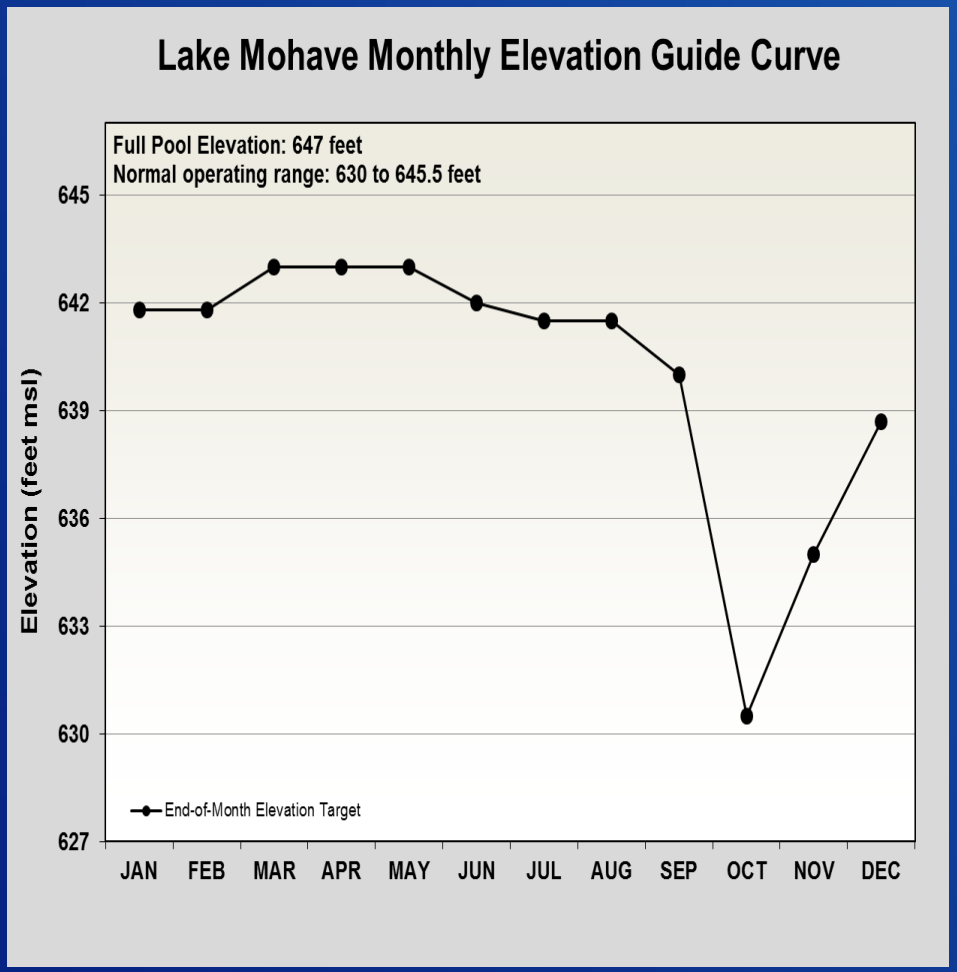
RECLAMATION

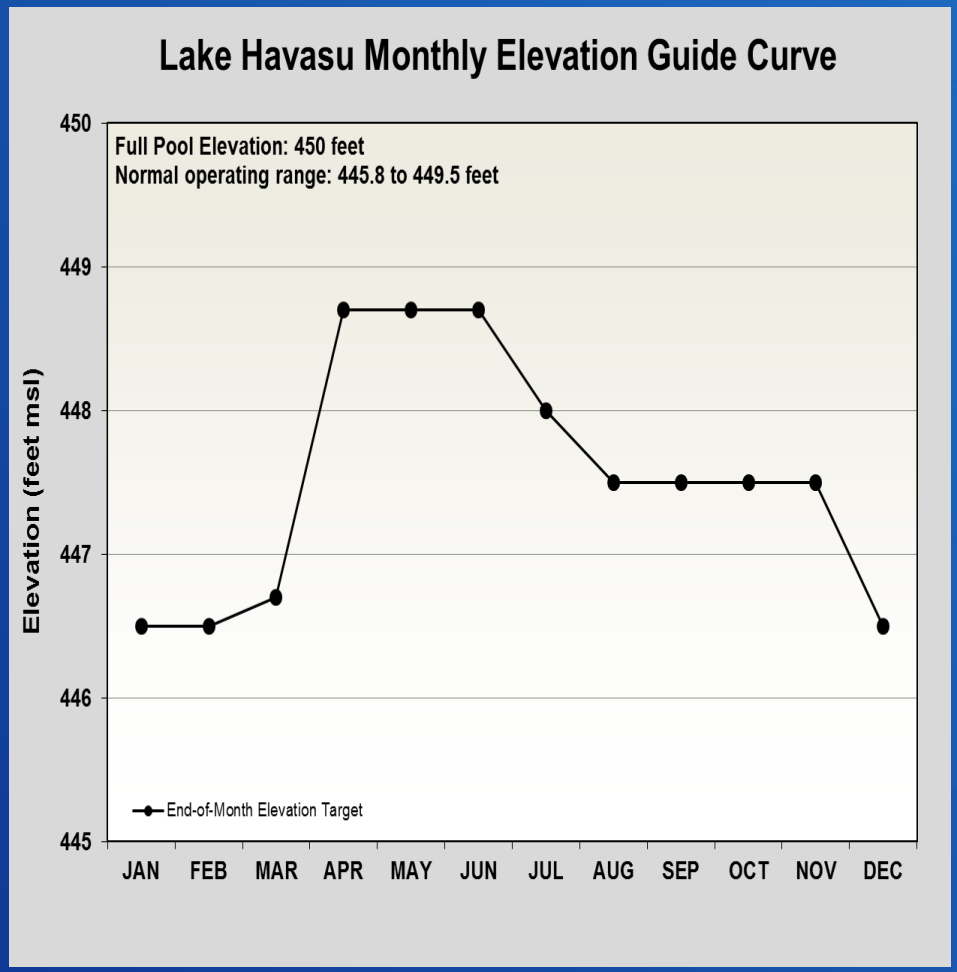
Operation of Davis and Parker Dams

- Monthly elevation targets for Lake Mohave and Lake Havasu are considered when setting Lake Mead releases
- Monthly elevation targets are based on:
  - Flood control operations
  - Water for downstream delivery
  - Environmental constraints
  - Recreational and boater safety considerations
- Releases from Davis and Parker are scheduled on an hourly basis
  - Hydropower projections are coordinated with Western



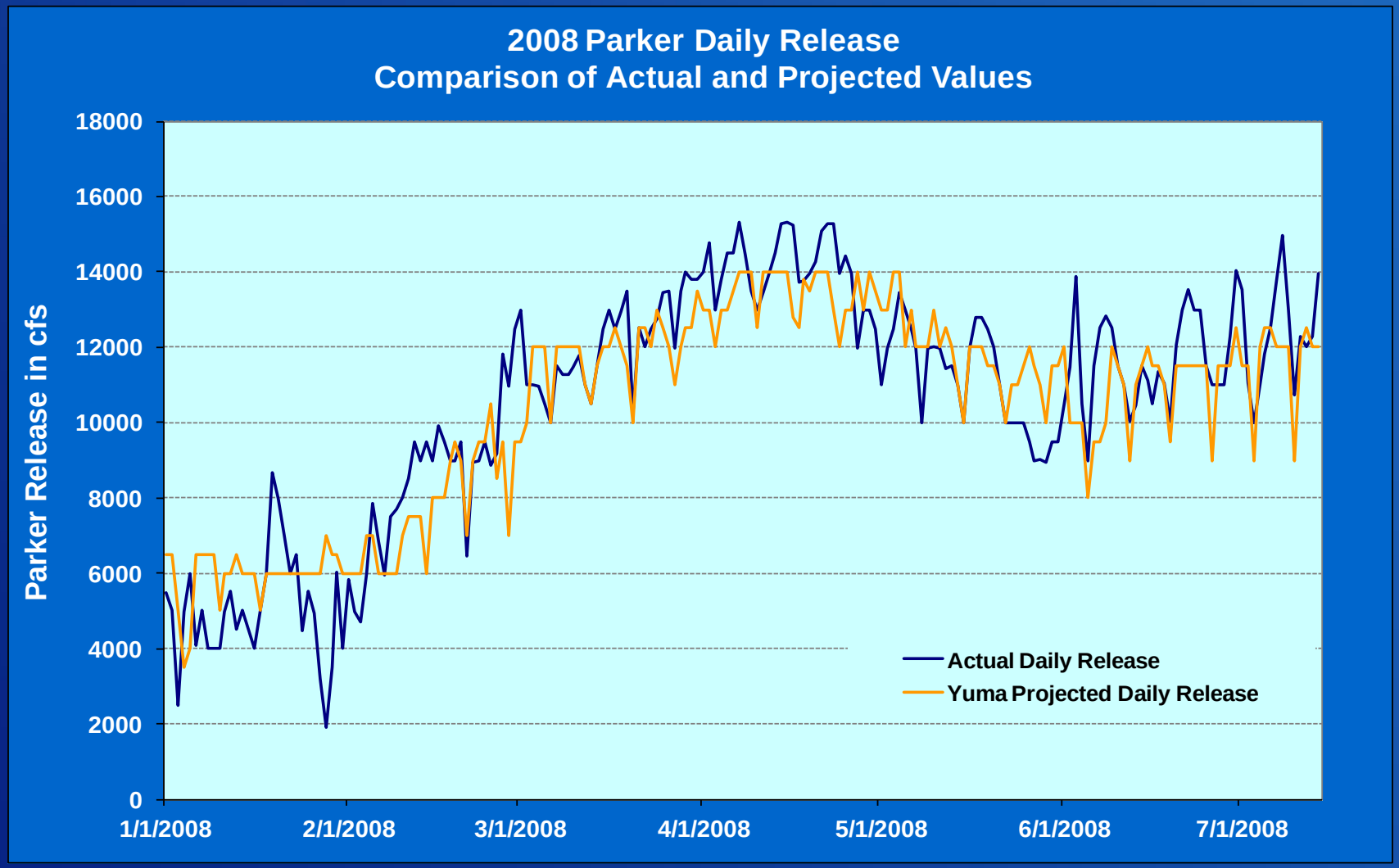
Monthly Elevation Guide Curves for Lake Mohave and Lake Havasu





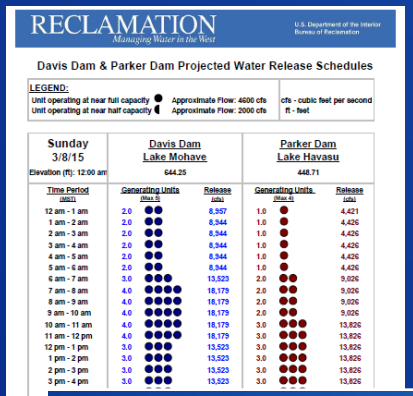
RECLAMATION

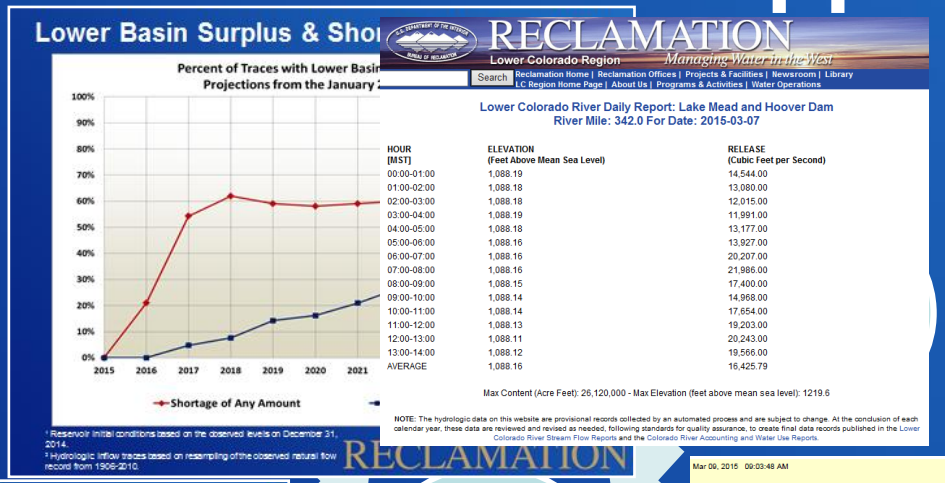
Parker Dam Daily Releases



RECLAMATION

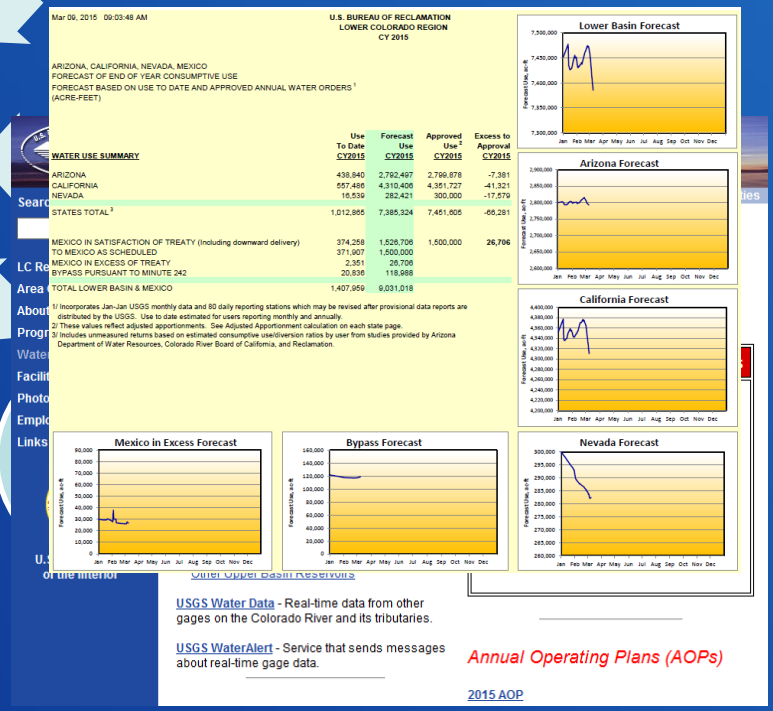
Data-centered Decision Support System





Hydrologic Database (HDB)

Disseminate Information & Knowledge



RECLAMATION

Boulder Canyon Operations Office
Water Operations Control Center

Operational Hours (Pacific Time)

Monday through Friday from 7:30 a.m. to 4:00 p.m.
Federal holidays and weekends (Saturday and Sunday) from 12:30 p.m. to 2:30 p.m.

Contact Information

Telephone: (702) 293-8373
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Email: bcoowaterops@usbr.gov
Web: http://www.usbr.gov/lc/riverops.html

Additional Contact Information

Daniel Bunk *River Operations Manager*	(702) 293-8013	dbunk@usbr.gov
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Rose Davis *Public Affairs Officer*	(702) 293-8421	jdavis@usbr.gov


For further information:
http://www.usbr.gov/lc/riverops.html
BCOOWaterOps@usbr.gov

Conner, Kelly <kconner@usbr.gov>

Fwd: Key Points - Hoover hydropower/Lake Mead water levels

2 messages

Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:33 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark
---------- Forwarded message ----------
From: **Davis, Jeannette (Rose)** <jdavis@usbr.gov>
Date: Tue, May 5, 2015 at 11:48 AM
Subject: Re: Key Points - Hoover hydropower/Lake Mead water levels
To: "Cook, Mark" <mrcook@usbr.gov>

Thank you Mark!!
Rose

On Tue, May 5, 2015 at 11:46 AM, Cook, Mark <mrcook@usbr.gov> wrote:

> Rose,
> These look like good points to me. Another big accomplishment that we have done is the unit overhauls and wicket gate replacements. Through this program to date, we have reclaimed 105 MW of capacity. It is about equivalent to having added another generator at the dam! Instead of the 1573 MW available today, we would only have 1468 MW available had we not done this work.
>
> The 950 elevation designation is not official yet. The phrase I like to use is "Our minimum power pool is 1050, but we are in the process of revising it to be 950."
>
> Thanks,
> Mark
>
> On Mon, May 4, 2015 at 4:09 PM, Davis, Jeannette (Rose) <jdavis@usbr.gov> wrote:
>
> > Hi Mark,
> > I put together some messages about low water levels in Lake Mead and the effects/interaction with hydropower generation. I had some hits and some misses. Chau and Larry Carr made some edits and I'm sending this to you for your edits.
> >
> > I am hoping the language can stay fairly simple so I can understand it myself and explain it as needed.
> > Please review and make your edits?
> > I really appreciate it.
> > Rose
> > ---------- Forwarded message ----------
> > From: **Nguyen, Chau** <cnguyen@usbr.gov>
> > Date: Mon, May 4, 2015 at 4:05 PM
> > Subject: Re: Key Points - Hoover hydropower/Lake Mead water levels
> > To: "Davis, Jeannette (Rose)" <jdavis@usbr.gov>
> >
> > Rose,
> > Attached is the revised key points with comments from me, Larry and Dan Bunk.
> >
> > Chau

On Thu, Apr 30, 2015 at 12:01 PM, Davis, Jeannette (Rose) <jdavis@usbr.gov> wrote:

> Thank you so much!!
> I made that mistake with KJZZ last Friday so rest assured with your tutoring me and working with the talking points we will get it right in the future. I really appreciate you!
> Rose
>
> On Thu, Apr 30, 2015 at 11:27 AM, Nguyen, Chau <cnguyen@usbr.gov> wrote:
>
> > Rose,
> > I will review the draft talking with Larry and provide you with the corrections before you send to Mark Cook for review.
> >
> > Chau
> >
> > On Wed, Apr 29, 2015 at 10:19 AM, Davis, Jeannette (Rose) <jdavis@usbr.gov> wrote:
> >
> > > Hi Chau,
> > > Here is my first cut at some talking points for the hydro questions we are getting. Would you review and make any corrections and then we'll send them to Mark?
> > > Thanks so much,
> > > Rose
> > >
> > > --
> > > Rose Davis, MPA
> > > Public Affairs Officer
> > > Lower Colorado Region
> > > Bureau of Reclamation
> > > (o) 702-293-8421
> > > (c) 702-591-0029
> > > jdavis@usbr.gov
> > >
> > > Check us out at: http://www.usbr.gov/lc/
> >
> > --
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Cook, Mark <mrcook@usbr.gov> Thu, Jun 2, 2016 at 8:34 AM
To: Kelly Conner <kconner@usbr.gov>

Kelly,
This is an email I have to add to the collection of information to fulfill FOIA request.

Thanks,
Mark
--------- Forwarded message ---------
From: **Cook, Mark** <mrcook@usbr.gov>
Date: Tue, May 5, 2015 at 11:46 AM
Subject: Re: Key Points - Hoover hydropower/Lake Mead water levels
[Quoted text hidden]