Group L

FOIA/PA NO: 2014-0027

RECORDS BEING RELEASED IN THEIR ENTIRETY

Perkins, Richard

From: Beasley, Benjamin
Sent: Wednesday, March 16, 2011 3:30 PM
To: Ader, Charles; Kokajko, Lawrence
Cc: Perkins, Richard
Subject: Appointment of Generic Issue Review Panel Members for Pre-GI-009

Charlie and Lawrence,

Do you approve of Marie Pohida and Keith Compton serving on the Pre-GI-009 screening panel? We expect to provide the screening analysis report to the panel members within the next few days and intend to call a panel meeting within a week or so.

If you approve of Marie and Keith serving on the screening panel, a reply to this email stating so will be sufficient documentation.

Regards,
Ben Beasley

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Benjamin Beasley, Chief
Operating Experience and Generic Issues Branch
Division of Risk Analysis
Office of Nuclear Regulatory Research
301-251-7676
Benjamin.Beasley@nrc.gov
Generic Issues Program
Operating Experience Databases

L/1

Perkins, Richard

From: Bensi, Michelle
Sent: Thursday, June 09, 2011 2:47 PM
To: Ferrante, Fernando; Rodriguez, Veronica
Cc: Perkins, Richard; Beasley, Benjamin
Subject: SECY paper referenced in meeting
Attachments: HandlingSensitiveUnclassifiedInformation_WithHighlights_ML042310663.pdf; HandlingSensitiveUnclassifiedInformation(approvalmemo)_ML043140175.pdf

Fernando and Veronica,

I have attached the SECY paper pertaining to the Handling of Sensitive Unclassified Information. I found reading the whole paper to be useful, but I have highlighted a few sections that I found particularly applicable to our specific issues. For reference I have also attached the associated approval memo.

With regard to the referencing of non-public documents, the following is an excerpt from the NRC Style Guide:

2 Availability

Include sources that are publicly available in a list of references. Do not include, for example, private communications, predecisional documents, technical notes, minutes of a meeting, or other sources that are not available in the NRC's Public Document Room. Avoid using a classified or proprietary document as a reference unless it is the only source of information cited. If you must use such a document as a reference, state, as appropriate, after its citation in the list of references:

Classified report. Not publicly available.
or
Proprietary information. Not publicly available.

The author of a document is responsible for ensuring that each reference is accurate and that each document referenced is publicly available, unless otherwise indicated. The NRC publishes an availability notice on the inside front cover of its reports (see Section 1 of the appendix to this guide). This notice directs the reader to sources for obtaining publicly available NRC documents and most codes and standards referenced in NRC reports. Therefore, the NRC does not include NRC documents as references but does include references to codes and standards as a separate category in a reference list for these reports. The availability statements presented in Section 1 of the appendix to this guide cover appropriate sources for most references that would be included in NRC documents other than NUREG–series reports. Often these statements would be used as a footnote to a reference that is fully identified in the text.

Thanks.

Michelle (Shelby) Bensi, Ph.D.
Reliability and Risk Engineer
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch

L/2

Perkins, Richard

From: Bensi, Michelle
Sent: Friday, June 17, 2011 10:17 AM
To: Perkins, Richard
Subject: FW: replacing file in ADAMS

Richard,
FYI.
The version of the screening report in ADAMS has been declared Official Agency Record (b/c it was included as a enclosure to the NSIR memo). Therefore, we can no longer check the document in and out to do version control. Instead, it appears that we will need to email the document to ADAMS IM to have them replace the document manually. I have done this with the most recent version of the report. As we make changes, we will have to remember to email ADAMS IM to have the document updated. This will be especially important in the next couple weeks because the panel (and everyone on the Comm Plan distribution list) will be accessing the draft report and we want to make sure they are viewing the most up to date version of the document.
Thanks,
Shelby

From: ADAMS IM
Sent: Friday, June 17, 2011 9:57 AM
To: Siu, Carolyn
Cc: Bensi, Michelle
Subject: FW: replacing file in ADAMS

Hello Carolyn,

The attached file has been exchanged with ML110740482. Since this file is and remains Non-Public, ADAMS IM can replace the updates you provide.

I hope this answers your question.

Thanks
Susie Hicks
OIS/IRSD
On behalf of ADAMS Support

From: Siu, Carolyn
Sent: Friday, June 17, 2011 8:44 AM
To: ADAMS IM
Cc: Bensi, Michelle
Subject: FW: replacing file in ADAMS

Good morning,

Per the email below, please switch document ML110740482 with the attached, as some changes have been made. Is there any way to undeclare this document (more edits are expected), or is our best option just to make a new document in ADAMS?

L|3

Carolyn Siu
301-251-7568

From: Bensi, Michelle
Sent: Thursday, June 16, 2011 4:39 PM
To: Siu, Carolyn
Subject: replacing file in ADAMS

Carolyn,

Please have the document currently associated with ML110740482 replaced with the attached file.
If possible, we would like to have this document changed back into a working/draft document (i.e. non-Official Agency Record) in ADAMS. The document is still under review and we anticipate more changes to it. We would like to use ADAMS for version control.

Thanks!

Michelle (Shelby) Bensi, Ph.D.
Reliability and Risk Engineer
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch

Perkins, Richard

From: Sancaktar, Selim
Sent: Tuesday, June 28, 2011 8:18 AM
To: Perkins, Richard
Subject: Fort Calhoun - just some tidbits
Attachments: Fort Calhoun defends against flood.docx

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Fort Calhoun defends against flood

27 June 2011

The Fort Calhoun nuclear power plant switched to diesel generators for a time yesterday amid the severe Missouri flooding that looks set to continue for another month.

The power plant has been in cold shutdown since 9 April, when it closed for a routine refueling outage. In the meantime, storms inundated the wider area causing the Missouri river to rise - with this being exacerbated by melting snow as well as emergency releases of water from upstream dams.

It was three weeks ago that the river rose to a point that Omaha Public Power District declared it an 'unusual event' to the US Nuclear Regulatory Commission (NRC) and this status still applies. The river level has now reached 36 feet (10 meters) above normal and surpassed the record set in 1993.

Fort Calhoun was designed for floods up to 1014 feet above sea level, and the current flood stands at 1006 feet. The official flooding alert will remain until waters recede to 1004 feet, but this may not happen for weeks.

Berms and temporary AquaDams have been installed around Fort Calhoun's main plant buildings as well as the electrical switchyard and administration area. These have prevented flooding of up to two feet (60 centimetres) in various important areas of the plant.

However, one part of an AquaDam suffered a puncture on 26 June allowing water to surround some of the plant buildings as well as the main electrical transformers. This prompted plant managers to disconnect from the grid and run plant safety systems from on-site diesel power. This status remained until checks confirmed it was safe to reconnect to the grid.

The NRC has said that normal and additional diesel tanks are full. Contingency measures are in place, such as sandbagging supplies, emergency food, firefighting kit and a spare diesel generator.

Staff at the Cooper nuclear power plant, also on the Missouri, are taking action against rising river levels but that plant continues to operate at full power while observing the 'unusual event'.

The Garrison Dam in North Dakota is one of six dams that comprise the principle flood control of the Missouri river and part of the protection for the Ft. Calhoun Nuclear Power Plant. As alarming as that might be the true issue may not be with the Garrison Dam, but the Fort Peck Dam the first dam in the system. Here is a scenario taken from Bernard Shanks a guest commentator from the St. Louis Today.com website.

The Fort Peck Dam is built with a flawed design that has suffered a well-known fate for this type of dam — liquefaction — in which saturated soil loses its stability. Hydraulic-fill dams are prone to almost instant collapse from stress or earthquakes. California required all hydraulic-fill dams be torn out or rebuilt — and no other large dams have been built this way since. At three miles wide, Fort Peck Dam last opened its floodgates 36 years ago. By the end of the first week in June, the U.S. Army Corps of Engineers will be releasing a record spill of water. Here is a likely scenario: Garrison, Oahe and three other downstream earthen dams would have to catch and hold a massive amount of water, an area covering

nearly 250 square miles 100 feet deep. But earthen dams, when overtopped with floodwater, do not stand. They break and erode away, usually within an hour. All are full. There is a possibility a failure of Fort Peck Dam could lead to a domino-like collapse of all five downstream dams. It probably would wreck bridges, highways, pipelines and power lines and split the heartland of the nation, leaving a gap 1,500 miles wide.

In 2003, when the Fort Calhoun nuclear plant had its operating license renewed for an additional 20 years, expiring in 2033, the renewal report had sounded this note of caution:

"During identification and evaluation of flood barriers, unsealed through wall penetrations in the outside wall of the intake, auxiliary and chemistry and radiation protection buildings were identified that are below the licensing basis flood elevation. A summary of the root causes included: a weak procedure revision process; insufficient oversight of work activities associated with external flood matters; ineffective identification, evaluation and resolution of performance deficiencies related to external flooding; and 'safe as is' mindsets relative to external flooding events."

In 2010, the Nuclear Regulatory Commission (NRC) conducted an inspection of Fort Calhoun Station (FCS) and found that the plant did not have adequate procedures to protect the intake structure and auxiliary building against external flooding events. Specifically, contrary to Technical Specification 5.8.1.a, the station failed to maintain procedures for combating a significant flood as recommended by Regulatory Guide 1.33, Appendix A, section 6.w, "Acts of Nature."

Looking for information on Fort Calhoun, I found this piece of news by ketv.com last April 1, 2011:

"Fort Calhoun's nuclear power plant is one of three reactors across the country that federal regulators said they are most concerned about. Nuclear Regulatory Commission officials said Fort Calhoun's reactor is operating safely, but it's still on the shortlist because they want to make sure it's prepared to handle major emergencies, like flooding. Last year, federal regulators questioned the station's flood protection protocol. NRC officials said they felt the Omaha Public Power District should do more than sandbagging in the event of major flooding along the Missouri river."

According to ketv.com, "OPPD officials said they have already made amends and added new flood gates."

Perkins, Richard

From: Pohida, Marie
Sent: Thursday, June 30, 2011 9:44 AM
To: Bensi, Michelle; Perkins, Richard
Cc: Compton, Keith
Subject: Downstream dam Failures impacting the ultimate heat sink.

Good Morning,

I spoke with Fernando this morning about the risk impact of downstream dam failures only/specifically dealing with draining of the ultimate heat sink (e.g. Robinson). I then re-read the Communications Plan and the Generic Issues Review Panel recommendations to see what these reports said about downstream dam failures. I noticed that the justification for not including downstream dam failures leading to a loss of the ultimate heat sink was not addressed in these reports. Was there a justification made before these reports were written? We discussed this issue at the Pre-GI panel meeting, but the context of issue was not discussed in detail. (I didn't understand the issue completely) I don't recall if Robinson was discussed in the pre-panel meeting report.

I understand that this issue was raised in the pre-GI submittal letter and explicitly discussed in the draft IN notice on dam failures. I would think that bulk of the work in evaluating the GI would be searching for and assessing the impacts of potential dam failures. I would think that it would a small increase in scope to include this issue and would close the issue of dam failures completely and permanently.

In any event, I believe that the justification for including or not including this issue needs to be clearly stated in the Communications Plan and the Screening Analysis report.

Thank you for your attention to this issue.
Please email/call me if you have any questions.
Marie Pohida

From: Bensi, Michelle
Sent: Friday, June 17, 2011 9:40 AM
To: Ruland, William; Pohida, Marie; Compton, Keith
Cc: Perkins, Richard; Beasley, Benjamin; Kauffman, John
Subject: Generic Issues Review Panel recommendation memorandum - Draft for Comment

Please note that the 2nd page of this email string was not included; however, the complete 9:40 email may be found as document M/13 in this response package.

Bill, Marie, and Keith,

I have attached a draft of the Generic Issues Review Panel recommendation memorandum for your review and comment. Please send your comments to Richard Perkins (with a copy to John Kaufmann and me).

Once we receive your comments, Richard will revise the memo accordingly. You will then be provided with a final version of the memo with appropriately labeled enclosure. Once the memo is finalized, Ben Beasley and Richard Correia will be asked for concurrence. Next, we will ask for your signatures followed by concurrence from the individual offices (NRR, NRO, NMSS). Brian Sheron will provide final approval before the memo and report are released publically.

I have also attached the most recent revision of the screening analysis report for your review. The attached report remains designated as Official Use Only. The report is currently under review by NSIR and we are awaiting guidance regarding the sensitivity classification of the document. Please note that the version of the report that is currently in ADAMS is not the most recent version. We hope to have the revised report included in ADAMS soon. If necessary, the report will be updated in ADAMS as revisions are made to it.

L/5

Perkins, Richard

From: Correia, Richard
Sent: Thursday, June 30, 2011 2:53 PM
To: Stapleton, Bernard; Holahan, Patricia; Westreich, Barry; Coe, Doug; Beasley, Benjamin; Kauffman, John
Cc: Norman, Robert
Subject: Re: review request

Thank you Bern for the requested information, advice and quick response. We will proceed as an uncontrolled document.
Regards
Rich
Richard Correia, Director
Division of Risk Analysis
RES

Sent from a Blackberry

From: Stapleton, Bernard
To: Holahan, Patricia; Correia, Richard; Westreich, Barry
Cc: Norman, Robert
Sent: Thu Jun 30 14:30:00 2011
Subject: RE: review request

Trish/Rich

Have spoken with RES on this issue several times (Beasley). All other times, it has been considered UNCONTROLLED unless the originating office wants it marked as OUO. Placed a call to FERC to ensure that information they have marked as CII on dam failures can be released as uncontrolled when documented by NRC officials. FERC has indicated over the phone that they do not have a problem with us issuing our own document and not calling it CII. The kicker would be if NRC copied FERC documents marked as CII and wanted to decontrol. I was waiting for an email to confirm same from last week but have not received it.

The position taken by RES in their document is sound and supports an uncontrolled, publicly available document. The SGI Designation Guide also supports this rationale since there is no mention of any security scenarios (document is a pure engineering and safety analysis that was not conducted as a result of a terrorist scenario – i.e., world trade center aircraft attack).

NOT Safeguards Information. If RES wants to release this as an UNCONTROLLED document, I have no objection and this has been confirmed with FERC as well (even though they mark such information as Critical Infrastructure Information).

Bern

From: Holahan, Patricia
Sent: Thursday, June 30, 2011 2:10 PM
To: Correia, Richard; Westreich, Barry; Stapleton, Bernard
Subject: Re: review request

Yes, I gave it to Bern. Bern - what's the status?

L|6

From: Correia, Richard
To: Holahan, Patricia; Westreich, Barry; Stapleton, Bernard
Sent: Thu Jun 30 09:44:18 2011
Subject: review request

Trish, Barry, Bern,

Greeting from Church St. Hope all is well in NSIR.

A couple of weeks ago we sent DSO a request for review of a possible generic issue on dam failure. We were looking for DSO's insights on whether the document(s) related to this effort should be considered OUO Security related information. Any idea when we might hear back on this request?

Thanks and happy Forth and happy Canada (Birthday) Day!

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

Perkins, Richard

From: Bensi, Michelle
Sent: Thursday, July 14, 2011 4:38 PM
To: Wray, John; Hilton, Nick; Riley (OCA), Timothy
Cc: Kauffman, John; Perkins, Richard; Correia, Richard; Coe, Doug
Subject: Communication plan for forthcoming Generic Issue related to dam failures
Attachments: PreGI009_CommunicationPlan_WorkingDraftForComment_2011_07_12.docx

Tim, John, and Nick,

As you may already know, we are currently processing a Generic Issue related to dam failures. In preparation for the official designation of the Generic Issue, we are developing a communication plan to aid communication with internal and external stakeholders. You have been recommended for inclusion in the communication team for this issue. Please refer to the email below (that went out to the communication team on Tuesday, July 12) for an update on the current status of the issue. For your review and comment, a draft of the communication plan is attached (this is the version that was distributed on July 12).

Please note the following:

- The communication plan is still in draft form and undergoing daily revisions (based on reviews from various offices). The content of the plan has not been vetted and it has not been approved by our management.
- The sites listed below only indicate that the site is mentioned in the screening assessment report and does not imply that the site is adversely affected by upstream dam failure.

Please let me know if you have any questions. I can be reached by email and phone (301-251-7570). I will be out of the office tomorrow (Friday, July 15) but will return on Monday.

Thank you,
Shelby

From: Bensi, Michelle
Sent: Tuesday, July 12, 2011 2:16 PM
To: Mitman, Jeffrey; Khanna, Meena; Wilson, George; Ruland, William; See, Kenneth; Raione, Richard; Pohida, Marie; Mrowca, Lynn; Compton, Keith; Felsher, Harry; Marcano, Jonathan; Schmidt, Wayne; Bartley, Jonathan; Hills, David; Meghani, Vijay; Gaddy, Vincent
Cc: Kauffman, John; Perkins, Richard; Coe, Doug; Correia, Richard; Ferrante, Fernando; Rodriguez, Veronica; Sancaktar, Selim; Philip, Jacob
Subject: Communication plan for forthcoming Generic Issue related to dam failures

All,

As many of you are aware, RES and the other program offices are processing a proposed Generic Issue pertaining to the flooding of nuclear power plant sites following upstream dam failure. We are expediting the processing of the Generic Issue largely due to:

- the recent events in Japan at the Fukushima Daiichi plant
- certain plants in the US that have experienced flooding
- the planned issuance on or about July 12 of the Task Force report (the Task Force chartered to review NRC processes and regulations following the events in Japan).

The memo officially designating this issue as a formal Generic Issue is expected to be issued this week. The memo will include an enclosure providing a synopsis of the screening assessment of the issue. The complete

L/7

screening assessment report is currently being finalized and is expected to be issued soon. In preparation for issuance of the screening assessment report, we have developed the attached communication plan to assure all affected NRC staff are prepared for the public release of the report.

The primary goal of this communication plan is to assist communications related to the forthcoming Generic Issue. However, the plan also provides information about two forthcoming NRR Information Notices (INs) related to dam failure frequencies (ML090510269) and design basis external flooding evaluation. Consequently, this communication plan will aid communications related to both the Generic Issue and the INs. We anticipate interest from the public, media, industry, and other stakeholders. A public meeting will be scheduled sometime later this summer.

The following plants are included, by name, in the Generic Issue screening assessment report:

Arkansas Nuclear One	Beaver Valley	Browns Ferry	Columbia
Cooper	Fort Calhoun	H.B. Robinson	Hope Creek
Indian Point	McGuire	Oconee	Peach Bottom
Prairie Island	Sequoyah	South Texas	Surry
Three-Mile Island	Vermont Yankee	Waterford	Watts Bar

The communication plan includes a list of staff members recommended to be part of the communication team of this Generic Issue and/or the Information Notices. Most of you are listed as members of the communication team (see pg. 4-5 of the communication plan). Please let me know if you do not wish to be included in the communication team or if you have any questions.

Finally, we request your feedback on the content of the communication plan. However, please note that the processing of the Generic Issue has been expedited, so we are limited on the number of iterations we can do in developing the communication plan. We request your feedback by Tuesday, July 19 (though we certainly welcome feedback before that date). Feel free to add comments/changes directly in the Word file (with changes tracked) or give me a hard copy with pen/paper changes. I will coalesce the comments into one document and then send a revised version of the communication plan to a broader distribution list as soon as possible.

Please feel free to email or call me (301-251-7570) if you have any questions.

Thank you,

Michelle (Shelby) Bensi, Ph.D.
Reliability and Risk Engineer
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch

Perkins, Richard

From: Perkins, Richard
Sent: Monday, July 18, 2011 6:06 PM
To: Bensi, Michelle
Subject: RE: replacing file in ADAMS

I sent the request in.

From: Bensi, Michelle
Sent: Monday, July 18, 2011 3:33 PM
To: Perkins, Richard
Subject: FW: replacing file in ADAMS

Info for file replacement.

From: ADAMS IM
Sent: Friday, June 17, 2011 9:57 AM
To: Siu, Carolyn
Cc: Bensi, Michelle
Subject: FW: replacing file in ADAMS

Hello Carolyn,

The attached file has been exchanged with ML110740482. Since this file is and remains Non-Public, ADAMS IM can replace the updates you provide.

I hope this answers your question.

Thanks
Susie Hicks
OIS/IRSD
On behalf of ADAMS Support

From: Siu, Carolyn
Sent: Friday, June 17, 2011 8:44 AM
To: ADAMS IM
Cc: Bensi, Michelle
Subject: FW: replacing file in ADAMS

Good morning,

Per the email below, please switch document ML110740482 with the attached, as some changes have been made. Is there any way to undeclare this document (more edits are expected), or is our best option just to make a new document in ADAMS?

Carolyn Siu
301-251-7568

L/8

From: Bensi, Michelle
Sent: Thursday, June 16, 2011 4:39 PM
To: Siu, Carolyn
Subject: replacing file in ADAMS

Carolyn,

Please have the document currently associated with ML110740482 replaced with the attached file.
If possible, we would like to have this document changed back into a working/draft document (i.e. non-Official Agency Record) in ADAMS. The document is still under review and we anticipate more changes to it. We would like to use ADAMS for version control.

Thanks!

Michelle (Shelby) Bensi, Ph.D.
Reliability and Risk Engineer
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch

Perkins, Richard

From: Perkins, Richard
Sent: Tuesday, July 26, 2011 11:10 AM
To: Killian, Lauren
Subject: FW: replacing file in ADAMS

Here's a message from Susan Hicks on the subject.

From: Hicks, Susan
Sent: Tuesday, July 19, 2011 8:36 AM
To: Perkins, Richard
Subject: RE: replacing file in ADAMS

Done.

I know that we have been working on this file together – but please always include ADAMS IM, incase I'm out – your request can still be processed.

Thanks
Susie Hicks
OIS/IRSD
On behalf of ADAMS Support

From: Perkins, Richard
Sent: Tuesday, July 19, 2011 8:29 AM
To: Hicks, Susan
Cc: Bensi, Michelle
Subject: RE: replacing file in ADAMS

Yes please. Thank you.

From: Hicks, Susan
Sent: Tuesday, July 19, 2011 8:13 AM
To: Perkins, Richard
Subject: FW: replacing file in ADAMS

Done. Attached file has been exchanged with ML110740482.

Also, document date within profile should be changed from 05/10/2011 to 07/05/2011 according to the checked in version.....is that OK?

Thanks
Susie Hicks
OIS/IRSD

L/9

On behalf of ADAMS Support

From: Perkins, Richard
Sent: Monday, July 18, 2011 6:06 PM
To: Hicks, Susan
Subject: FW: replacing file in ADAMS

Good Afternoon Susan,

We have completed the bulk of our edits to this document. Could you please change document ML110740482 to the attached document. This document (which is still draft) was used as an enclosure in another ML document and we are unable to swap it out ourselves. Thank you.

Richard H. Perkins, P.E.
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch
Phone - 301/251-7479

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Thanks
Susie Hicks
OIS/IRSD
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Thanks!

Michelle (Shelby) Bensi, Ph.D.
Reliability and Risk Engineer
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch

Perkins, Richard

From: Perkins, Richard
Sent: Wednesday, July 27, 2011 10:50 AM
To: Kauffman, John
Subject: FW: Updating file in ADAMS

John,

FYI

Based on the feedback below, I'll be loading the report into ADAMS as a non-public document, but with the document markings readied for public release in the next weeks.

Richard

From: Kilgore, Linda **On Behalf Of** ADAMS IM
Sent: Wednesday, July 27, 2011 10:43 AM
To: Perkins, Richard
Cc: Hicks, Susan
Subject: RE: Updating file in ADAMS

Richard,

Susan is out today. Yes, the profile can remain nonpublic until you are ready to release it. At that time, send ADAMS IM an e-mail confirming that the SUNSI Review has been completed and the profile should be changed to publicly available.

Linda Kilgore
OIS/IRSD
ADAMS Support Center

From: Perkins, Richard
Sent: Wednesday, July 27, 2011 10:26 AM
To: Hicks, Susan
Cc: ADAMS IM
Subject: Updating file in ADAMS

Good Morning Susan,

I have a question for you.

I am ready to forward the final version of ML110740482, which is a technical report. Right now, it is OUO – DELIBERATIVE PROCESS (because the purpose of the report is to help a panel make a technical decision). In a few days, the decision will be made and we will want to release the report publicly (it will no longer be OUO). The (then public) report will also be an enclosure in a publicly available declaration. Right now, the headers and footers in the document say "OUO-Deliberative Process". So - once the declaration is announced publicly, the report will be publicly releasable.

Can I remove the OUO headers and footers in the document I am getting ready to send to you, but maintain it in ADAMS as a non-public document until the declaration memo is released publicly? Do you know how this is typically handled?

L|10

Thanks!!
Richard Perkins
301-251-7479

From: Perkins, Richard
Sent: Tuesday, July 19, 2011 8:29 AM
To: Hicks, Susan
Cc: Bensi, Michelle
Subject: RE: replacing file in ADAMS

Yes please. Thank you.

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Richard H. Perkins, P.E.
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch
Phone - 301/251-7479

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On behalf of ADAMS Support

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Carolyn Siu
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Carolyn,

Please have the document currently associated with ML110740482 replaced with the attached file.
If possible, we would like to have this document changed back into a working/draft document (i.e. non-Official Agency Record) in ADAMS. The document is still under review and we anticipate more changes to it. We would like to use ADAMS for version control.

Thanks!

Michelle (Shelby) Bensi, Ph.D.
Reliability and Risk Engineer
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch

Perkins, Richard

From: Correia, Richard
Sent: Wednesday, August 10, 2011 11:16 AM
To: Bowman, Gregory; Imboden, Andy; Erlanger, Craig
Cc: Beasley, Benjamin; Uhle, Jennifer; Kauffman, John; Coe, Doug; Sheron, Brian; Perkins, Richard
Subject: RE: GI-204 - DEDO briefings
Attachments: GI204_Communication Plan_2011_08_10.docx

Thanks Greg for the expedited offer to brief today. However, after discussion with you, Craig Erlanger told us Marty's interest is primarily with the GI-204 Communications Plan and if necessary, he will request a brief after reviewing the Plan. Attached is the current version of the Comm. Plan that is going out shortly for formal office & region concurrence. The GI-204 Communications team and the offices/regions have been interacting during the development of the Plan and we expect to receive formal concurrence next week.

We very much appreciate your and Craig's attention and support to facilitate this effort.

Please call me or Doug Coe should you have any questions.

Regards

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Bowman, Gregory
Sent: Wednesday, August 10, 2011 9:51 AM
To: Coe, Doug; Kauffman, John
Cc: Correia, Richard; Beasley, Benjamin; Imboden, Andy; Uhle, Jennifer; Erlanger, Craig
Subject: RE: GI-204 - DEDO briefings

Marty's previously scheduled 3:00 meeting was cancelled today, and he said he's available to meet with you from 3:00 – 3:30. I have the slot reserved on his calendar. Please let me know if you'll be able to get ready in time. If not, I'll try to come up with something later this week.

Greg

From: Erlanger, Craig
Sent: Wednesday, August 10, 2011 9:46 AM
To: Coe, Doug; Kauffman, John
Cc: Correia, Richard; Beasley, Benjamin; Imboden, Andy; Uhle, Jennifer; Bowman, Gregory
Subject: RE: GI-204 - DEDO briefings

Doug,

Heads up. Marty may have a free slot from 3:00 – 3:30 p.m. today. Would you be able to support that time? Greg Bowman will be in touch if this is a possibility.

L/11

Thanks, Craig

From: Coe, Doug
Sent: Wednesday, August 10, 2011 8:40 AM
To: Erlanger, Craig; Kauffman, John
Cc: Correia, Richard; Beasley, Benjamin; Imboden, Andy; Uhle, Jennifer
Subject: GI-204 - DEDO briefings

Craig – got your voicemail thanks.

John – Craig will be turning over ETA duties in OEDO to Andy Imboden while he is away (b)(6) (starting noon today) for a week. The DEDO's (Mike/Marty) would like a GI-204 briefing prior to rollout but both are not available (together) until the first week of Sept which is too long for us to wait. Please work with Andy to schedule separate DEDO briefings as needed, and invite office directors (unless they prefer or need separate briefings).

Many thanks,
Doug

Doug Coe
Deputy Director
Division of Risk Analysis (DRA)
Office of Nuclear Regulatory Research (RES)
U.S. Nuclear Regulatory Commission
Rockville, MD
301-251-7914
doug.coe@nrc.gov

Perkins, Richard

From: Bensi, Michelle
Sent: Wednesday, August 17, 2011 8:27 AM
To: Perkins, Richard
Subject: Document for ADAMS?
Attachments: RE: use of NID data in public document (UNCLASSIFIED)

Richard,

The attached email contains the approval from the Army Corps of Engineers relating to the data from the NID that is used in the report. Do we want to put this email into ADAMS to ensure there is a record of the approval?

-Shelby

L|12

Perkins, Richard

From: Ragon, Rebecca AGC <Rebecca.Ragon@usace.army.mil>
Sent: Tuesday, May 24, 2011 2:23 PM
To: Bensi, Michelle
Subject: RE: use of NID data in public document (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Michelle,

Everything sounds good to me. Thanks for checking before publishing the report.

Rebecca

-----Original Message-----
From: Bensi, Michelle [mailto:Michelle.Bensi@nrc.gov]
Sent: Tuesday, May 24, 2011 2:14 PM
To: Ragon, Rebecca AGC
Subject: RE: use of NID data in public document (UNCLASSIFIED)

Rebecca,

Thanks for getting back to me.

To answer your question: We do not intend to make any "raw" data available for download with the report. The information contained in the report has all been "processed" in some way. For example, as mentioned in the previous email, the report contains a figure plotting the distance between individual dams and downstream nuclear power plant versus the storage capacity of the dams (using the metric NID storage). In the report, we also describe several individual dams and provide other information from the NID such as the dam type and other storage metrics (normal and maximum storage). We also provide several maps/images showing locations or pictures of individual dams. These images were generated using Google Maps and Bing Maps based on latitude and longitude.

Please let me know if any of these uses causes a problem with regard to the nondisclosure agreement. Thank you again for taking the time to address our concerns.

Michelle

-----Original Message-----
From: Ragon, Rebecca AGC [mailto:Rebecca.Ragon@usace.army.mil]
Sent: Tuesday, May 24, 2011 8:01 AM
To: Bensi, Michelle
Subject: RE: use of NID data in public document (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Michelle,

I apologize for the long delay in responding to your email. Thanks for the phone call reminder. It has been very crazy the last few months!

It sounds like your report is fine and not violating the NID security restrictions. As you stated, you are not providing government-restricted information. Will the NID data on these 50 dams be available for download or just as reference in the document? Non-government users cannot download the NID information so we do not want any government office providing aggregate information in electronic format.

I will call you later this morning so we can discuss over the phone as well.

Rebecca Ragon
National Inventory of Dams
US Army Corps of Engineers
7701 Telegraph Road
Alexandria, VA 22315-3864
703-428-6820
rebecca.ragon@usace.army.mil

-----Original Message-----
From: Bensi, Michelle [mailto:Michelle.Bensi@nrc.gov]
Sent: Tuesday, May 10, 2011 4:09 PM
To: National Inventory of Dams AGC
Subject: use of NID data in public document

Dear National Inventory of Dams Manager:

We are currently performing a study at the U.S. Nuclear Regulatory Commission related to dams upstream of nuclear power plants. We have utilized a few public data fields (pertaining to approximately 50 dams) from the NID database in our study and corresponding report. Following our normal practice, we would like to make the report publicly available. We believe the terms of use allow for this, but we would like to check to be certain. Specifically, we have used the fields: latitude, longitude, storage (NID, maximum, normal) and dam type. We have used location and storage data to create a figure plotting storage volumes and upstream distances for approximately 50 dams located upstream of plants. We have also selectively used information about dam type in descriptions of several sites. We have not used any government-user-restricted data in our report.

The report is intended for public disclosure. The NRC generally makes all publically available documents available via our internet website. The NID non-disclosure agreement indicates that we should "coordinate with the NID Manager before placing any NID information on the internet." Could you please reply by e-mail to let me know if the use I have described herein is acceptable? Please feel free to call me at 301-251-7570 if you have any questions.

Thank you for your help,

Michelle (Shelby) Bensi, Ph.D.

Reliability and Risk Engineer

Nuclear Regulatory Commission

Office of Nuclear Regulatory Research

Division of Risk Analysis

Operating Experience and Generic Issues Branch

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

Perkins, Richard

From: Perkins, Richard
Sent: Friday, August 19, 2011 1:48 PM
To: Kauffman, John; Bensi, Michelle
Subject: RE: GI-204 Working Group

Going through it now. Will do.

From: Kauffman, John
Sent: Friday, August 19, 2011 1:43 PM
To: Bensi, Michelle; Perkins, Richard
Subject: FW: GI-204 Working Group

FYI. I would appreciate hearing your thoughts/reaction to this, including anything I can use to help us get the desired outcome. JVK

From: Bowman, Eric
Sent: Friday, August 19, 2011 1:32 PM
To: Farzam, Farhad; Khanna, Meena; Wilson, George; Stang, John; Norman, Robert; Kauffman, John; Kulesa, Gloria; Perkins, Richard
Subject: GI-204 Working Group

All,

Attached are my thoughts on what we need to consider for the question of designation of the GI-204 documents as security related information. John Kauffman suggested use of the TAC KC0030 (GI Program and GI Activities) for this effort.

Thanks!

Eric

Eric E. Bowman
Sr. Project Manager
Generic Communications & Power Uprate Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
301-415-2963
Eric.Bowman@nrc.gov

L113

Perkins, Richard

From: ADAMS IM
Sent: Friday, August 26, 2011 2:03 PM
To: Perkins, Richard
Subject: FW: Corrected file for ADAMS record ML110740482
Attachments: PreGI-009_Analysis_2011_07_28_final.pdf; image001.jpg

ML13256A369, as released in FOIA-2013-0006A

Done. Attached file has been exchanged with ML110740482

Thanks
Susie Hicks
OIS/IRSD
On behalf of ADAMS Support

From: Perkins, Richard
Sent: Friday, August 26, 2011 1:49 PM
To: ADAMS IM
Subject: Corrected file for ADAMS record ML110740482

ADAMS IM,
The file in ADAMS ML110740482 contains a .pdf file. It was just brought to our attention that some of the equations did not print correctly when we generated the .pdf file – resulting in blank spaces where an equation/number should have been (for example on page 9). I have run the file again to generate a proper file (attached). This file is identical except for the correction in .pdf printing. Could you please substitute the attached file into the current ADAMS record.

Thanks,

Richard H. Perkins, P.E.
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch
Phone - 301/251-7479

L/14

Perkins, Richard

From: Perkins, Richard
Sent: Wednesday, September 14, 2011 10:56 AM
To: Bernardo, Robert
Subject: RE: Ben's tour at Oconee

Thanks.
I received a debrief from Ben this morning - very interesting.

From: Bernardo, Robert
Sent: Wednesday, September 14, 2011 10:46 AM
To: Wegner, Mary; Criscione, Lawrence; Perkins, Richard
Cc: Thorp, John; King, Mark
Subject: Ben's tour at Oconee

Saw this today in the region 2 PITA, thought you guys might be interested

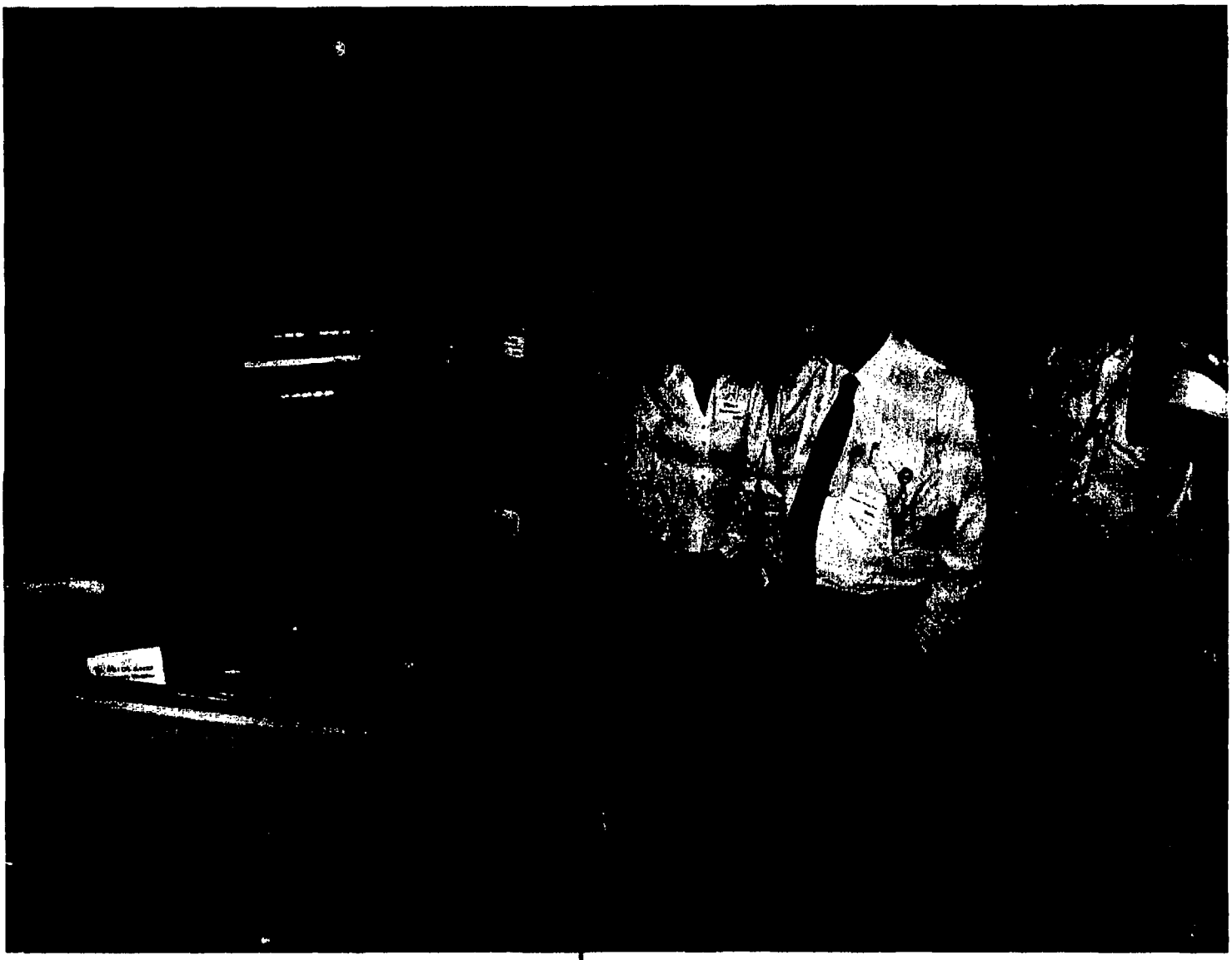
Commissioner Apostolakis, his TA and Ben Beasley (RES Chief of the Operating Experience and Generic Issues Branch) toured the Jocassee Hydro facility, a number areas of the protected area at Oconee and the Keowee Hydro facility. An all-hands lunch was held where employees were able to interact with the Commissioner and Ben which was well received and another session was held with the management team later in the day. Feedback from the Commissioner was very positive in terms of what was seen and communicated by the licensee.

in jocasse control room.jpg in ons control room.jpg in psw bldg.jpg

Bob Bernardo
Reactor Systems Engineer
US Nuclear Regulatory Commission
NRR/DIRS/IOEB
Mail Stop: O-7C02A
301-415-2621
Robert.Bernardo@nrc.gov

L/15

BEST COPY AVAILABLE



Perkins, Richard

From: Tifft, Doug
Sent: Monday, October 03, 2011 10:54 AM
To: Perkins, Richard
Subject: RE: GI-204 Status Update

Rich,

Is this still in a holding pattern? I haven't heard an update in a little while.

Thanks,
-Doug

From: Perkins, Richard
Sent: Tuesday, September 06, 2011 4:37 PM
To: Barker, Allan; Bartley, Jonathan; Beasley, Benjamin; Beaulieu, David; Bensi, Michelle; Burnell, Scott; Cahill, Christopher; Coe, Doug; Compton, Keith; Correia, Richard; Emche, Danielle; Erlanger, Craig; Felsher, Harry; Ferrante, Fernando; Gaddy, Vincent; Hills, David; Hilton, Nick; Imboden, Andy; Kauffman, John; Khanna, Meena; Logaras, Harral; Maier, Bill; Marcano, Jonathan; McNamara, Nancy; Meghani, Vijay; Miller, Chris; Mitman, Jeffrey; Mrowca, Lynn; Perkins, Richard; Philip, Jacob; Pohida, Marie; Raione, Richard; Riley (OCA), Timothy; Rosenberg, Stacey; Ruland, William; Sancaktar, Selim; Schmidt, Wayne; See, Kenneth; Sheehan, Neil; Tifft, Doug; Trojanowski, Robert; Virgilio, Rosetta; Wilson, George; Wilson, Peter; Woodruff, Gena; Wray, John
Subject: GI-204 Status Update

GI-204 Communication Team,

We are awaiting NRR office concurrence on the GI Review Panel Recommendation Memo (ML111890588), due July 15, 2011. [The members of the review panel provided their concurrence prior to July 15]

Coordination of the GI-204 Communication Plan (ML112220477) has been completed. The plan is available for use as an internal draft document, but has not been signed yet. Throughout the Generic Issue Investigation, the communication plan will be updated as needed. Please feel free to send me any comments or edit requests you may have at any time.

The attached "Declaration Timeline" provides the status of relevant documents and the release timeline. I will provide additional updates as the status changes.

Regards,

Richard H. Perkins, P.E.
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch
Phone - 301/251-7479

L/16

Perkins, Richard

From: Curran, Bridget
Sent: Wednesday, October 05, 2011 9:52 AM
To: Miller, Chris; Croteau, Rick; West, Steven; Vegel, Anton; Brown, Frederick; Coe, Doug
Cc: Wong, See-Meng; Boger, Bruce; Grobe, Jack; Cheok, Michael; Lee, Samson; Laur, Steven; Franovich, Rani; Weerakkody, Sunil; Harrison, Donnie; Klein, Alex; Vaughn, Stephen; Barrett, Harold; Hyslop, JS; Lew, David; Wert, Leonard; Pederson, Cynthia; Howell, Art; Correia, Richard; Coyne, Kevin; Demoss, Gary; Beasley, Benjamin; Peters, Sean; Salley, MarkHenry; Marksberry, Don; Appignani, Peter; Kauffman, John; Perkins, Richard; Sancaktar, Selim; Shen, Song-hua; Stroup, David; Wood, Jeffery; Helton, Donald; Schmidt, Wayne; Cook, William; Cahill, Christopher; Rogers, Walt; Bernhard, Rudolph; MacDonald, George; Hanna, John; Kozak, Laura; Passehl, Dave; Valos, Nicholas; Loveless, David; Runyan, Michael; Replogle, George; Hopper, George; Lara, Julio; RidsNrrDraApob Resource; Alexander, Cheryl
Subject: ML112510179 - Senior Reactor Analyst Counterpart Meeting, October 18-20, 2011
Attachments: ADAMS Document.ADC

Memorandum Dated: October 4, 2011

Memorandum To: Christopher Miller, Director
Division of Reactor Safety
Region I

Rick Croteau, Director
Division of Reactor Projects
Region II

Steven West, Director
Division of Reactor Projects
Region III

Tony Vegel, Director
Division of Reactor Safety
Region IV

Frederick Brown, Director
Division of Inspection and Regional Support
Office of Nuclear Reactor Regulation

Douglas Coe, Deputy Director
Division of Risk Analysis
Office of Nuclear Reactor Research

From: Joseph G. Giitter, Director
Division of Risk Assessment
Office of Nuclear Reactor Regulation

Subject: Senior Reactor Analyst Counterpart Meeting, October 18-20, 2011

ML112510179

Bridget Curran
Division Administrative Assistant
NRR/DRA

L/17

301-415-2884

October 4, 2011

MEMORANDUM TO: Christopher Miller, Director
Division of Reactor Safety
Region I

Rick Croteau, Director
Division of Reactor Projects
Region II

Steven West, Director
Division of Reactor Projects
Region III

Tony Vegel, Director
Division of Reactor Safety
Region IV

Frederick Brown, Director
Division of Inspection and Regional Support
Office of Nuclear Reactor Regulation

Douglas Coe, Deputy Director
Division of Risk Analysis
Office of Nuclear Reactor Research

FROM: Joseph G. Giitter, Director **/RA by S. Lee for/**
Division of Risk Assessment
Office of Nuclear Reactor Regulation

SUBJECT: SENIOR REACTOR ANALYST COUNTERPART MEETING, OCTOBER 18-20, 2011

A Senior Reactor Analyst (SRA) counterpart meeting is scheduled for October 18-20, 2011, at the Region 1 Office, King of Prussia, Pennsylvania. Participation by all SRAs is requested. Other Nuclear Regulatory Commission (NRC) risk analysts and staff with advanced risk training are also encouraged to attend. The purpose of this meeting is to provide training on the state-of-the-art processes that have been under development, including methods for determining common-cause failure, human reliability analysis, external event risk analyses, fire risk assessment methods, and the new risk-informed techniques in the inspection and regulatory decision making processes.

CONTACT: See-Meng Wong, NRR/DRA
301-415-1125

The overall purpose of the meeting is to maintain the SRA skills current with the programmatic and technical issues that have been identified during implementation of the Reactor Oversight Process. The meeting also provides important opportunities for SRAs to offer feedback for enhanced coordination of their activities, to make recommendations for Headquarters actions and initiatives, and to share their experiences for the benefit of all SRAs and other Probabilistic Risk Assessment professionals within the NRC.

The meeting agenda is enclosed. For planning purposes, please have your SRAs inform See-Meng Wong, DRA and Wayne Schmidt, Region 1 of their availability and intention to attend the meeting.

Enclosure:
Agenda

The overall purpose of the meeting is to maintain the SRA skills current with the programmatic and technical issues that have been identified during implementation of the Reactor Oversight Process. The meeting also provides important opportunities for SRAs to offer feedback for enhanced coordination of their activities, to make recommendations for Headquarters actions and initiatives, and to share their experiences for the benefit of all SRAs and other Probabilistic Risk Assessment professionals within the NRC.

The meeting agenda is enclosed. For planning purposes, please have your SRAs inform See-Meng Wong, DRA and Wayne Schmidt, Region 1 of their availability and intention to attend the meeting.

Enclosure:
Agenda

DISTRIBUTION:

SWong	BBoger	JGrobe	FBrown
MCheok	SLee	SLaur	RFranovich
SWeerakoddy	DHarrison	AKlein	SVaughn
HBarrett	JHyslop	DLew	LWert
CPederson	AHowell	RCorreia	DCoe
KCoyne	GDemoss	BBeasley	SPeters
MSalley	DMarksberry	PAppignani	JKauffman
RPerkins	SSancaktar	SShen	DStroup
JWood	DHelton	CMiller	WSchmidt
WCook	CCahill	WRogers	RBernhard
GMacdonald	JHanna	LKozak	DPassehl
NValos	DLoveless	MRunyan	GReplogle
GHopper	JLara	RidsNrrDraApob	

Accession Number: ML112510179 **NRR-106** *via e-mail

OFFICE	NRR/DRA/APOB	NRR/DIRS/IPAB	NRR/DRA/APOB	NRR/DRA
NAME	SWong	SVaughn*	SWeerakkody	JGiitter (SLee for)
DATE	10/02/2011	10/04/2011	10/04/2011	10/04/2011

OFFICIAL RECORD COPY

Senior Reactor Analyst Counterpart Meeting
Region 1 Office, King of Prussia, PA
October 18-20, 2011

Tuesday, October 18, 2011

Morning Session

8:30 a.m. – 9:00 a.m.	Welcome and Opening Remarks – David Lew, Deputy Regional Administrator, Region 1
9:00 a.m. – 9:45 a.m.	Common Cause Failure (CCF) Analysis in Event and Condition Assessments (ECA): Status of Draft NUREG, Ground Rules, and Example – Song Shen, RES
9:45 a.m. – 10:00 a.m.	Break
10:00 a.m. – 10:30 a.m.	Support System Initiating Event (SSIE) Models – Peter Appignani, RES
11:30 a.m. – 12:15 p.m.	Human Reliability Analysis Methods and HRA Data Research Activities – Sean Peters, RES
12:15 p.m. – 1:30 p.m.	Lunch

Afternoon Session

1:30 p.m. – 3:00 p.m.	New Generic Issue: Flooding of Nuclear Power Plant Sites Following Upstream Dam Failures – John Kauffman, Richard Perkins, RES
3:00 p.m. – 3:15 p.m.	Break
3:15 p.m. – 4:00 p.m.	Inspection Manual Chapter 0609 Appendix G Revisions – Jeff Mitman, NRR
4:00 p.m. – 4:45 p.m.	Inspection Manual Chapter 0609 Appendix F Revisions – Jeff Circle

Enclosure

Wednesday, October 19, 2011

Morning Session

8:30 a.m. - 9:45 a.m.	Fire Research and Impact on Regulatory Environment: Fire Cable Tests, Electrical Control Cabinet Fire Propagation Modeling, and Fire Modeling Verification and Validation (NUREG 1824) – David Stroup, RES
9:45 a.m. - 10:15 a.m.	Fire PRA Methods Development (NUREG/CR 6850) – J.S. Hyslop, RES
10:15 a.m. - 10:30 a.m.	Break
10:30 a.m. - 11:15 a.m.	Unreviewed Analysis Methods in Fire PRA: Peer Review Panel Dispositions – Donnie Harrison, NRR
11:15 a.m. - 12:00 noon	NFPA-805 Implementation: Rule, Regulatory Guide 1.205, FAQs, License Condition Equivalency Criteria and Enforcement Discretions – Harold Barrett, NRR
12:00 noon - 1:15pm	Lunch

Afternoon Session

1:15 p.m. – 2:00 p.m.	NFPA-805 Pilot Program Lessons Learned: Safe Shutdown and Fire Protection Issues – Harold Barrett, NRR
2:00 p.m. – 2:45 p.m.	Risk-Informed Fire Protection Inspections: Inspection Procedures and Pilot Plant Lessons Learned – Harold Barrett, NRR
2:45 p.m. – 3:00 p.m.	Break
3:00 p.m. – 4:45 p.m.	SRA Round Table:

- Near-Term Task Force Recommendations – See-Meng Wong, NRR
- Lessons Learned: Ft. Calhoun Flooding Issue – David Loveless, Region 4
- Region IV
- Region III

- Region II
- Region I

Thursday, October 20, 2011

Morning Session

8:30 a.m. - 9:30 a.m.	Inspection Manual Chapter 0609 Appendix A Revisions: Phase 1 and Phase 2 Process – Steve Vaughn, NRR
9:30 p.m. - 10:00 a.m.	SAPHIRE 8 Update – Jeff Wood, RES
10:00 a.m. - 10:15 a.m.	Break
10:15 a.m. – 11:00 a.m.	All-Hazard SPAR Model – Selim Sancaktar, RES, Fernando Ferrante, NRR
11:15 a.m. – 11:45 a.m.	Emerging Topics in PRA Research – Don Helton, RES
11:45 a.m. – 12:00 noon	Closing Remarks – Christopher Miller, Director, DRS, Region 1

Perkins, Richard

From: Perkins, Richard
Sent: Wednesday, November 09, 2011 10:39 AM
To: Killian, Lauren
Subject: Panel Establishment Memo for PreGI-009
Attachments: ML1103403790.pdf

Richard H. Perkins, P.E.
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch
Phone - 301/251-7479

418

Perkins, Richard

From:	Perkins, Richard
Sent:	Wednesday, December 14, 2011 12:10 PM
To:	Beasley, Benjamin
Cc:	Ibarra, Jose
Subject:	RE: Daily text with edits from Ben included
Attachments:	Declaration Timeline.pptx

Also – Doug has the release timeline (attached)

From: Beasley, Benjamin
Sent: Wednesday, December 14, 2011 11:42 AM
To: Perkins, Richard
Subject: RE: Daily text with edits from Ben included

Thanks Richard!

From: Perkins, Richard
Sent: Wednesday, December 14, 2011 11:38 AM
To: Coe, Doug
Cc: Beasley, Benjamin; Ibarra, Jose
Subject: Daily text with edits from Ben included

Doug,
Proposed daily text is below:

The RES Director approved Generic Issue 204, Flooding of Nuclear Power Plant Sites Following Upstream Dam Failures, on December 15, 2011. A press release on this issue will be issued in the next few days. The communication plan for this issue (ML112020629) was coordinated with stakeholders, including Regional offices, and includes sample questions and answers. The next stage of activity on this issue is the Generic Issue Program safety/risk assessment. The assessment of this Generic Issue is being coordinated with the Japan Lessons Learned Directorate.

Richard H. Perkins, P.E.
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch
Phone - 301/251-7479

L/19

GI-204 Declaration Timeline – ~~Internal Information – Not for Public Release~~

Documents Required for GI Declaration:	Status
Recommendation Memo from GI Review Panel	Approved by GI Review Panel.
Communication Plan (non public)	Approved and available for use
Screening Analysis Report (enclosure)	Completed and final (not released)
OPA Press Release	Approved by Chairman's Office – awaiting release Subject to continuing edits in real time

Significant Critical Path Tasks:

With RES Director for review and consideration for approval

Sequence and Timeline: [Organization responsible for action]

---	Formal coordination of Communication Plan is completed
---	RES Director: Signs out Communication Plan (non public)
---	Approved Communication Plan is distributed to communication team [RES]
-3 work days	RES Director: Approves GI Recommendation Memo (release clock begins)
-3 work days	Public release day (not Friday) and time is selected with OPA [OPA & RES]
-3 work days	'Heads up' notification to Regional State Liaison Officers (RSLOs) and OCA [RES]
-2 work days	Communication Team is notified of release day and time [RES]
-2 work days	Communication Team notifies internal stakeholders [Communication Team Members]
As appropriate	RSLO actions and communications with States [RSLOs]
0 time	OPA Press Release [OPA]
+1 hour	Recommendation Memo and Screening Analysis Report become publicly available in ADAMS [RES]
+1 hour	Communication Team is notified of press release and document status [RES]

POC: Richard Perkins,
NRC/RES/DRA/OEGIB
richard.perkins@nrc.gov
301-251-7479

Perkins, Richard

From: Laur, Steven
Sent: Wednesday, November 23, 2011 9:22 AM
To: Perkins, Richard
Subject: Oahe document
Attachments: MissouriRiverFloodingUpdate 2011.pdf

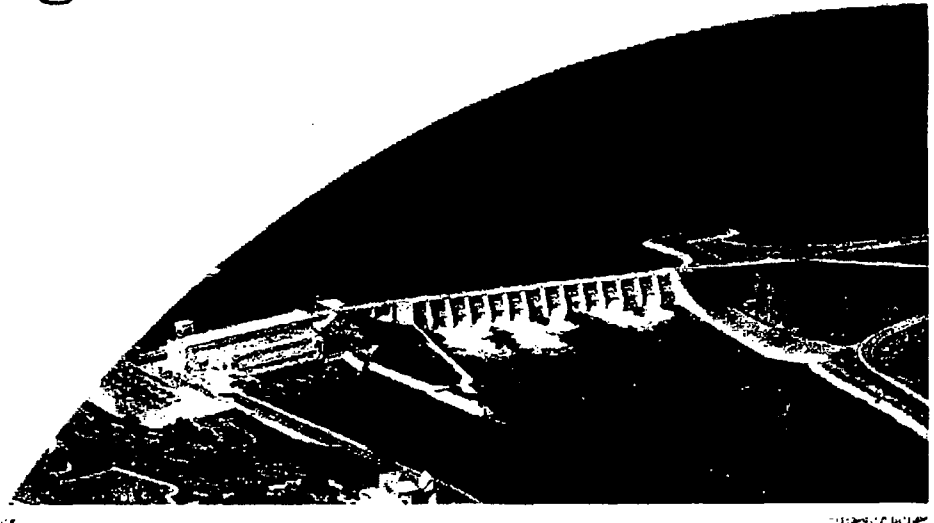
FYI

Steven A. Laur
NRR Division of Risk Assessment
OWFN 10-C15
(301) 415-2889
steven.laur@nrc.gov

L120

Missouri River Mainstem Reservoir System

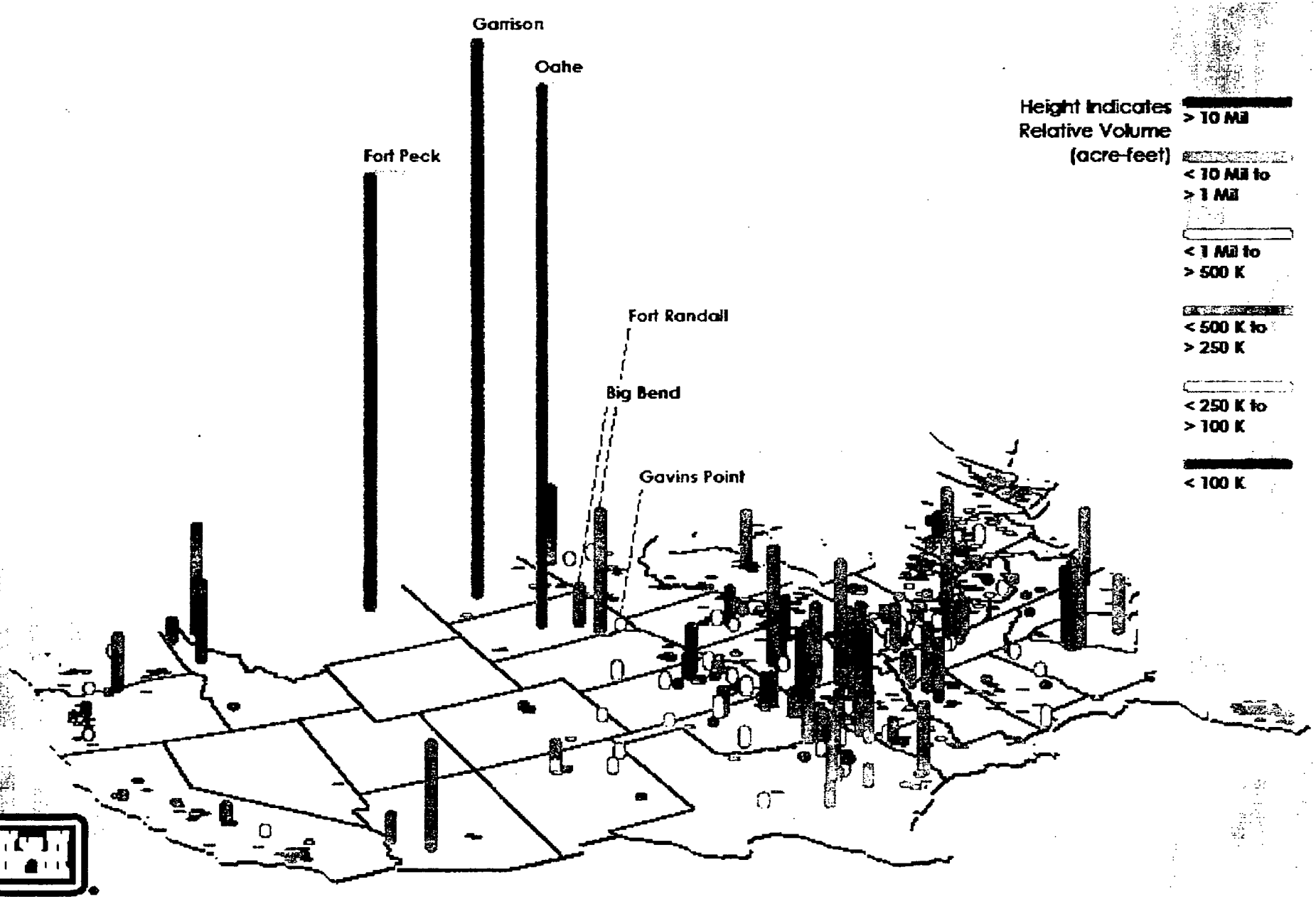
2011 Flood Regulation



1 October 2011

US Army Corps of Engineers
BUILDING STRONG®

Storage Capacity of Corps Reservoirs



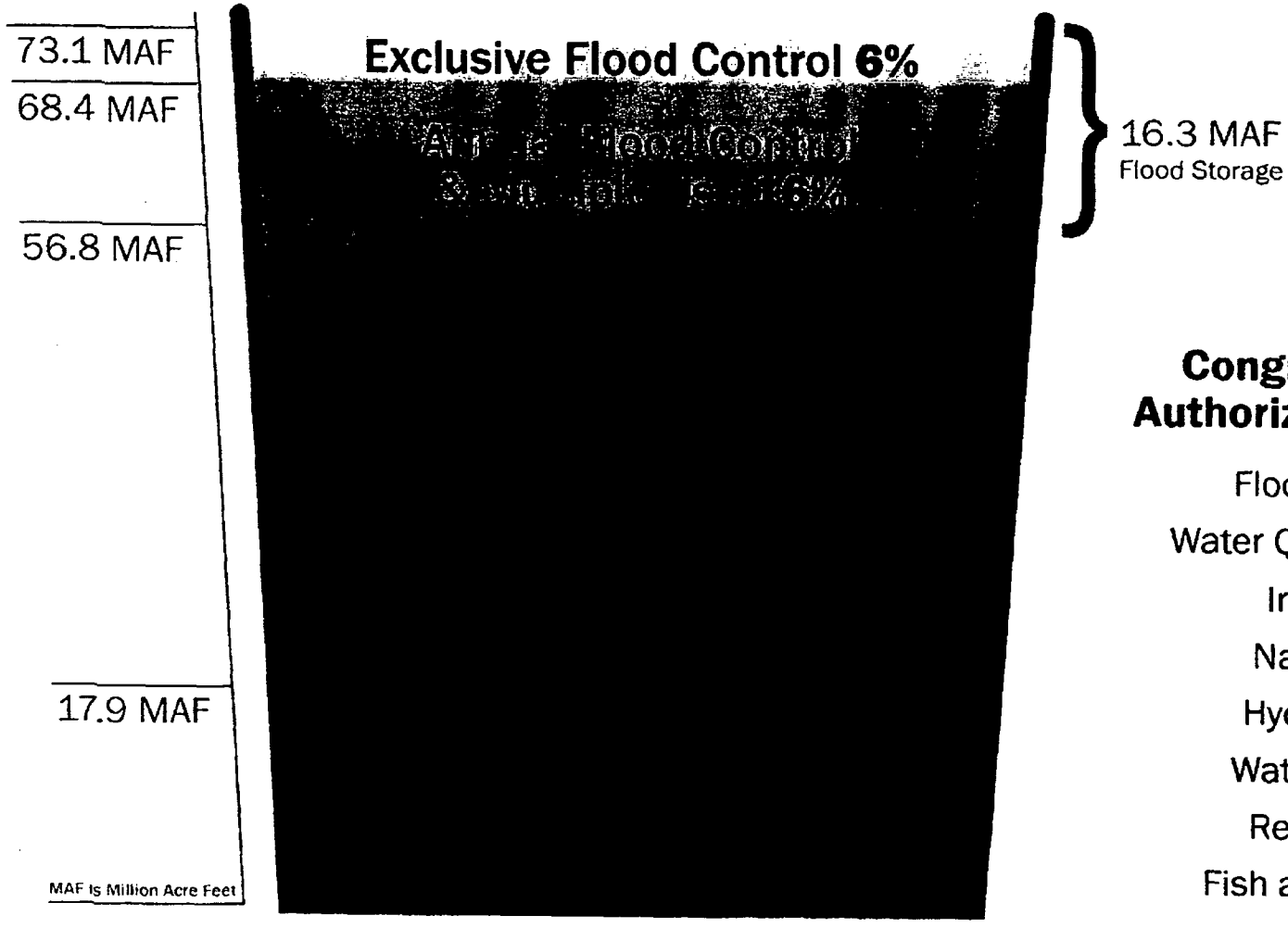
US Army Corps of Engineers
BUILDING STRONG

Prepared and Produced by the U.S. Army Corps of Engineers Omaha District 2010

US Army Corps of Engineers
BUILDING STRONG

Missouri River Mainstem Reservoir System

Zones & Allocations of the Total Storage Capacity



Congressionally Authorized Purposes

Flood Control

Water Quality Control

Irrigation

Navigation

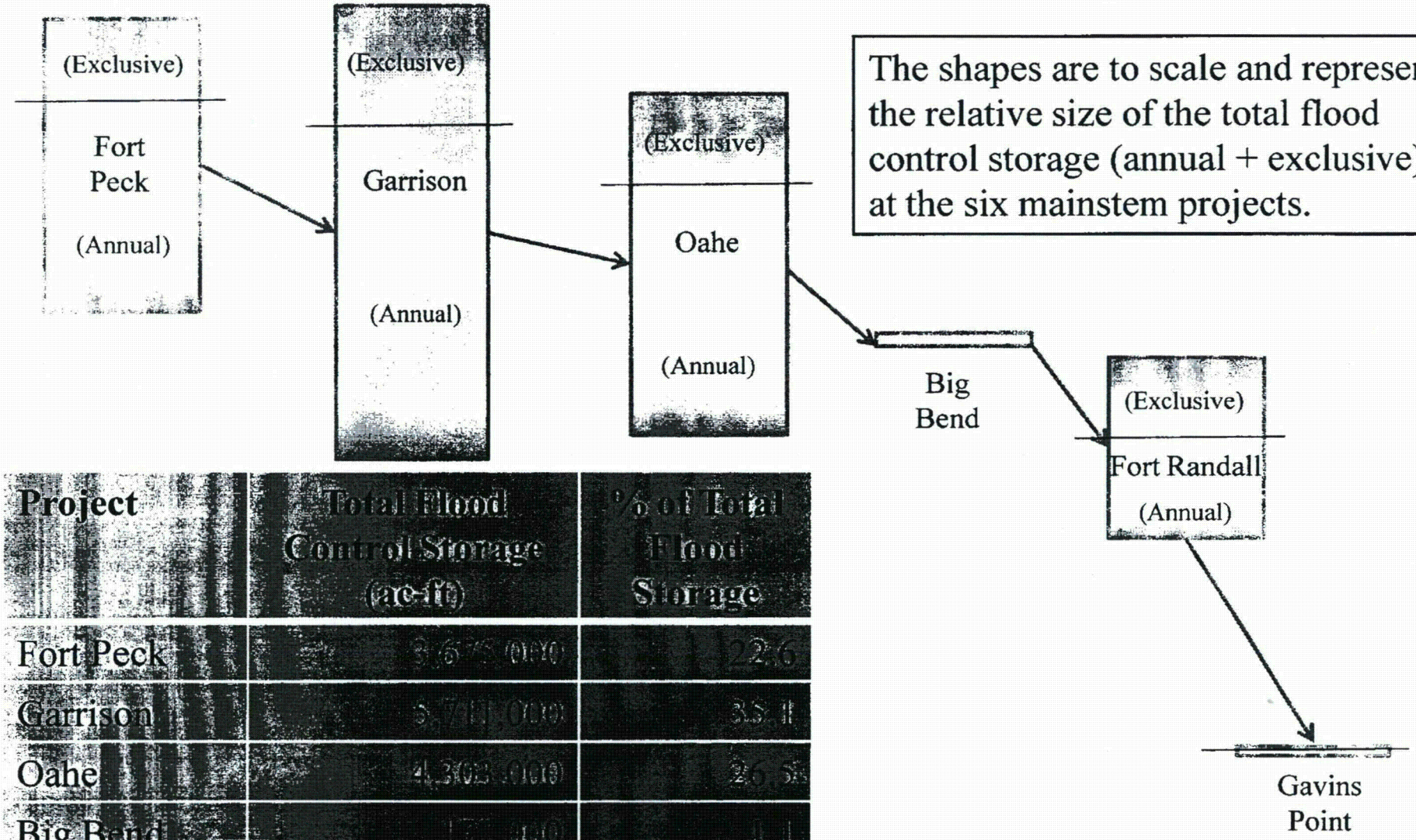
Hydropower

Water Supply

Recreation

Fish and Wildlife

Flood Control Storage

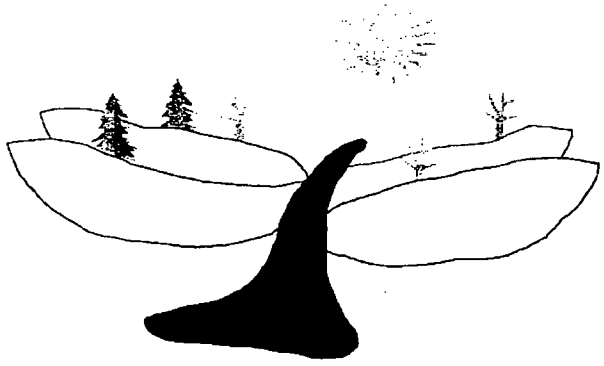


The shapes are to scale and represent the relative size of the total flood control storage (annual + exclusive) at the six mainstem projects.

Project	Total Flood Control Storage (ac-ft)	% of Total Flood Storage
Fort Peck	3,675,000	22.6
Garrison	5,740,000	35.4
Oahe	4,300,000	26.5
Big Bend	170,000	1.1
Fort Randall	2,298,000	14.1
Gavins Point	108,000	0.7

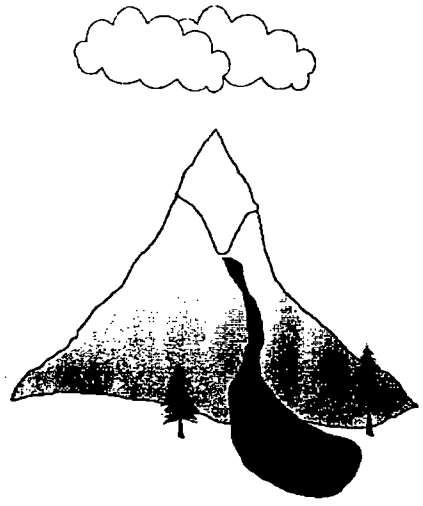
Runoff Components

Plains Snowpack



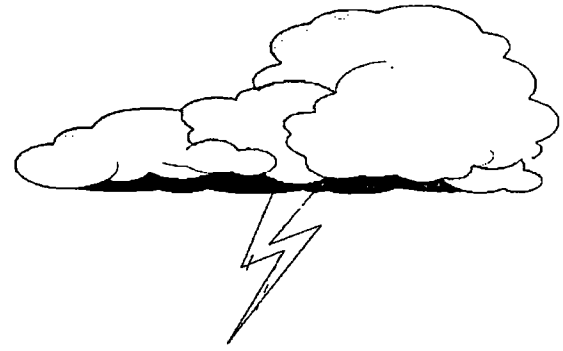
March and April

Mountain Snowpack



May, June and July

Rainfall



March through October

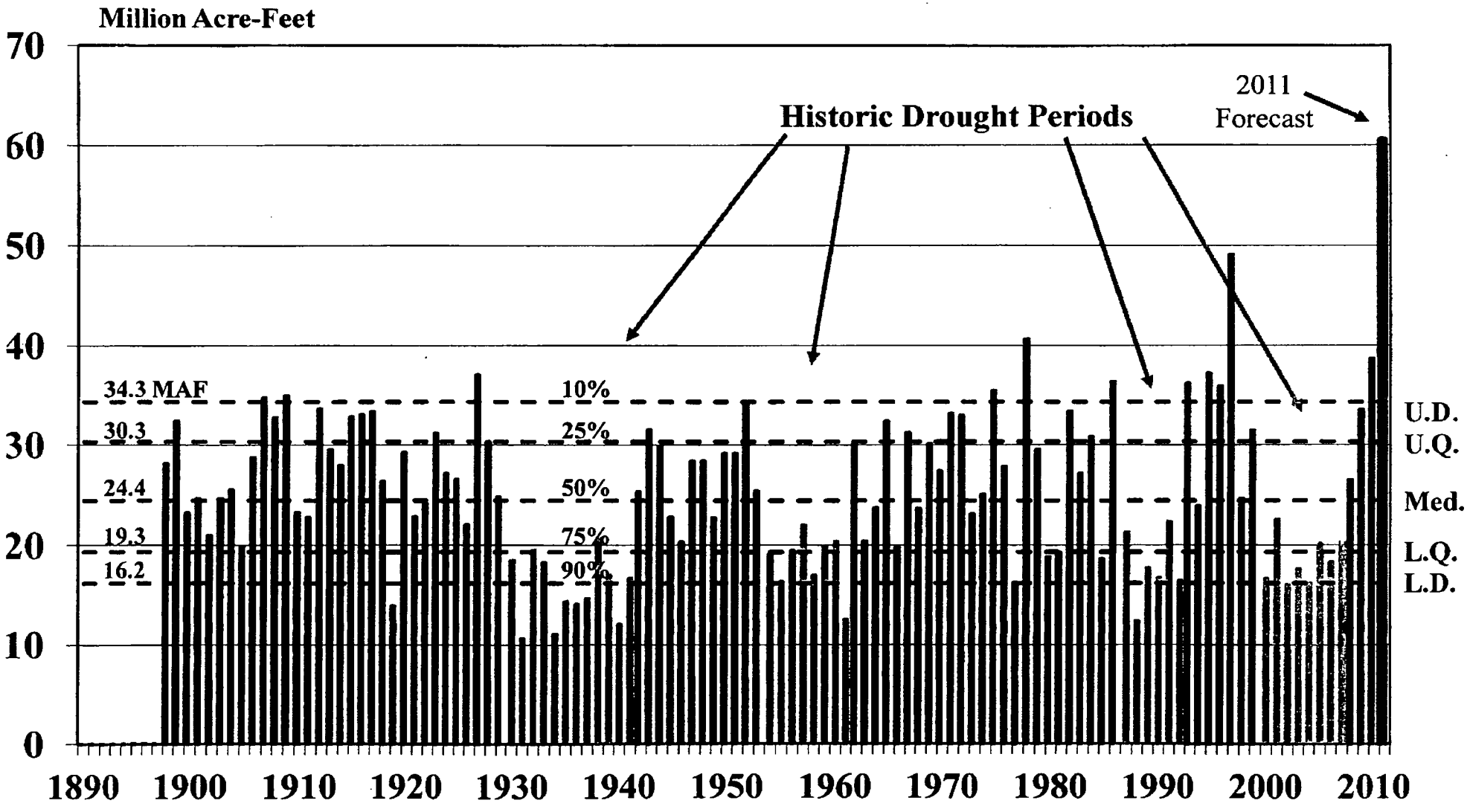
2011 Forecast* = 60.4 MAF

Highest runoff since 1898

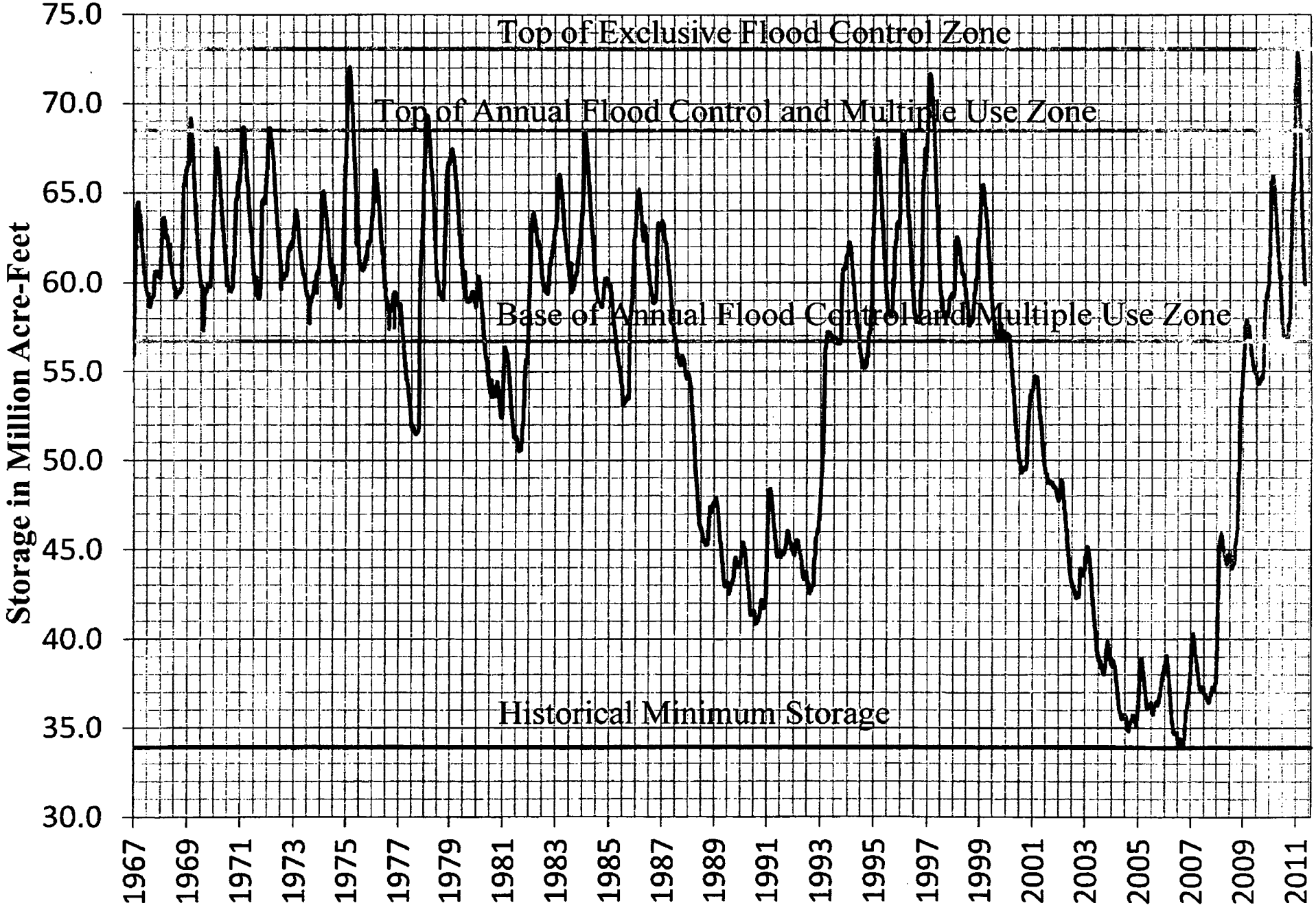
Previous Record was 49.0 MAF in 1997

*October 1 Forecast

Missouri River Mainstem System
Annual Runoff above Sioux City, IA

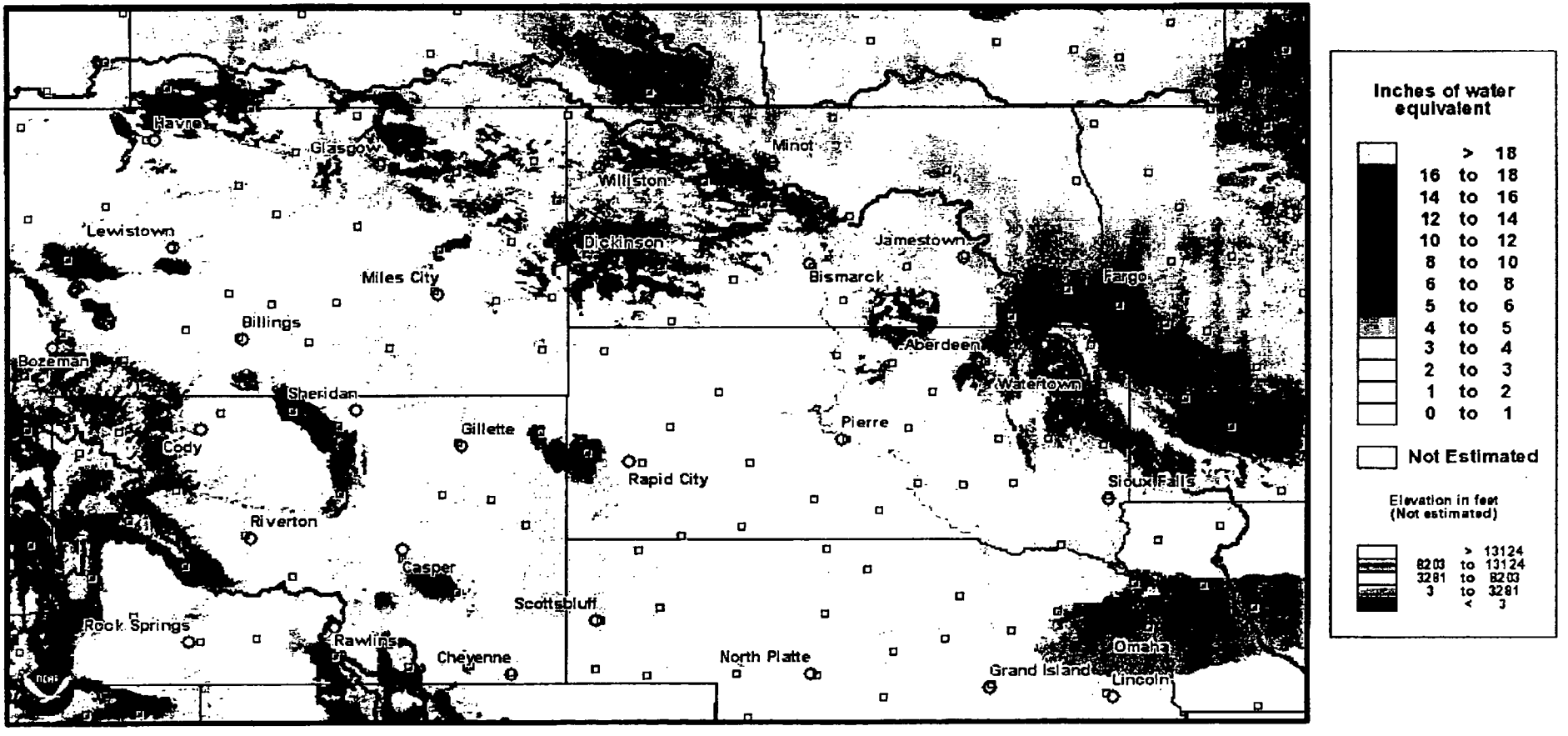


Missouri River Mainstem Reservoir System



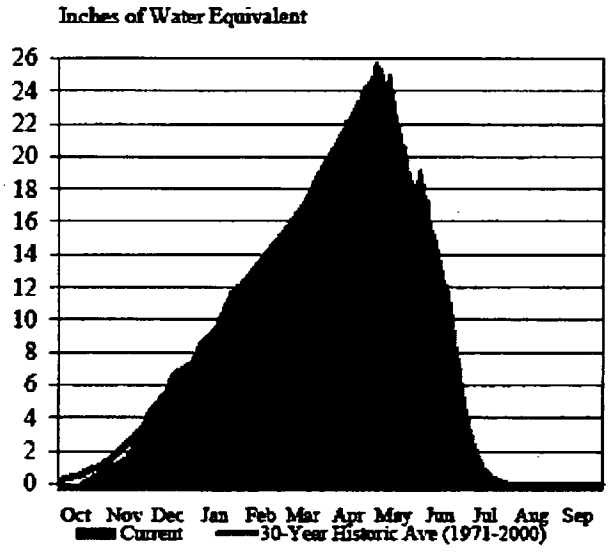
Plains Snowpack

25 February 2011

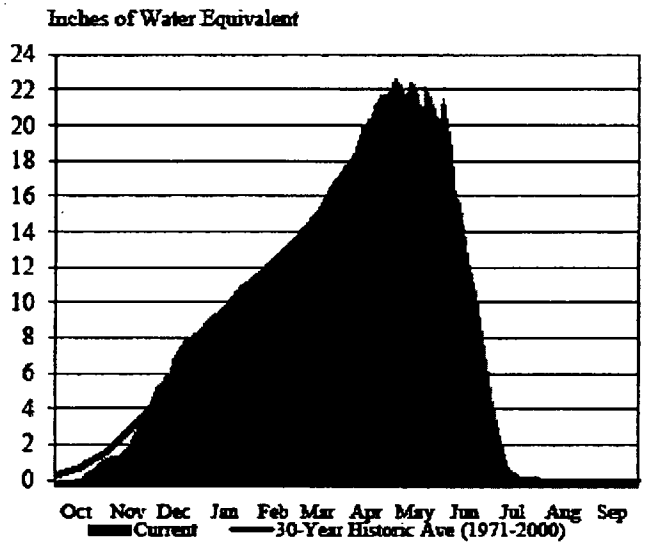


Missouri River Basin
Mountain Snowpack Water Content
2010-2011

Total above Fort Peck



Total Fort Peck to Garrison



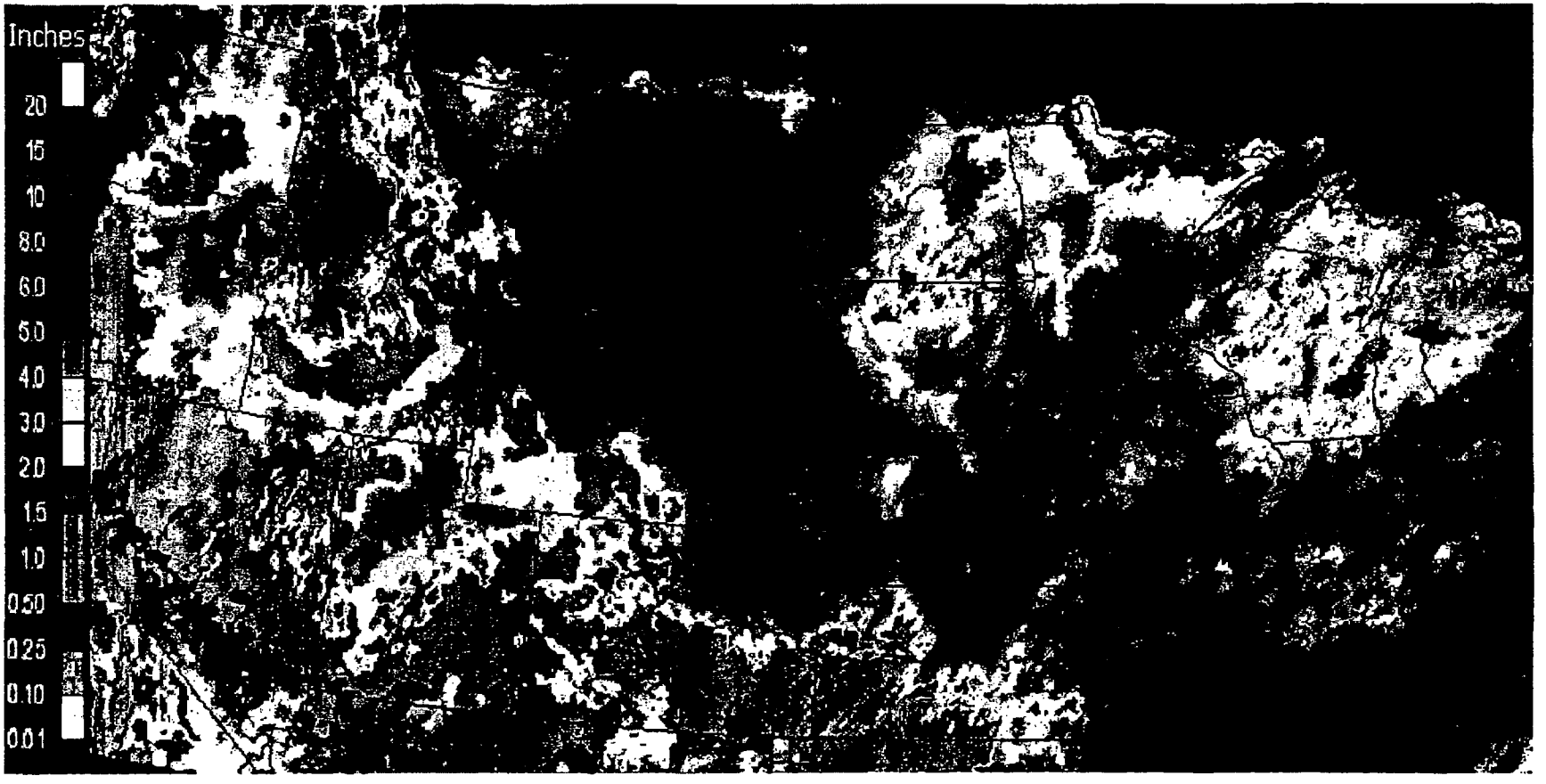
The Missouri River Basin mountain snowpack normally peaks near April 15. The mountain snowpack in both the "Total above Fort Peck" and the "Total Fort Peck to Garrison" reaches peaked on May 2 at 141 percent and 136 percent of the normal April 15 peak, respectively. As of August 1, the mountain snowpack has melted in both reaches .

August 1, 2011

Provisional data. Subject to revision.

May 2011 Precipitation

Missouri Basin RFC Pleasant Hill, MO: May, 2011 Monthly Observed Precipitation
Valid at 6/1/2011 1200 UTC- Created 6/2/11 17:40 UTC



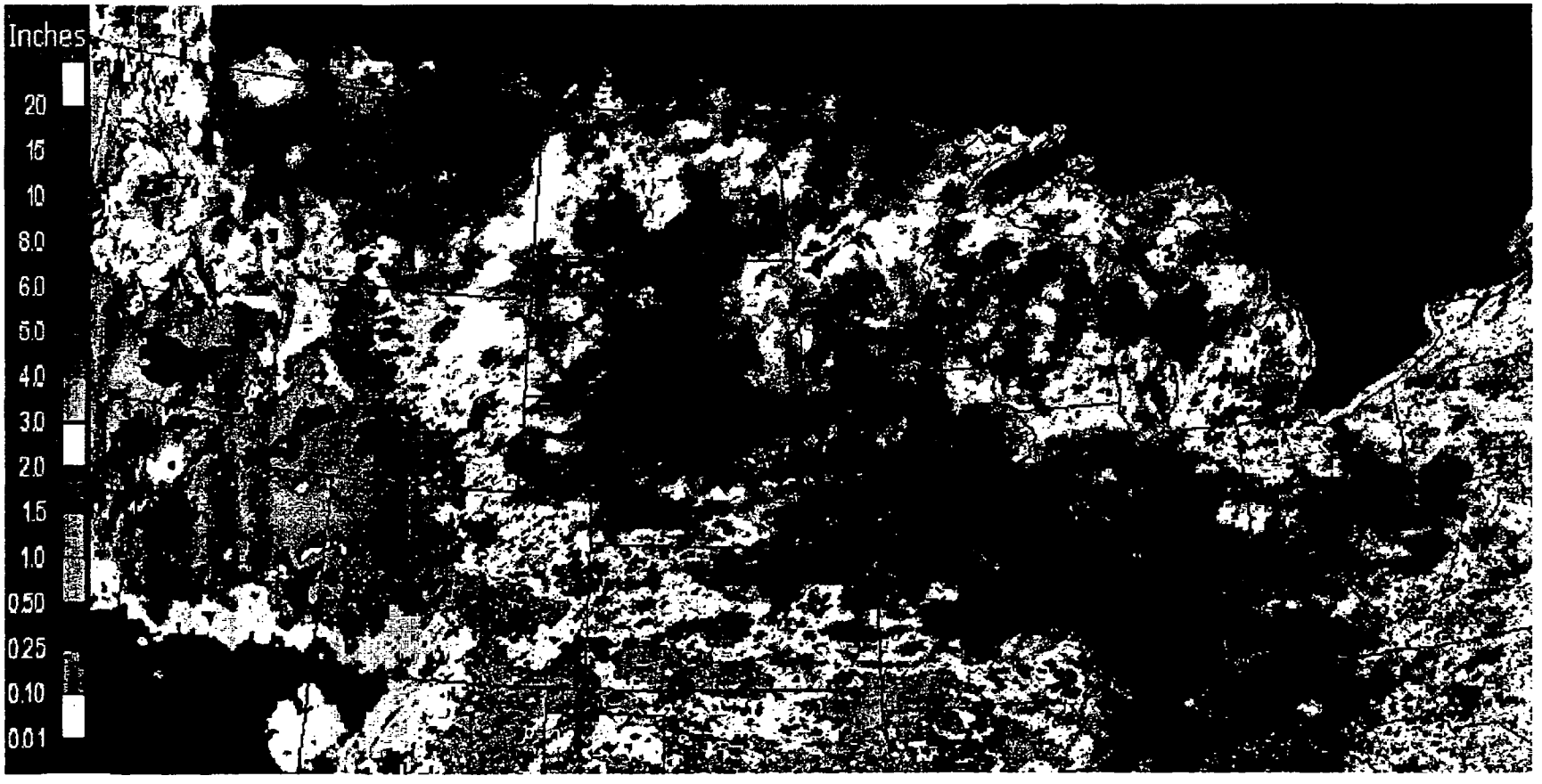
Missouri River Mainstem Reservoir May 2011 Runoff

Total runoff above Sioux City = 10.5 MAF
Wettest May on record
Second (now third) highest single month on record

	2011	Previous May Record
Fort Peck	2.9 MAF	2.6 MAF(1975)
Garrison	4.4 MAF	2.8 MAF(1978)
Fort Peck and Garrison	7.3 MAF	6.7 MAF(1952)
Total Above Sioux City	10.5 MAF	7.2 MAF(1995)

June 2011 Precipitation

NWS Central Region: June, 2011 Monthly Observed Precipitation
Valid at 7/1/2011 1200 UTC- Created 7/2/11 17:40 UTC



Missouri River Mainstem Reservoir June 2011 Runoff

Total runoff above Sioux City = 13.8 MAF
Wettest June on record
Highest single month on record
Previous record was 13.2 MAF in April 1952

	2011	Previous June Record
Garrison	6.2 MAF	5.1 MAF(1909)
Fort Randall	0.9 MAF	0.7 MAF(1962)
Total Above Sioux City	13.8 MAF	10.3 MAF(1909)

July 2011 Precipitation

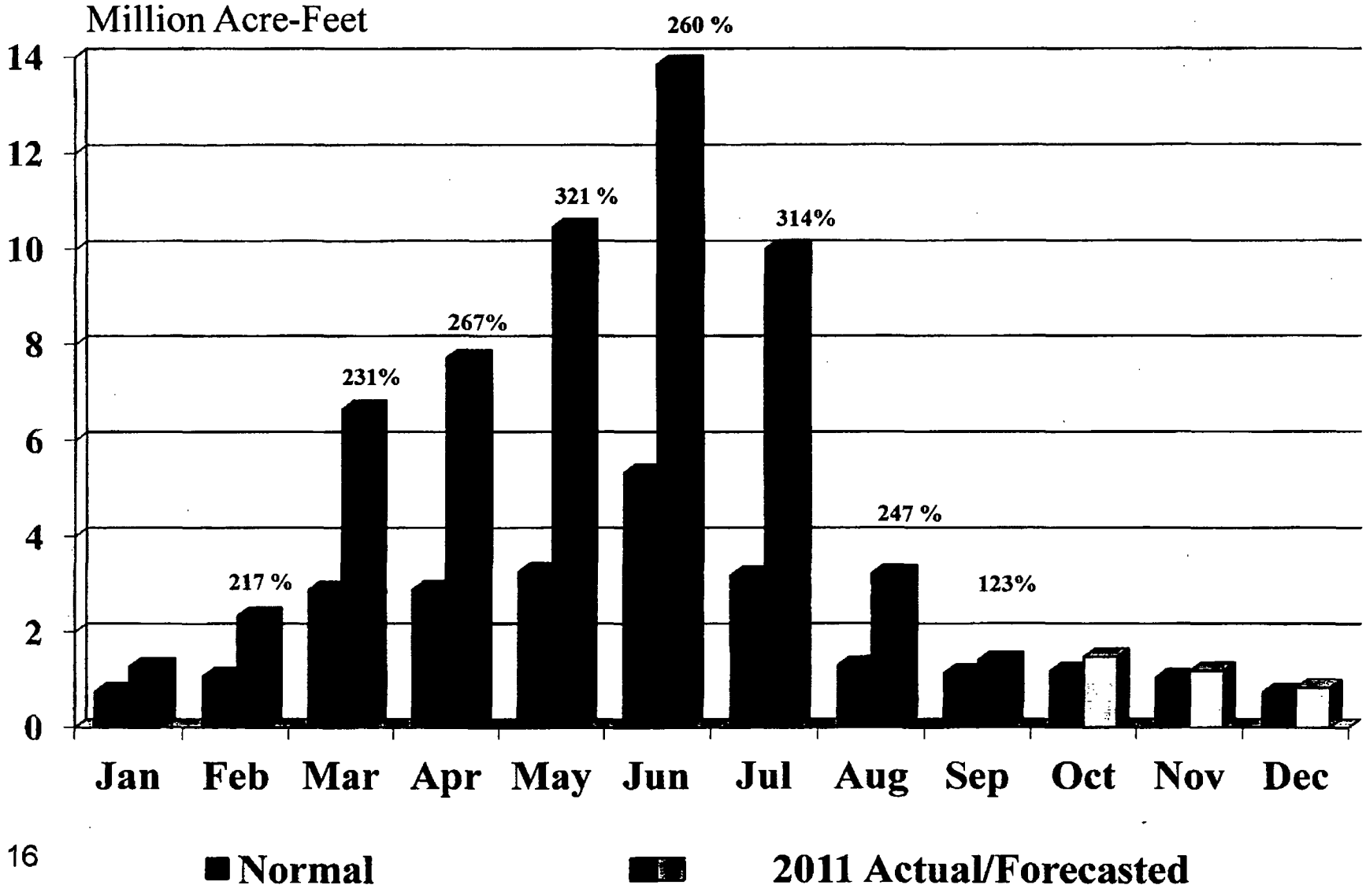
Missouri Basin RFC Pleasant Hill, MO: July, 2011 Monthly Observed Precipitation
Valid at 8/1/2011 1200 UTC- Created 8/2/11 17:40 UTC

Missouri River Mainstem Reservoir July 2011 Runoff

Total runoff above Sioux City = 10.0 MAF
Wettest July on record
Fifth highest single month on record

	2011	Previous July Record
Garrison	5.6 MAF	4.1 MAF(1907)
Total above Sioux City	10.0 MAF	8.2 MAF (1993)

Missouri River Runoff above Sioux City 2011 Actual/Forecasted versus Normal



2011 Mainstem System Regulation
(What We Forecast)

- Full flood control capacity of the mainstem reservoir system was available at the start of the 2011 runoff season
  - 2010 was 3rd highest runoff year on record
  - All flood water was evacuated prior to start of runoff
- Until rain events in May, there was no need to evacuate water at historic levels
  - April 1 runoff forecast = 33.8 MAF; Gavins Point peak releases = 39 to 45 kcfs
  - May 1 runoff forecast = 44.0 MAF; Gavins Point peak releases = 57.5 kcfs
  - June 1 runoff forecast = 54.6 MAF; Gavins Point peak releases = 150 kcfs

2011 Mainstem System Regulation
(What Actually Happened)

- Unprecedented runoff occurred in the Missouri River Basin above Sioux City, Iowa during May, June and July
  - June was the single wettest month on record with 13.8 MAF of runoff, surpassing the old record of 13.2 MAF set in April 1952.
  - May was the third wettest single month on record, with 10.5 MAF of runoff shattering the previous May record of 7.2 MAF set in May 1995
  - July was the fifth wettest single month on record with 10.0 MAF
  - Combined May through July runoff of 34.3 MAF is higher than the total annual runoff in 102 of 113 years in the period of record

2011 Mainstem System Regulation
(Dispelling Rumors and Myths)

- Mainstem Reservoir System has been operated in accordance with the Master Manual, with flood control as the highest purpose.
- Release schedules have been coordinated with Corps Divisions along the Mississippi River, but we do not have authority to regulate the mainstem reservoir system solely for the benefit of the Mississippi River.
- No operational decisions have been driven by Endangered Species Act (nesting least terns and piping plovers or pallid sturgeon); reservoirs have been operating for flood risk reduction.
- The dams are safe and we're monitoring them closely.
- We released water when we should have; we could not have evacuated earlier.

2011 Mainstem System Regulation
(The Way Ahead)

- **Desired end state:** Restore the System infrastructure and levees to pre-2011 event condition and ensure adequate storage for the 2012 runoff season—be READY for 2012
- Determine the best strategy to evacuate remaining 2011 runoff
- Assess risks related to achieving end state via multiple evacuation strategies
- Evacuate the water out of the system as fast as possible in a responsible way to enable:
  - Return of citizens to homes, farms and businesses to begin recovery
  - Inspection, assessment and repair of infrastructure and levees
  - Engender public confidence with Governor and Congressional support
- Reduce known risks where we can and anticipate other risks, both known and unknown

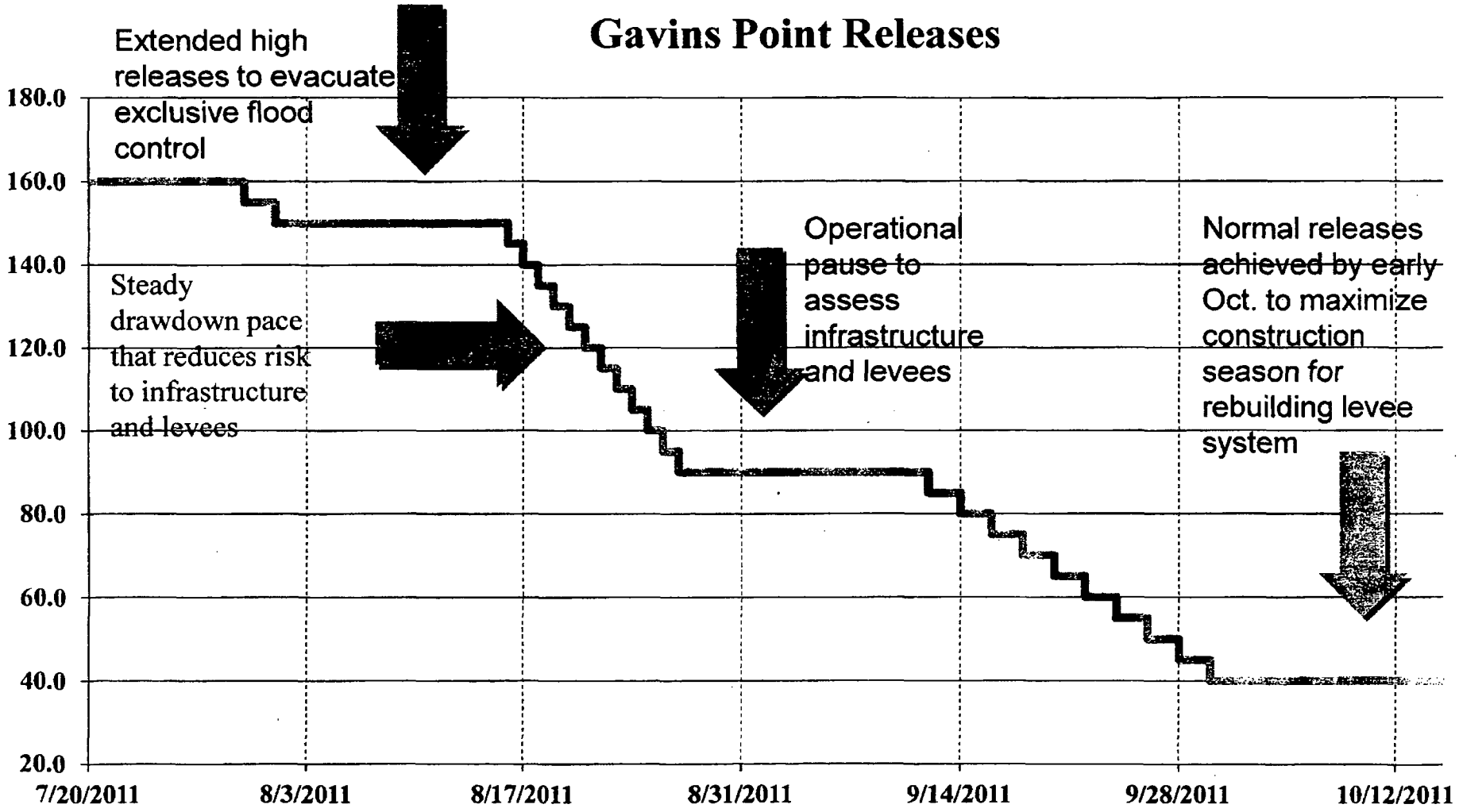
Key Engineering Considerations

- Evacuate exclusive flood control zones of all reservoirs as soon as possible—gain back our flexibility.
- Ensure fall releases are low enough to facilitate damage assessment and repair of infrastructure and levees (<40k cfs).
- Ensure winter releases are low enough to permit winter construction and minimize the risk of ice jam flooding (<20k cfs).
- Ensure rates of change in releases and reservoir levels are acceptable.
- Consider releases that take water off critical infrastructure.
- Consider releases that avoid continued use of various project features such as spillways and outlet tunnels.
- Consider releases that allow temporary measures to be removed.

Risk Assessments

- Key considerations:
  - Flood plain drainage and impacts
  - Condition of levees
  - Condition of dams
  - Other infrastructure
  - Weather forecast
  - Amount of flood control storage needed
  - Funding available
  - Project Information Reports (PIRs) and Designs
  - Contractor capability
  - Winter construction season constraints
  - Impacts to Kansas Reservoirs

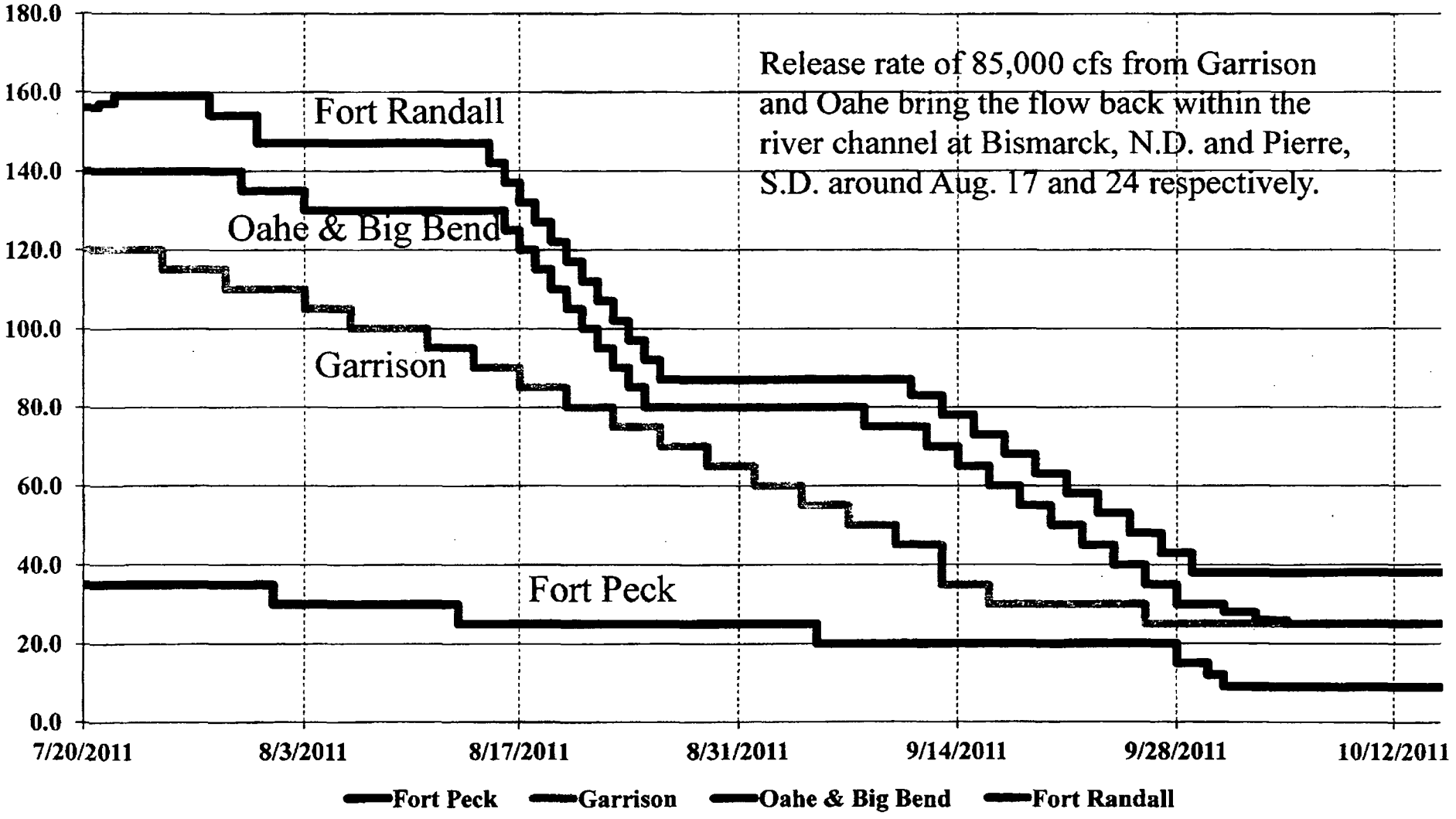
Drawdown Strategy



All dates provided above are best approximations, based on current forecast conditions and the best available information at the time. Adjustments to the release schedule may be necessary if conditions change.

Drawdown Strategy

Fort Peck, Garrison, Oahe/Big Bend, and Fort Randall Releases

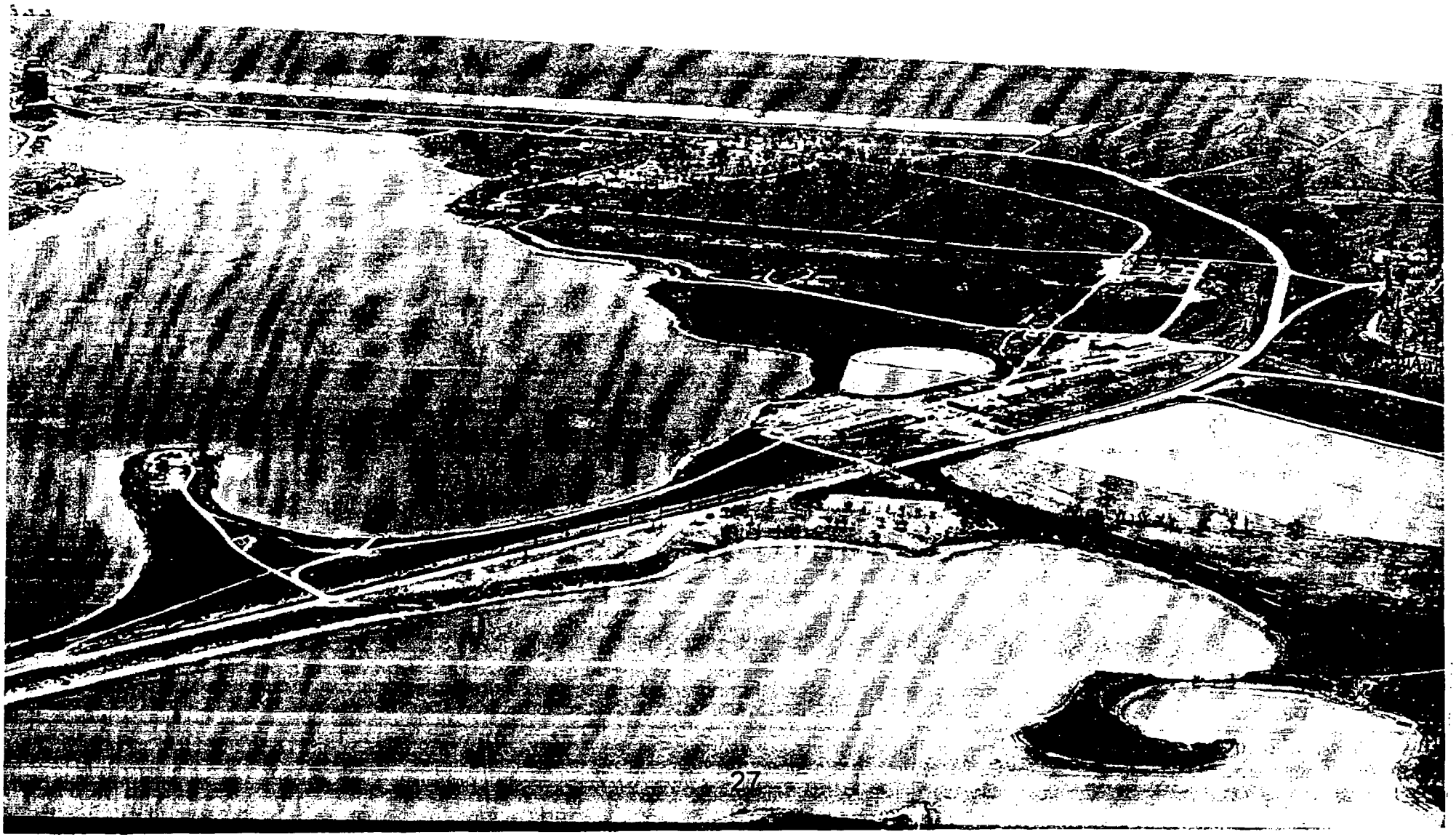


All dates provided above are best approximations, based on current forecast conditions and the best available information at the time. Adjustments to the release schedule may be necessary if conditions change.

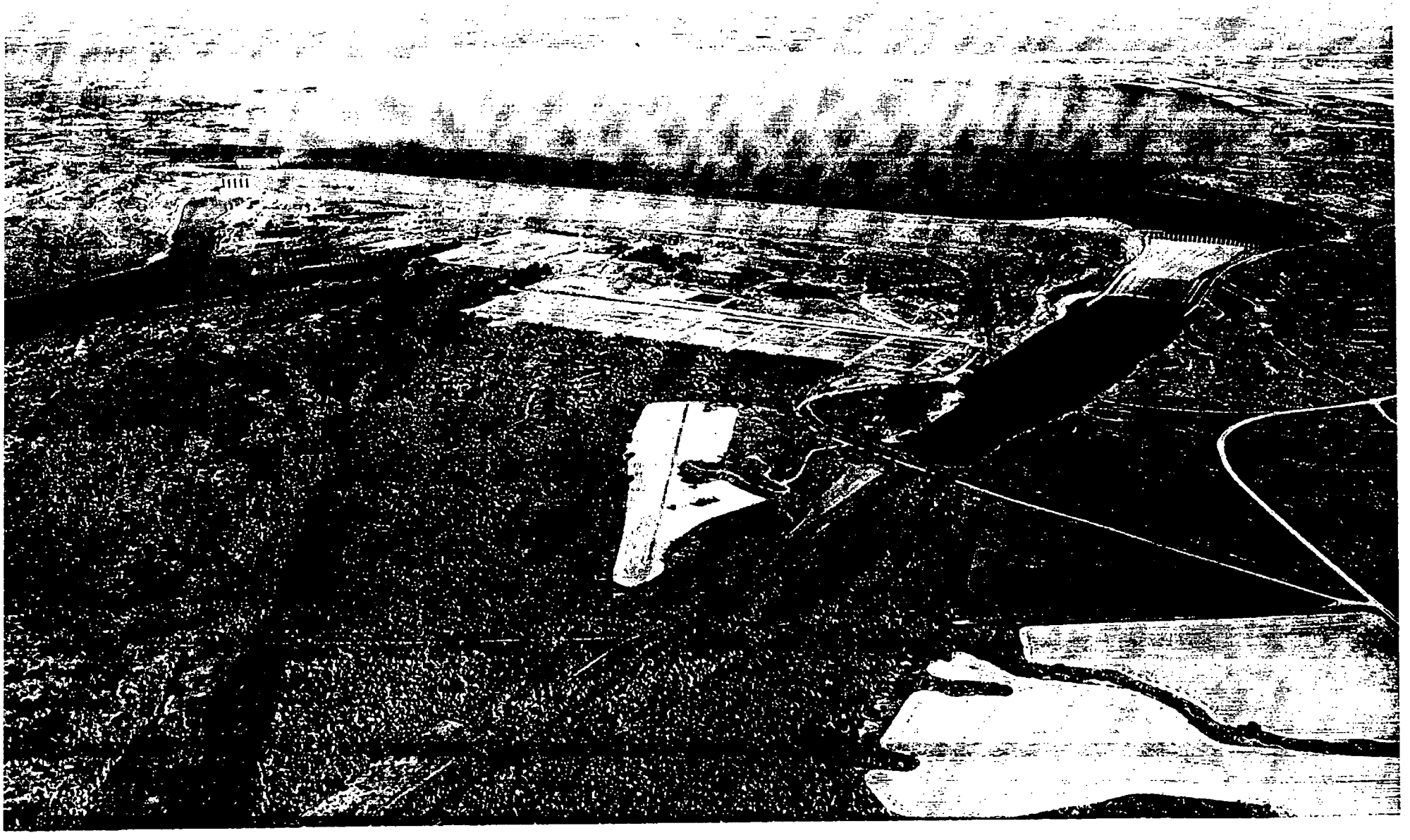
Questions?

Background slides

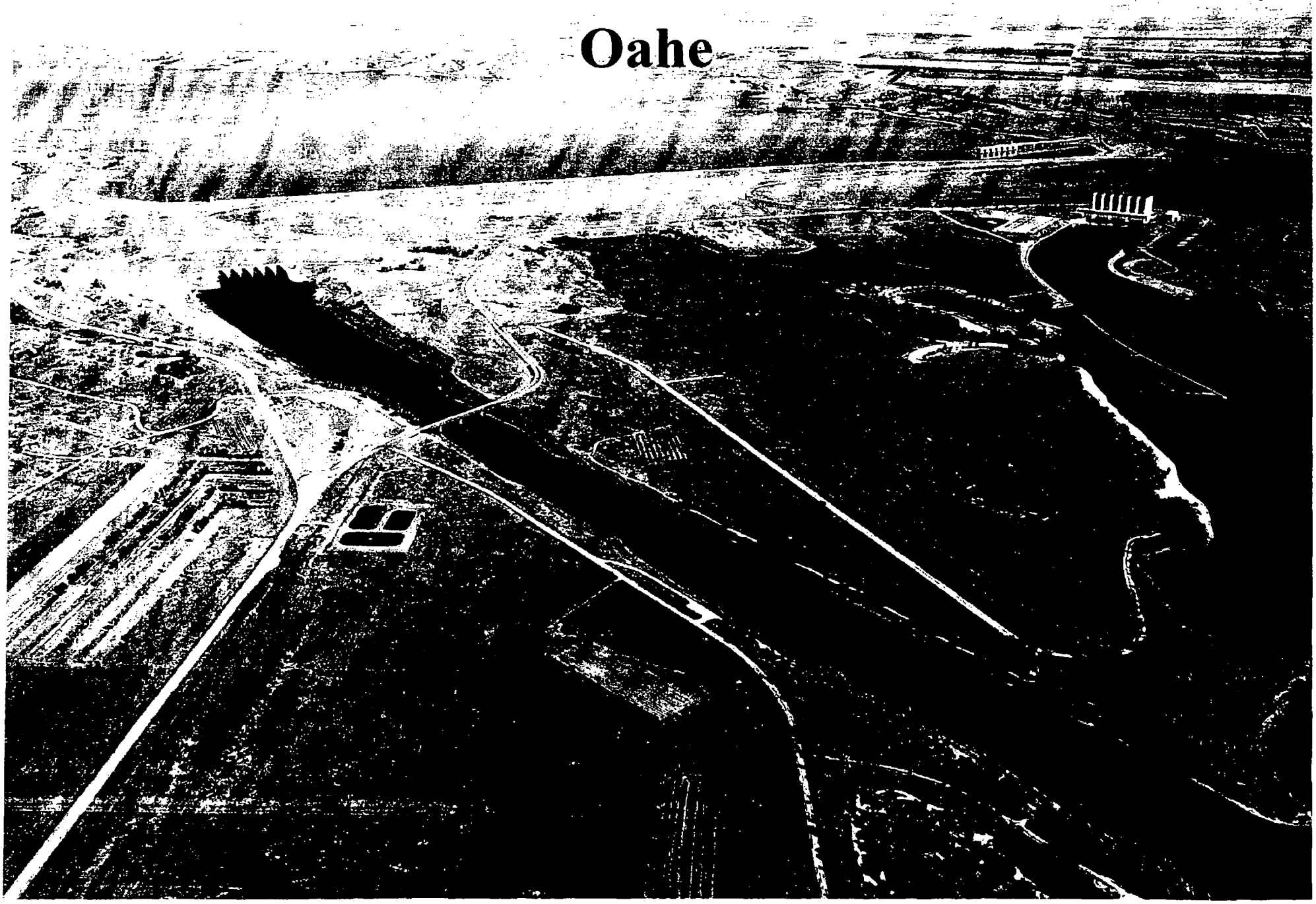
Fort Peck

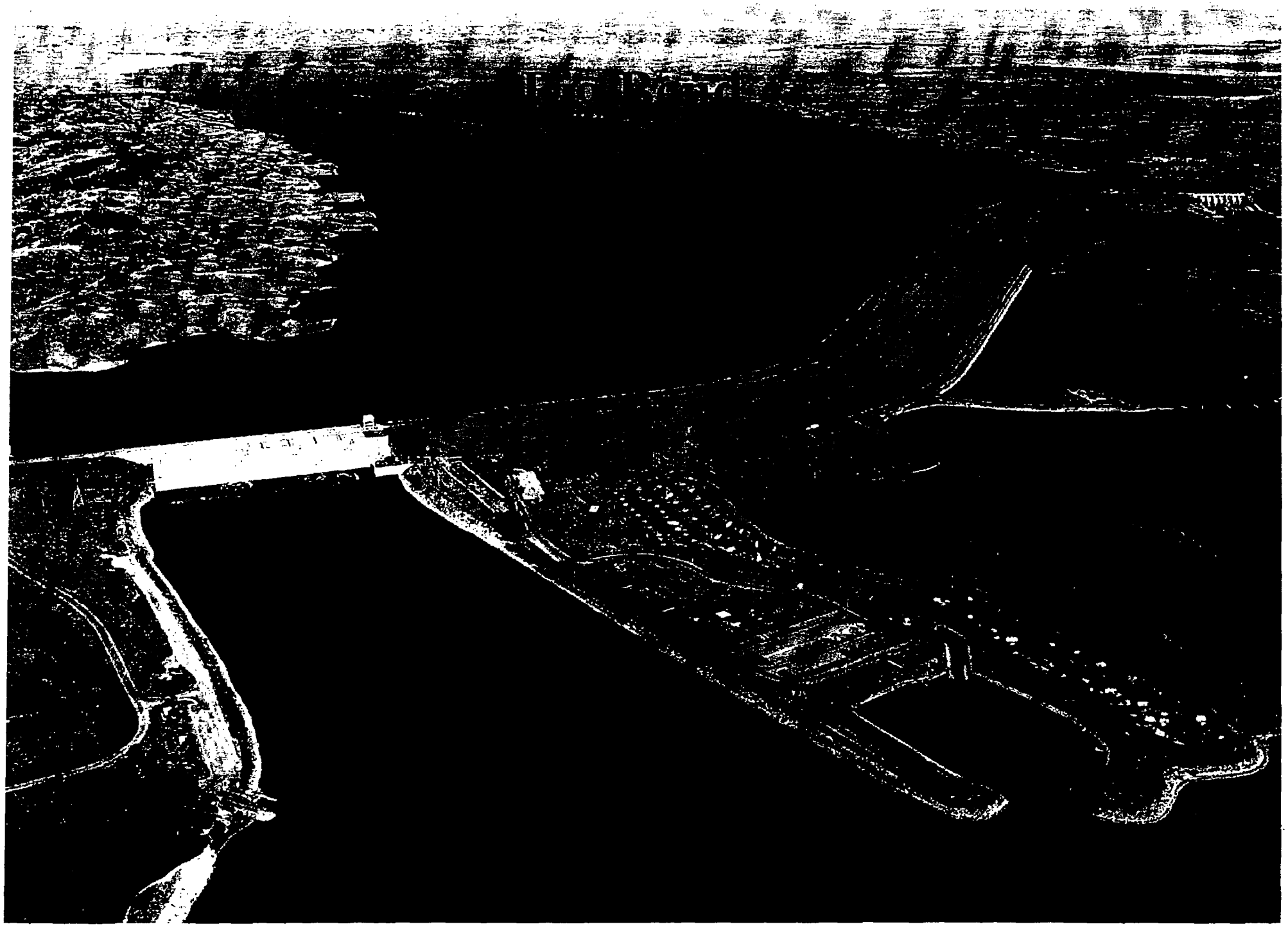


Garrison

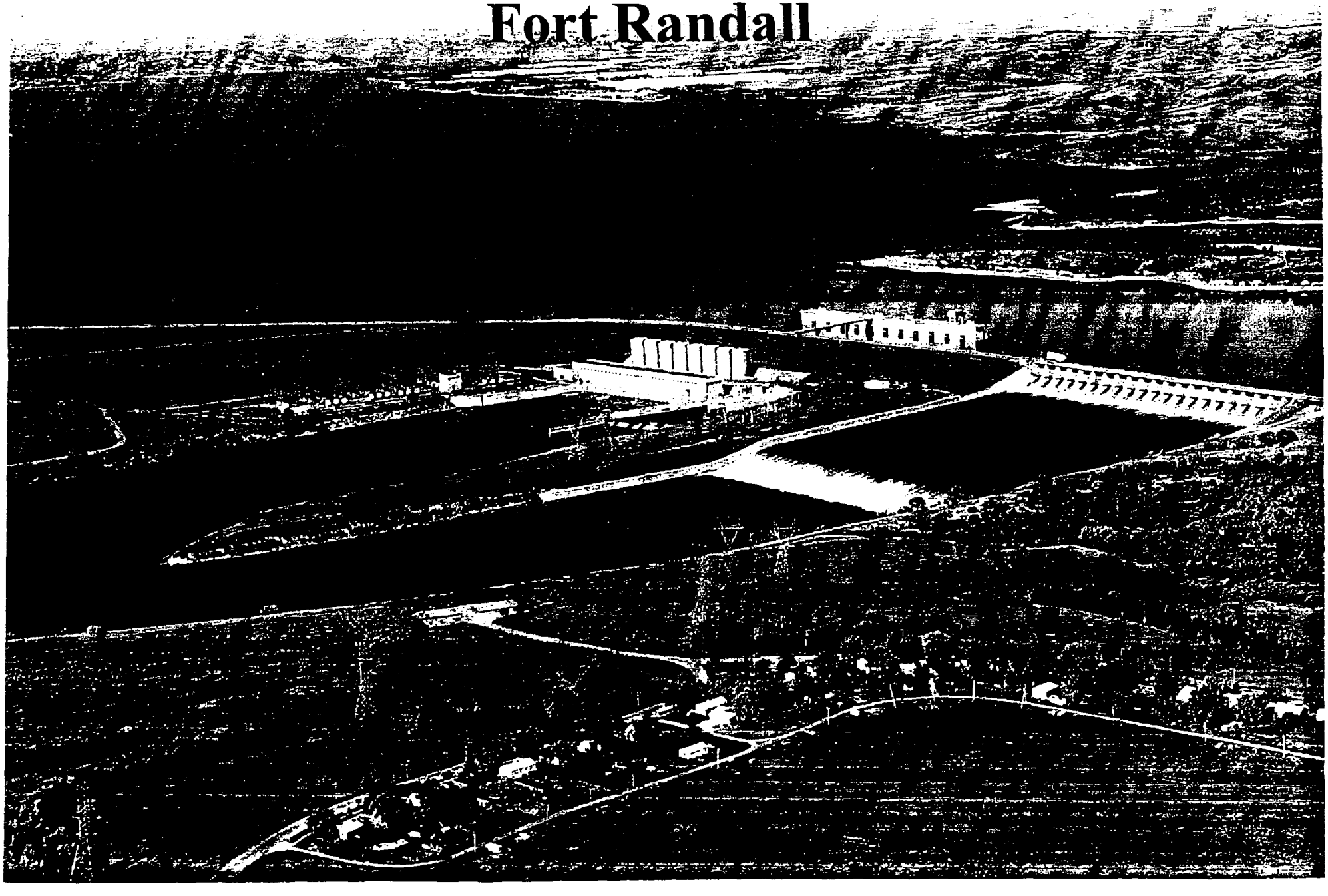


Oahe

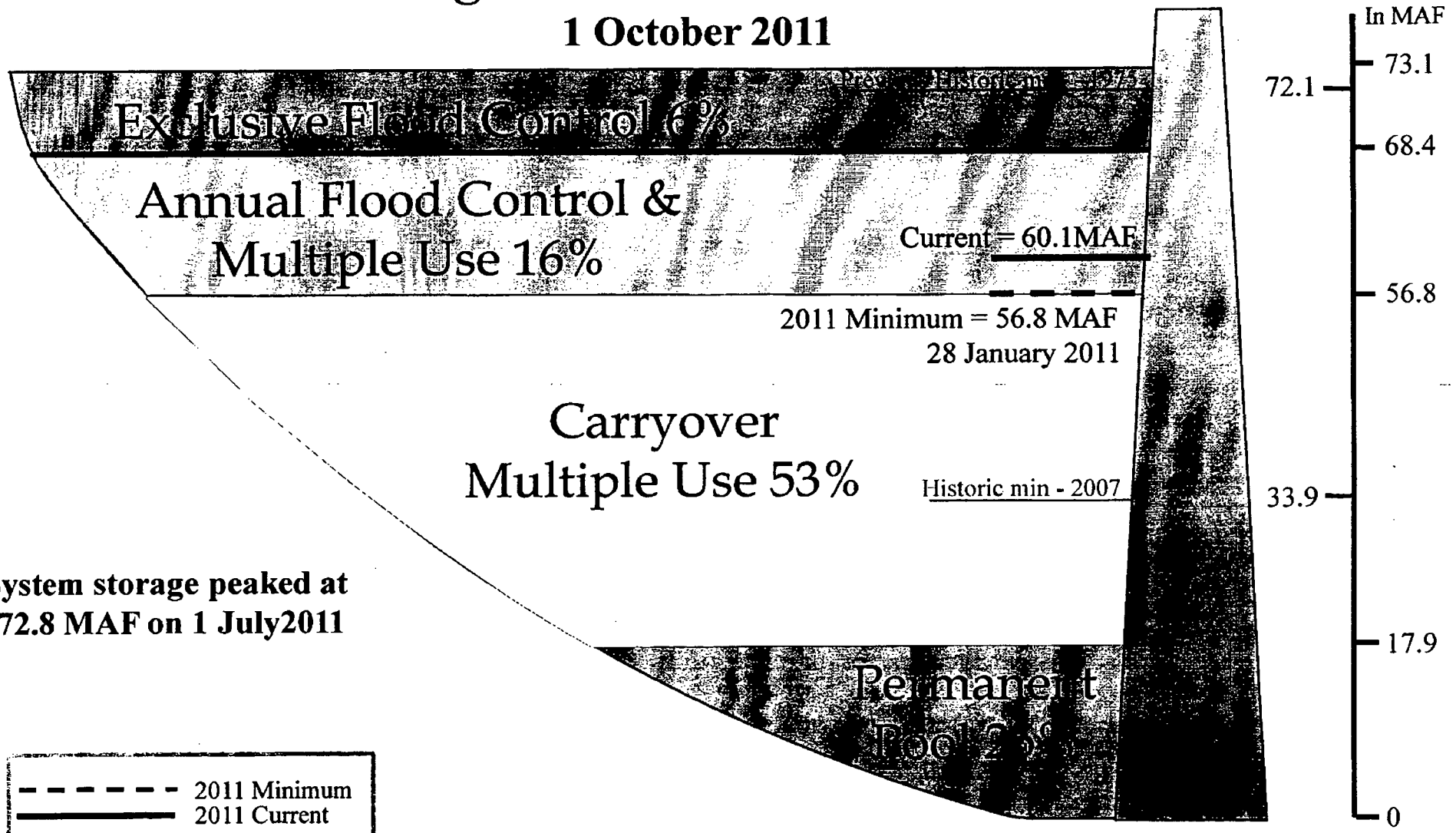




Fort Randall

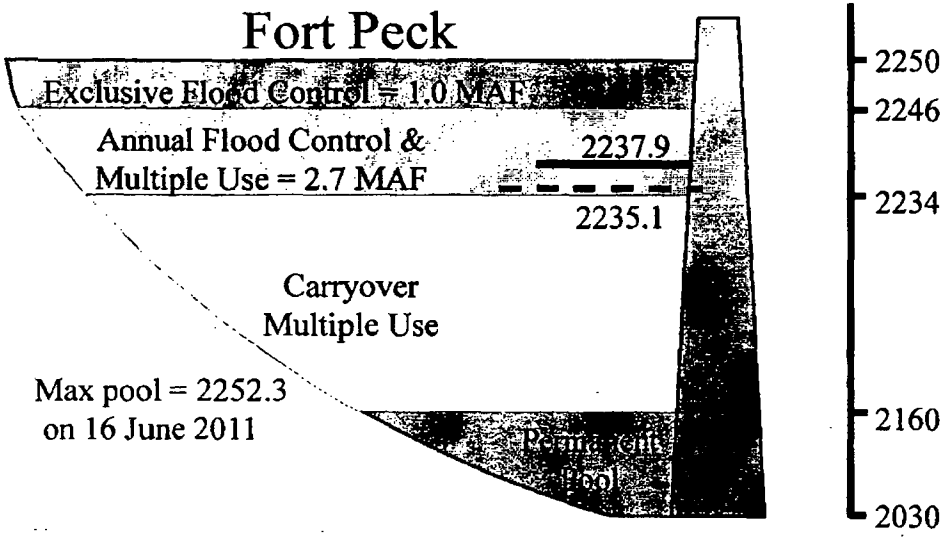


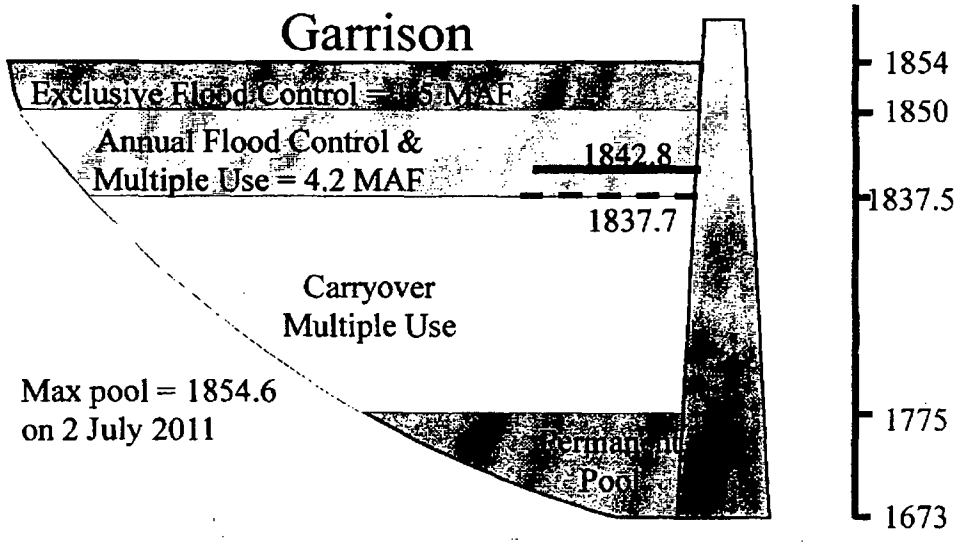
Missouri River Mainstem System
Storage Zones and Allocations
1 October 2011

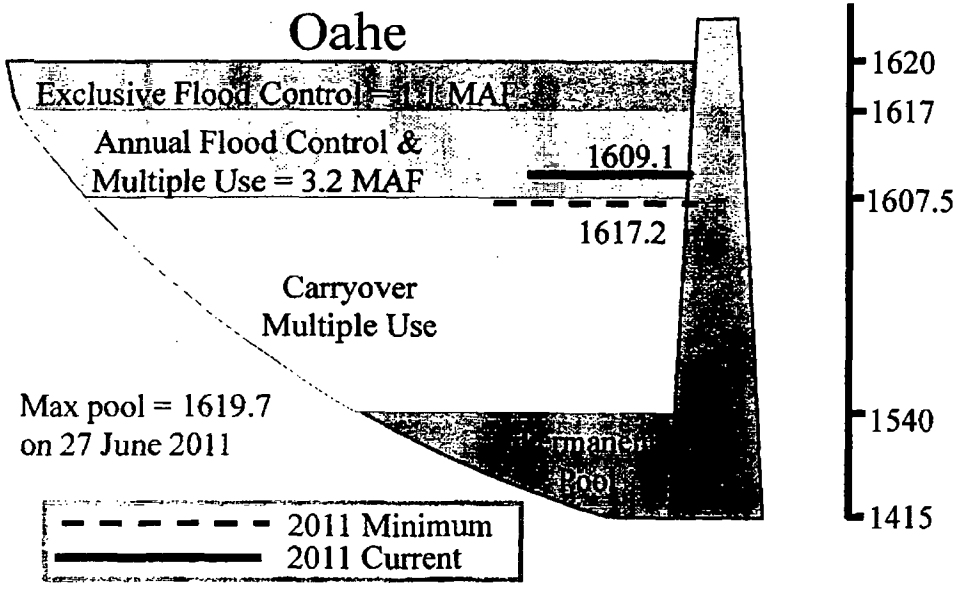


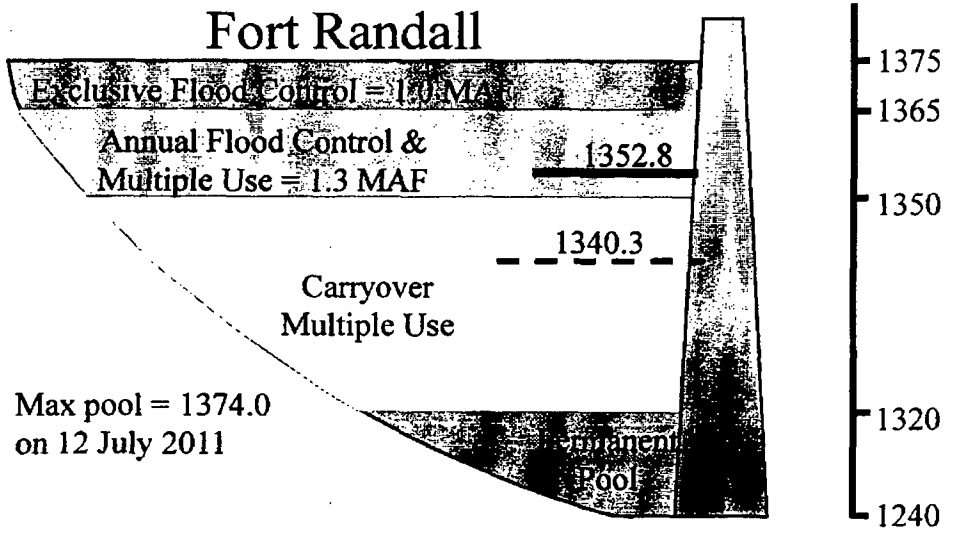
System storage peaked at 72.8 MAF on 1 July2011

Mainstem Reservoir Levels
1 October 2011

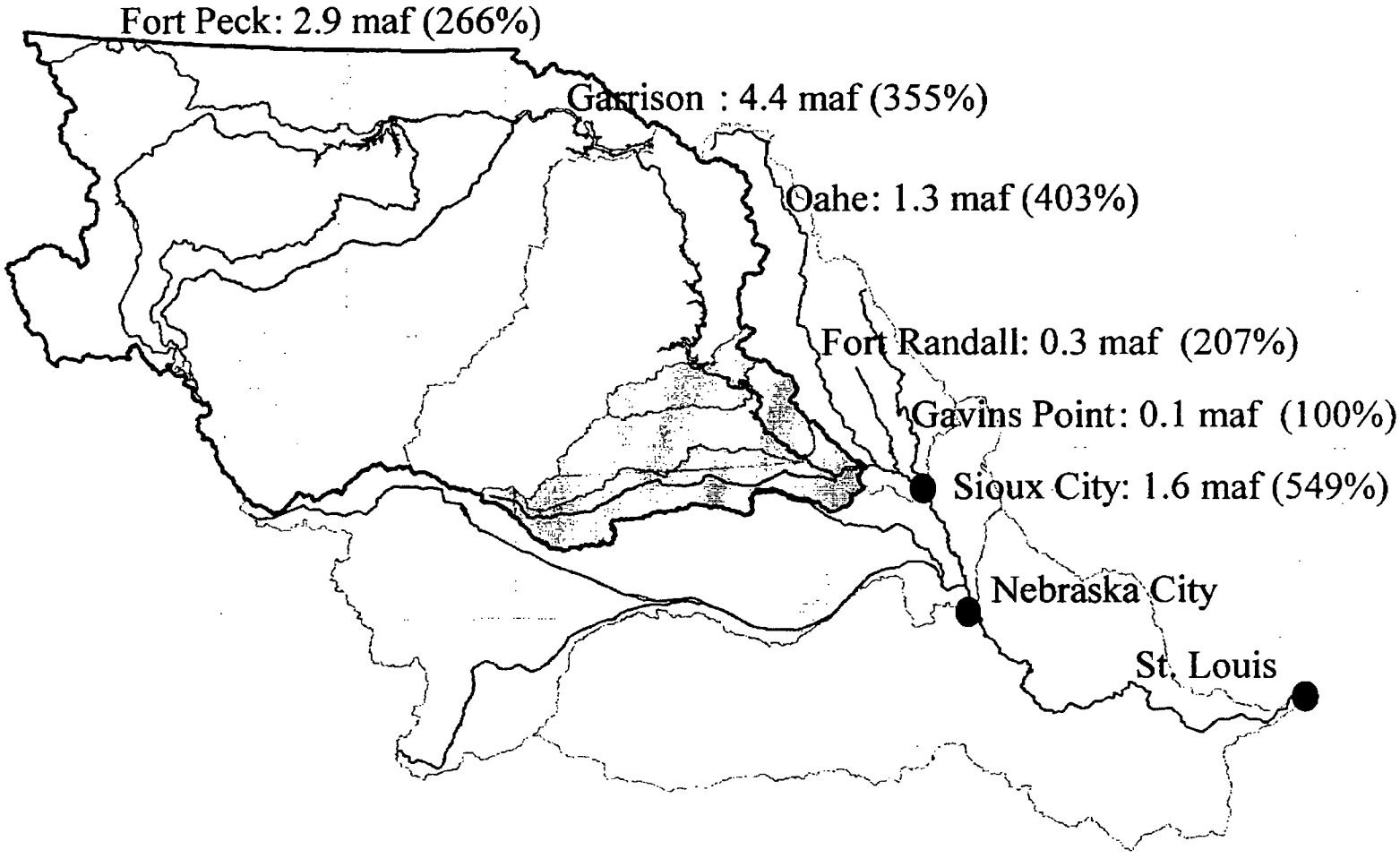




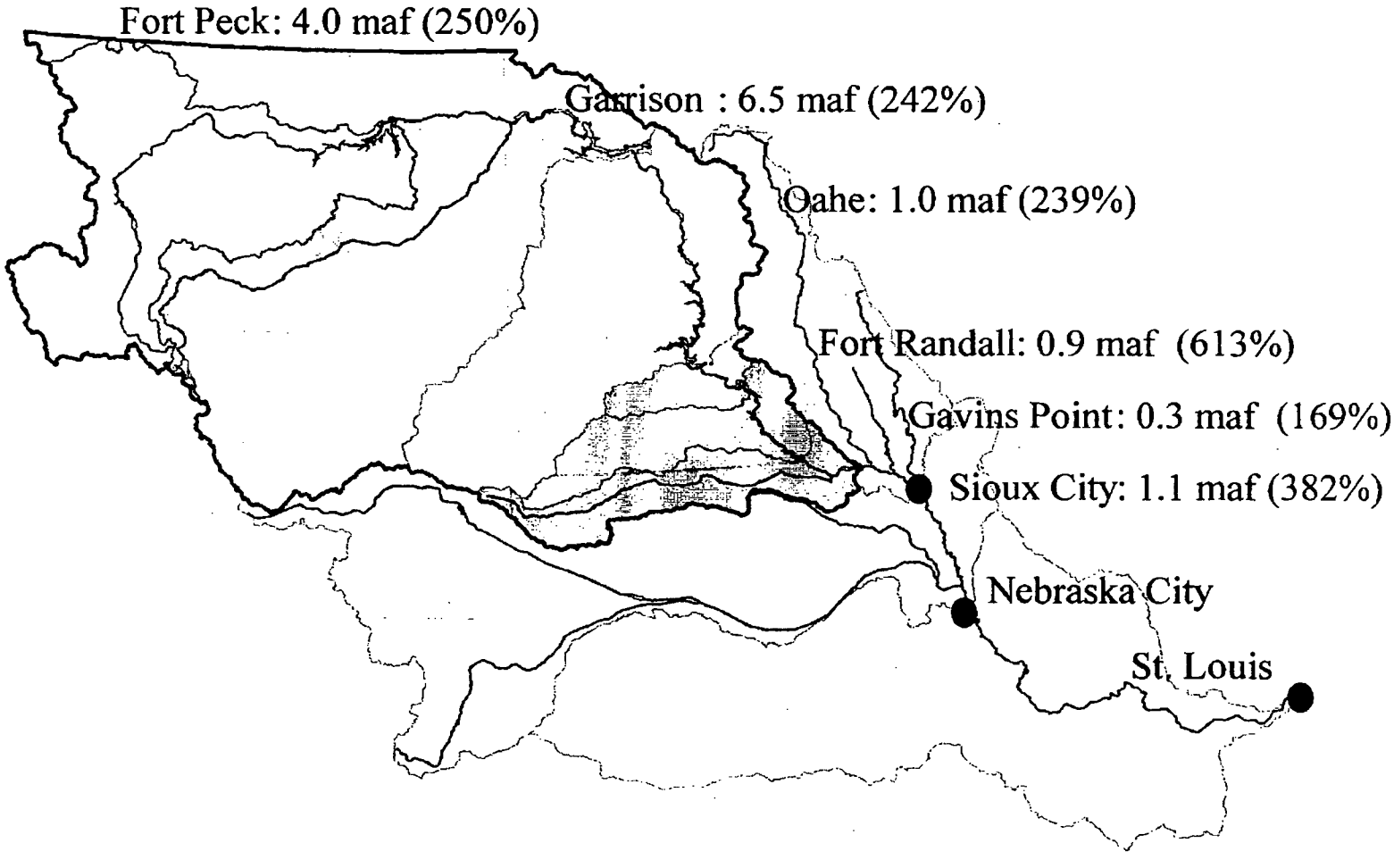




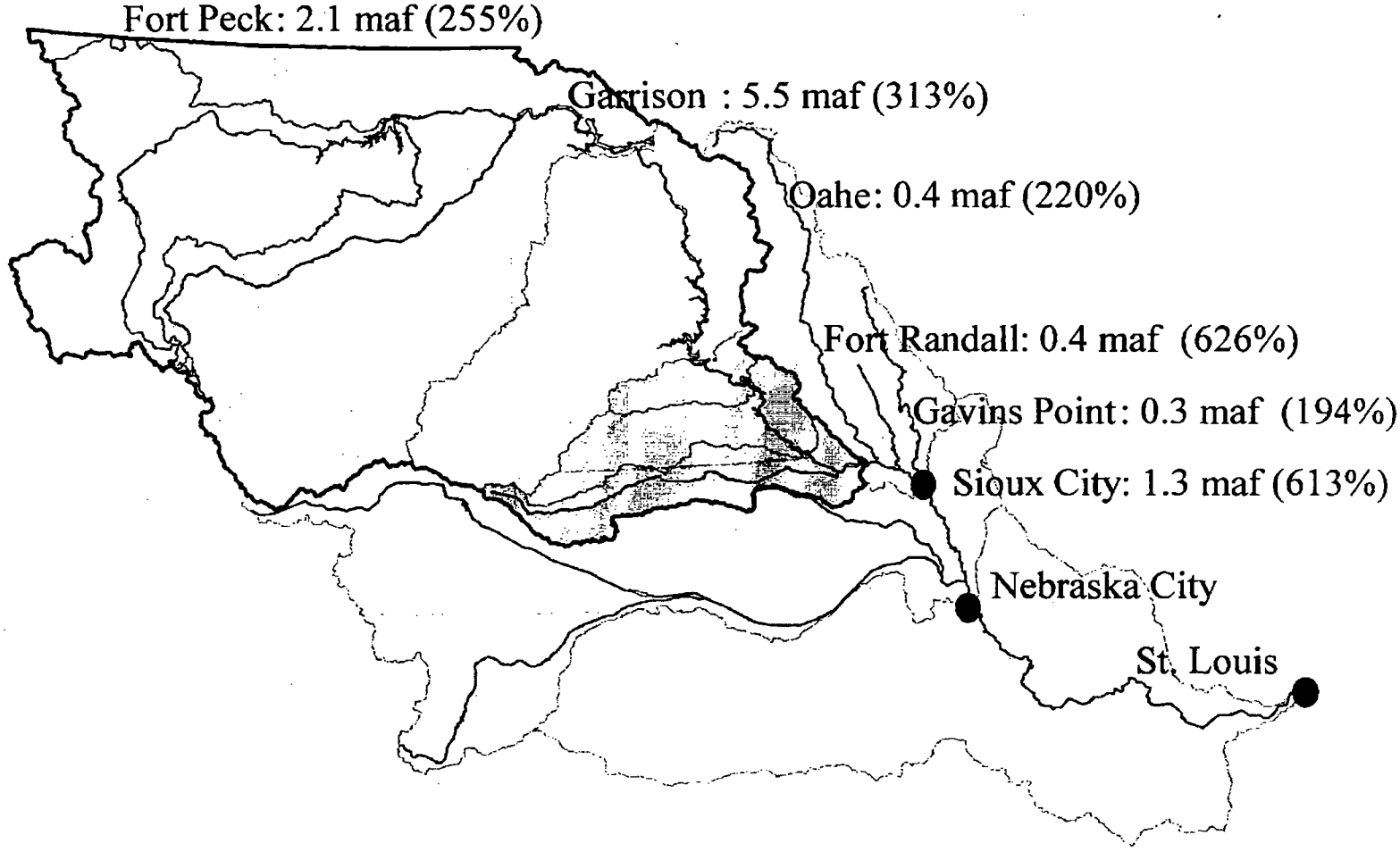
Missouri River Basin – May 2011 Runoff



Missouri River Basin – June 2011 Runoff



Missouri River Basin – July 2011 Runoff



Missouri River Mainstem Reservoir System Master Manual

- First published in 1960
- Updated in 1975 and 1979
- Master Manual Review and Update began in November 1989 in response to late 1980's / early 1990's drought
- Amended Biological Opinion received from USFWS in December 2003
- Manual was revised for drought conservation in March 2004
- Again revised in March 2006 for Gavins Point spring pulse
- Annual Operating Plan (AOP) developed annually in accordance with Master Manual

Perkins, Richard

From: Laur, Steven
Sent: Wednesday, November 23, 2011 9:23 AM
To: Perkins, Richard
Subject: Oahe
Attachments: Missouri River Hydr Statistics F-99.pdf

FYI

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OWFN 10-C15
(301) 415-2889
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US Army Corps
of Engineers

Missouri River Region
Reservoir Control Center

Missouri River Region
RCC
Since 1953
Reservoir Control Center

February 1999

Missouri River Main Stem Reservoirs
Hydrologic Statistics

RCC Technical Report F-99

Table of Contents

INTRODUCTION

The purpose of this report is to describe the methodology, assumptions, data used, and results of the statistical analyses of hydrologic data for the Missouri River Main Stem Missouri River Reservoir System. Results of this analysis include the development of hydrologic statistics consisting of pool and release duration relationships, pool-probability relationships, and release probability relationships for each of the six main stem reservoir projects. The six projects comprising the Missouri River Main Stem Reservoir system include Fort Peck, Garrison, Oahe, Big Bend, Fort Randall and Gavins Point. Pool duration and release duration relationships were based on observed and modeled data from historical reservoir operation records. Pool-probability and release-probability relationships were derived from historical records reflecting actual reservoir regulation and from the results of model simulation studies reflecting current regulation criteria over a long term hydrologic record. Results of these analyses were compared with the previously developed relationships to determine the recommended or adopted pool-probability and release probability relationships. This report contains a summary of the current reservoir regulation philosophy as well as a description of actual past regulation during some of the more significant high runoff years. It also contains a description of the assumptions used in the long term computer model simulation studies.

Pool duration relationships are used to define the percent of time that a given pool elevation is equaled or exceeded, while release duration relationships represent the percent of time that a given release from the reservoir is equaled or exceeded. Duration curves represent the cumulative distribution function of all data recorded at the site which can be based on annual or seasonal periods. Seasonal duration curves can be defined to represent particular months or seasons such as the navigation or non-navigation season. A duration curve is not a probability curve. It should not be interpreted on a annual event basis because it provides only the fraction of time that a given event was exceeded and not the annual probability of an event occurring. It can be used to determine the average number of days per year that a particular magnitude is equaled or exceeded if it is annual duration curve or the number of days during a particular month or season if it is a seasonal duration curve. Daily or monthly data can be used to develop a duration curve. A shorter time step in the data used will typically result in a duration curve with steeper slopes at the extremes. Duration curves are developed using class interval analysis. Class interval analysis involves subdividing the data into defined class intervals and computing the relative frequency of each class interval based on the number of data within each class.

Pool-probability relationships are used to define the annual probability of the reservoir pool level reaching or exceeding a certain elevation. Current standards are to express the probability in terms of annual "percent chance of exceedance." For example, a given pool elevation that has an annual exceedance probability of 0.05 would have a 5 percent chance of being equaled or exceeded in any year. The percent chance of exceedance is equal to the annual exceedance probability multiplied by 100. Once the exceedance probability is estimated, the recurrence interval or return period can be computed as the reciprocal of the of the exceedance probability. For example, a given pool elevation with a 5 percent chance of exceedance would have a recurrence interval of 20 years.

This means that over a long period of time, the given pool elevation would be equaled or exceeded on the average of five times every 100 years. This elevation would be commonly referred to as the 20-year pool elevation.

Release-probability relationships are used to define the annual probability of making a release from the reservoir equal to or greater than a certain discharge. For an uncontrolled reservoir, the release probability relationship may be derived directly from the pool probability relationship and a fixed elevation-outflow relationship since the maximum outflow is a function of the maximum pool elevation. For a regulated reservoir, such as those that comprise the Missouri River Main Stem reservoir system, the release-probability relationship must be determined independently of the pool-probability relationship since maximum releases do not necessarily correspond with maximum pool elevations. For the Missouri River Main Stem Reservoir System, maximum releases are dependant on a variety of factors in addition to the pool elevation within the reservoir. These factors include downstream flow targets for flood control, navigation, water supply, and environmental needs, hydropower requirements, recreation, and intra system balancing for all authorized purposes. Duration of the maximum releases can vary considerably from project to project and from year to year. For example, evacuation of significant accumulated flood storage can require many months, of sustained high releases, while short term peaking hydropower releases can occur for durations less than one hour. Therefore, if the duration or volume of the maximum releases is of concern, the release probability relationships defined in this report should not be used. Additional release-volume-probability studies should be completed to determine the frequency of release volumes for various durations.

Prior to this study, the adopted pool probability and release probability relationships were based on a study completed in April 1976 with only nine years of actual historical data from the period of 1967 through 1975. The April 1976 study is referred to as MRD-RCC Technical Report B-76 "100-year Maximum Releases and Pool Elevations -1975 Development Level -Missouri River Main Stem Reservoir System." This study has been updated utilizing 31 years actual historical data from the period of 1967 through 1997. This updated study was completed by the Reservoir Control Center, Missouri River Region of the U.S. Army Corps of Engineers and is published as NWD-MRR-RCC Technical Report Number F-99. Supporting data and reports referenced herein are on file in the Reservoir Control Center.

BACKGROUND INFORMATION

Six projects comprise the Missouri River Main Stem System, including Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point Dams. These dams were constructed by the Corps of Engineers on the main stem of the Missouri River for flood control, navigation, irrigation, hydro power, water supply, water quality control, recreation, and fish and wildlife. The main stem projects are operated as a hydrologically and electrically integrated system in order to achieve the multipurpose benefits for which they were authorized. Figure 1 shows the location of each of these reservoirs. Pertinent data for each project are listed in table 1.

Table 1
Pertinent Data for Missouri River Main Stem Reservoirs

Description	Fort Peck	Garrison	Oahe	Big Bend	Fort Randall	Gavins Point	System Total
River Mile	1771.5	1389.9	1072.3	987.4	880.0	811.1	
Drainage Area (sq.mi)	57,500	181,400	243,490	249,330	263,480	279,480	
Gross Storage (kaf)	18,688	23,821	23,137	1,859	5,418	470	73,393
Flood Storage (kaf)	3,692	5,711	4,303	177	2,294	149	16,326
Carryover Storage	10,785	13,130	13,461		1,607		38,983
Top of Dam (ft-msl)	2280.5	1875	1660	1440	1395	1234	
Max Surcharge Pool (ft-msl)	2256.1	1858.5	1644.4	1433.6	1379.3	1221.4	
Max Operating Pool	2250	1854	1620	1423	1375	1210	
Max Normal Pool	2246	1850	1617	1422	1365	1208	
Base Flood Pool	2234	1837.5	1607.5	1420	1350	1204.5	
Base Carryover	2160	1775	1540	1420	1320	1204.5	
Spillway Cap (cfs)	275,000	827,000	304,000	390,000	620,000	584,000	
Outlet Cap (cfs)	45,000	98,000	111,000	0	128,000	0	
Power Plant Cap (cfs)	16,000	41,000	54,000	103,000	44,500	36,000	
Date of Closure	Jun 1937	Apr 1953	Aug 1958	Jul 1963	Jul 1952	Jul 1955	

The flood control storage zones in the Missouri River main stem reservoirs were designed in a series of Detailed Project Reports in the mid-1940's to provide control of the severe 1881 flood, with maximum releases of about 100,000 cfs from all projects other than Fort Peck and with maximum pools at or near the top of the exclusive flood control storage space. The 1881 flood inflows were based on estimates of what actually occurred, without reduction to allow for operational effects of upstream tributary reservoirs or for consumptive use by upstream irrigation and other purposes. If the flood runoff were to recur today, its severity as far as the main stem reservoir designs are concerned would be significantly reduced by these factors. On the other hand, regulation criteria used in the 1881 reservoir design studies were based largely on hindsight, with little regard for downstream runoff conditions. Releases of approximately 100,000 cfs were assumed to be made from mid-April to mid-July from the five lowermost reservoirs, without any requirement for reducing releases to desynchronize with downstream flood peaks. Thus, under today's conditions, the impacts of reductions in upstream runoff due to the construction of tributary reservoir flood storage and increased water-use primarily for irrigation might well be offset by release reductions necessary due to deteriorated downstream channel conditions and potential tributary flood inflows.

The March through July flood season volume of the 1881 flood at Sioux City has been estimated in past studies to be about 42 million acre-feet (maf), compared to a March through July 1978 runoff of 31 maf and the 1997 runoff of 37 maf, the highest years since record keeping began in 1898. The 1978 flood season runoff approximates the 1 percent chance exceedance flood runoff and the 1997 runoff is between the 0.5 and 0.2 percent chance of exceedance. The 1881 flood sequence as it occurred is considerably more infrequent. However, the frequency of the 1881 flood runoff volume has not been determined, nor routed through the reservoir system using current regulation criteria. To do so would require a considerable amount of work and judgement since 1881 flows are not available at most key tributary reservoirs and downstream gaging locations, and the extrapolation of data would make the results of the analysis unreliable. The remainder of this report addresses the development of pool-probability and release-probability relationships for the main stem reservoirs, without consideration of the 1881 flood --except to recognize that it is much more severe than the 1 percent chance exceedance condition.

The main stem reservoirs have been operating as an integrated system since 1954 although it was not until 1967 that initial fill of the system was completed. During the period of initial fill, regulation of the projects was very atypical of what may be expected in the future. In addition, during the period that the reservoirs have been operating, regulation philosophy and criteria have been modified and past regulation does not entirely reflect current criteria. For example, beginning in 1986, special release consideration from Fort Randall and Gavins Point were required for least terns and piping plovers to accommodate nesting requirements during the May through August period. Modest changes have been made in flood control criteria as additional experience has been gained.

When developing hydrologic data for a study of this type, it should be recognized that neither regulation criteria, available water supply, or characteristics of the reservoir system will remain static

through the years. Numerous refinements to regulation criteria have been made since system operation first began and more can be expected in the future. Water resource development, in the Missouri Basin, is a dynamic process and has the greatest effects with changes in streamflow depletions. It is anticipated that some continued development could occur in the future. While the main stem system construction is complete, modifications in project structures are always possible. All of these conditions could affect the frequency estimates. Therefore, a considerable amount of engineering judgement, based on many studies and experience gained from years of actual operation, was used in developing the frequency estimates in this report.

One means of investigating a long-term period of hydrologic record and obtaining data that would be considered satisfactory for frequency estimates is by the means of long-term system regulation studies. A flow record extending from 1898 to present time, representing 100 years of data is available. There are two similar computer models of the Missouri main stem reservoirs and downstream Missouri River control points used to simulate long-term reservoir regulation. One model uses a monthly time step called the Long Range Study (LRS) and the other uses a daily time step and is called the Daily Routing Model (DRM). The DRM was used in the analysis presented in this report. Daily data is not available before 1929 at all stations used by the model and as a result, the pre-1929 data used in the DRM was estimated based on data available between 1898 to 1929. The data derived in this time period is often referred to a "synthesized" data Criteria incorporated in these models reflect current regulation criteria to the maximum extent possible. In some respects the computer studies provide the most valid frequency estimates because:

1. The period of hydrologic records is far greater than the years of experience in system operation.
2. Hydrologic records used in the system operation studies have been adjusted to reflect a 1990 level of basin water resource development, and;
3. The daily model utilizes a consistent set of reservoir regulation criteria throughout the entire period. As referenced previously, refinements to criteria have been made during the period of actual reservoir operations. These changes, although modest in nature, are not reflected in previously recorded releases and reservoir elevations.

While there are advantages to using a long-term study for development of frequency estimates, as described above, it should also be recognized that the long-term studies do not entirely reflect regulation that may have occurred. Reasons for this include:

1. System regulation is extremely complex and precludes writing a computer model that totally simulates system operation, particularly during extreme runoff events.
2. Simplification of regulation criteria is necessary for the long-term studies. For example, long-term criteria cannot reflect the multi-year changing emphasis on operations for fish and wildlife enhancement that occurs in actual regulation.
3. Long term studies do not reflect limits on power generation that occurs during actual regulation due generally to power units being unavailable because of scheduled or unplanned maintenance outages. Changes in value of marketed energy at a particular time

also affects system generation.

4. The models are not capable of fully predicting runoff from spring and mountain snowpack conditions, as is done in real time regulation. The deviations between historic regulation and model results are the greatest during the extreme events.

Based on the discussion presented previously, it was reasoned that frequency estimates should be based on both the historical record of actual system regulation experience and on the long-term reservoir operation studies. The most recent long-term study reflecting current operation utilizing the Long Range Study (LRS) model is referred to as the Current Water Control Plan (CWCP). This study was completed as part of the Missouri River Master Water Control Manual Review and Update studies and is documented in Volume 2: Reservoir Regulation Studies-Long Range Study Model dated July 1994. That study has been updated and contains the experienced hydrologic record extending from 1898 through 1997 and reflects, to the degree possible in long-term studies of this type, regulation criteria at the current level. The results of the daily model (DRM) were reviewed for this analysis as well. Significant short term differences have been noted between model results and actual operations for the recent flood years. Hydrologic data for the DRM model was extended to include daily reach inflows through 1997.

Two methods were used to determine the pool-probability relationships, a graphical analysis of the 100 years (1898-1997) of simulated maximum daily pool elevations for the DRM model simulation, and a graphical analysis of the 31 years (1967-1997) of observed maximum daily pool elevations based on the historical rank. Throughout this report, the analysis based on the DRM model is referred to as "Simulated", while the analysis based on the 31 years of historical record is referred to as "Observed". Each graphical analysis was based on the Weibull plotting position formula. Eye fit curves for each of these methods were compared with the adopted curve from the 1976 study to obtain the adopted curve for this update study. Similar procedures were used to develop the release-probability relationships.

MAIN STEM RESERVOIR SYSTEM REGULATION

Regulation of the main stem reservoir system follows a repetitive annual cycle. Winter snows and spring and summer rains produce most of the years's water supply which results in rising pools and increasing storage accumulation. After reaching a peak, usually during July, storage declines until early the following spring when the cycle begins anew. A similar pattern may be found in rates of releases from the system, with the higher levels of flows from mid-March to late November, followed by low rates of winter discharge from late November until mid-March, after which the cycle repeats. Two primary high risk flood seasons are the plains snowmelt season extending from late February through April and the mountain snowmelt period extending from May through July. Overlapping the two snowmelt flood seasons is the primary rainfall flood season which includes both upper and lower basin regulation considerations. The highest average power generation period extends from mid-April to mid-October with high peaking loads during the winter heating season (mid-December to mid-February) and the summer air conditioning season (mid-June to mid-August). The power needs during winter are supplied primarily with Fort Peck and Garrison releases and the peaking capacity of Oahe and Big Bend. During the spring and summer period, releases are geared to navigation and flood control requirements and primary power loads are supplied using the four lower dams. During the fall when power needs diminish, Fort Randall pool is drawn down to permit generation during the winter period when the pool is refilled by Oahe and Big Bend peaking power releases. The major maintenance period for the main stem power facilities extends from mid-February through May and from September to mid-November which normally are the lower demand and off-peak energy periods. The exception is Gavins Point where maintenance is performed after the end of the navigation season since all three turbines are normally required to provide navigation flow needs.

Normally, the navigation season extends from April 1 through December 1 during which time reservoir releases are increased to meet downstream target flows in combination with downstream tributary inflows. Much of the increased flow for navigation comes from the large carryover storage in Oahe Reservoir. Winter releases after the close of navigation season are much lower and vary depending on the need to conserve or evacuate main stem storage volumes, downstream ice conditions permitting. Minimum release restrictions and pool fluctuations for fish spawning management generally occur from April 1 through July. Endangered and threatened species nesting (interior least tern and piping plover) occurs from early May through August. During this period, special release patterns are made from Fort Peck, Garrison, Fort Randall, and Gavins Point to avoid flooding nesting sites on low-lying sandbar islands downstream from the projects.

The general regulation principles presented above provide the philosophy for main stem system regulation. Detailed operation plans are developed, and adjusted as conditions warrant due to changes in runoff and streamflow. Beginning in 1953, projected operation of the Missouri River main stem reservoir system for the year ahead was developed annually as a basis for advance coordination with the various interested Federal, State, and local agencies and private citizens. These regulation schedules are prepared by the Reservoir Control Center, Missouri River Region, Corps of Engineers. A discussion of the specific system regulation requirements for a few of the more

significant runoff years is presented in the following paragraphs.

REGULATION OF 1975 RUNOFF

Runoff during 1975 from the drainage area controlled by the Missouri River main stem reservoir system upstream from Sioux City, Iowa, totaled 35.5 million acre-feet (maf) which ranks as the eighth highest since the main stem first reached normal operating levels in 1967 and the eighth largest during the 1898-1997 period. Over 80 percent of the 1975 runoff originated upstream from Garrison. Upstream from Fort Peck and Garrison, the 1975 runoff was the highest on record, totaling 28.8 maf from those two reaches. In the process of regulating this unprecedented runoff, three of the projects (Fort Peck, Garrison, and Oahe) exceeded previous maximum reservoir elevations, while sustained releases from all projects were at higher rates than any previous release. All maximum release rates were well below the flow rates which occurred frequently prior to operation of the system and below those that would have occurred on numerous occasions since operation began.

In early 1975, it appeared that runoff above the reservoirs would be less than normal, due to a subnormal mountain snowpack. However, much above normal precipitation occurred over Montana and North Dakota through July. The most severe event was the extremely heavy rainstorm of 18-19 June centered to the east of the continental divide in Montana where average precipitation amounts exceeding 10 inches covered a 2,500 square mile area and an area of 10,000 square miles had an average rainfall exceeding 6 inches. Flood control provided by the reservoirs, prevented stages below the system from exceeding flood stage. Consequently, significant damages were prevented and credited to the system.

The regulation of runoff in 1975 resulted in the pool levels at Fort Peck and Garrison that were record highs. At Fort Peck, the pool reached elevation 2251.6, which is still the maximum level ever reached. This elevation is 1.6 feet above the top of the exclusive flood control pool and into the surcharge zone provided for the control of extraordinary floods. The Garrison pool level reached a maximum elevation of 1854.8, which is 0.8 foot into the surcharge zone and is still the highest level ever reached. Maintaining lower levels in the upstream reservoirs would have required substantial increases in the releases from these projects. When it became apparent that utilization of surcharge storage was probable, releases were increased up to the maximum rate believed practicable without causing substantial lowland flooding through the immediate downstream areas. Since encroachment into the surcharge zone of any reservoir project reduces the effectiveness of the project for control of subsequent flood inflows that may occur, consideration is given to the time of year and risk of subsequent floods. If the encroachment had occurred early in the flood season prior to mountain snowmelt, it would have been much more serious and greater project releases would have been made. However, actual encroachment occurred after it became evident that mountain snowmelt was essentially completed and the normal season of large runoff producing rains in upstream areas had passed. Maintaining relatively higher Fort Peck and Garrison reservoir levels than at downstream projects also served to maintain an increased overall flood control capability of the main stem system by providing additional flood control storage space in downstream projects.

Criticism of the 1975 system regulation by specific river interests was that higher than normal releases should have been initiated earlier in order that the maximum reservoir elevations and maximum release rates would have been at lower levels. However, prior to early May, runoff above the main stem reservoir system was forecasted to be in the sub-normal to normal range. The excess runoff resulted primarily from much above normal precipitation occurring in the April through early July period. Additionally, after it became evident that above normal inflows could be anticipated, tributary inflows to downstream reaches of the Missouri River were high enough to require restrictions to system releases during June in order to prevent significant flooding.

If a similar flood were to occur in future years, with current regulating criteria, it is doubtful that regulation would be the same as that experienced in 1975 for the following reasons:

1) Releases during the period extending from March through May were less than would normally be made with the amount of storage accumulated at Fort Peck. Reasons for this included low forecasts of subsequent runoff, the desire to make large releases during the later irrigation season because of temporary irrigation intake deficiencies, and power plant maintenance requirements. This combination, coinciding with such an unprecedented amount of runoff is considered to be remote.
2) Analysis of the release pattern in combination with pool levels indicates that during the 1975 flood there was a several-day delay in increasing releases to all levels, including particularly those that exceeded power plant capacity. Now that such a flood with a large volume has occured, and record releases were made without significant problems to at least the mouth of the Yellowstone, future releases could be expected to be higher during the early portions of a repetition of this event, resulting in lower maximum pool levels than those that occurred in 1975.

REGULATION OF 1978 RUNOFF

Runoff above Sioux City during 1978 totaled 40.6 maf, the second highest on record during the period of 1898 through 1997. System storage increased rapidly at the beginning of the 1978 navigation season. On March 22, system storage was 54 maf and increased at an average of more than 500,000 acre-feet per day during the remainder of the month. Storage gains continued at a high rate through April as plains snowmelt runoff continued and mountain snowmelt began. As mountain snowmelt continued through the summer months, the system storage crested on July 23 at 69.3 maf.

Prior to the beginning of the navigation season, plans were made to provide less than full service navigation releases during the beginning months of the navigation season due to lower than normal storage levels that resulted from the basin-wide drought of 1977. The melting of the heavy snowpack over the plains area caused unprecedented daily system storage gains, and an upward adjustment of the forecasted annual runoff resulting in the decision to increase navigation support to full service. Gavins Point releases were gradually increased to the full power plant capacity of 35,000 cfs by the end of May as downstream tributary flows receded. Spills began the second week of June and continued into December to evacuate the flood waters stored. In October and November,

maximum releases were maintained near 52,000 cfs. During a four day period in March, the Gavins Point pool rose from elevation 1205 to 1209.2, the highest pool elevation until 1995.

Releases from Fort Randall generally paralleled those from Gavins Point with the exception of the flood runoff period and a scheduled weekly cycle that permitted Fort Randall to share the Sunday release sags occasioned by the reduced power loads. Due to the large runoff that began about mid-March, releases were reduced to about 1,000 cfs for one week to limit the pool rise in Lewis and Clark Lake and permit Gavins Point releases to be held to a minimum. Lake Francis Case rose rapidly during the early part of the navigation season to a crest of 1362.5 in response to the reduced Fort Randall release and the high plains snowmelt runoff. Releases were increased to a maximum of 53,200 cfs in October to evacuate the flood storage, drawing the pool down to elevation 1339.3 by the end of November.

At Oahe, the pool level increased from elevation 1600 at the end of February to 1616.2 in July. Releases from both Oahe and Big Bend fluctuated quite widely from hour-to-hour and day-to-day to meet varying power loads and to back up system releases. Oahe outflows of at least 3,000 cfs were maintained during weekend daylight hours to enhance downstream fishing and recreational use during the recreation season. Oahe releases reached a maximum of 54,300 cfs in September. Lake Sharpe was maintained near elevation 1420 during the entire period.

At the beginning of the period, the Lake Sakakawea pool level was at elevation 1826, ten feet lower than one year earlier. Like the other projects, the level rose rapidly in response to the snowmelt runoff with an inflow of 150,000 cfs reported on March 27. It continued to rise before cresting at elevation 1849.5 on July 25. Releases from Garrison were reduced at the beginning of the navigation season to prevent flooding in the reach downstream of Bismarck as tributary streams crested at near record levels. Releases were gradually increased to full power plant capacity during June, reaching a maximum daily release of 39,300 cfs in September and October.

At Fort Peck, the pool level was near elevation 2230 in early March. It rose to elevation 2245 by the end of May and crested at elevation 2249.6 on July 20. Releases from the project were reduced from 8,000 cfs to only 3,000 cfs or less during the last two days of March and the first nine days of April to minimize flooding near the mouth of the Milk River as stages in that stream reached record levels. Release were gradually increased to full power plant capacity by late July, reaching a maximum of 14,800 cfs in August.

The regulation of the 1997 flood, which also involved a significant plains snowmelt component, would indicate that system releases would be initiated both earlier and at greater amounts than occurred in 1978 resulting in lower maximum pools and less system storage accumulation. The change is due to the recognition of the significant runoff volumes that occur with a heavy plains snowpack. An improved technique for estimating plains snow pack was not available prior to 1997.

REGULATION OF 1986 RUNOFF

Runoff during 1986 above Sioux City was 36.2 maf, the fifth highest on record and the fourth highest during the period that the main stem reservoirs have been operating. System storage at the beginning of the 1986 navigation season was 58.4 maf. Heavy precipitation during April resulted in near record runoff volumes in many Missouri River tributaries. These large runoff volumes caused significant gains in storage in both Oahe and Fort Randall. Oahe set a new record high pool level in June 1986, a level not exceeded until 1995. Storage gains tapered off during early July, but heavy rains over portions of Montana and North Dakota caused additional storage accumulation resulting in a 1986 system storage crest of 65.2 maf on July 20.

Missouri River flows at Sioux City and all downstream locations exceeded navigation requirements by mid-March even though Gavins Point releases remained near the winter release level of 18,000 cfs. Missouri River flows continued well above normal during April with near record precipitation. As a result, Gavins Point releases during April averaged only 17,200 cfs, which, at that time, was the third lowest since the system became operational in 1967. Despite these low releases, rains caused the lower river to exceed flood stage at several locations downstream from the Platte River. Heavy May rains preceded by near record April rainfall caused unprecedented runoff in tributaries downstream from Garrison Dam. High inflows and low project releases combined to raise the Oahe pool into the exclusive flood zone, prompting a gradual increase in Gavins Point releases to 35,000 cfs by mid-May. Although it was desired to initiate spillway releases in late July, they were delayed to mid-August to facilitate the completion of nesting of least terns and piping plovers. In October, maximum daily releases from Gavins Point reached 45,000 cfs.

At Fort Randall, a minimum release of 20,000 cfs was targeted to enhance downstream fish spawning. However, because of high downstream tributary flows, this rate was not attained until mid-May. On one occasion during April, the daily flow was reduced to as low as 7,500 cfs because of flood control actions. The pool at Fort Randall fluctuated from a minimum of 1354.5 feet msl to a maximum of 1362.0.

Lake Sharpe was maintained between a minimum elevation of 1419.5 and a maximum of 1421.5 feet msl. At the beginning of the period, the Oahe pool was near elevation 1612.0 feet msl, 4.5 feet above the base of annual flood control. It reached a record elevation of 1618.5 feet msl on May 16, 0.2 foot higher than the previous record set in 1984. This remained the record pool elevation until 1995.

Garrison releases began the period at 28,000 cfs and were gradually decreased to 14,000 cfs by the end of April. To keep the Oahe pool from filling higher, Garrison releases were reduced to 10,000 cfs by early May. Releases were maintained at this level until they were gradually increased in early June. The Garrison pool rose 4 feet in May, 6 feet in June and 2 feet in July, cresting at elevation 1848.7 feet msl.

At Fort Peck, the pool was near elevation 2229.1 feet msl at the beginning of the 1986 navigation season. This was 4.9 feet below the base of the annual flood control space and 6.9 feet lower than in 1985. The pool had been intentionally drawn down below normal levels to provide shoreline revegetation for improved fish spawning habitat. The pool refilled to the base of the annual flood control zone by the end of June and continued a gradual climb to elevation 2238.3 by the end of December.

REGULATION OF 1993 RUNOFF

During 1993, runoff above Sioux City totaled 36.2 maf, the sixth highest on record and fifth highest since main stem regulation began. Downstream from Sioux City to the mouth of the Missouri River, runoff during 1993 was an unprecedented 111.8 maf, which was 255 percent of average. Upstream from Sioux City, runoff was 147 percent of normal. Six consecutive years of below normal runoff in the upper Missouri River basin ended dramatically in 1993. System storage began 1993 at 42.7 maf, the second lowest January level since the system initially filled in 1967. System storage for the year crested at 57.2 maf on September 7 near the base of the annual flood control zone. Low releases from the main stem system because of the Great Flood of 1993 had a significant impact on the accumulation of storage during July through September. The Great Flood of 1993 with its widespread, severe downstream flooding, and above normal upstream inflows not only ended the 6-year drought but nearly refilled the main stem reservoir system to normal levels, a feat that under normal runoff conditions would have taken more than 6 years. Over 4.4 billion dollars in damages prevented resulted from the regulation of the main stem dams, the second highest to date.

Gavins Point releases averaged 11,200 cfs in April, 17,600 cfs in May, 17,000 cfs in June, and 8,000 cfs in July. April, May, and July monthly average releases were the lowest since the system reached normal operating levels in 1967. Daily average releases ranged from a minimum of 6,000 cfs in early July to a maximum of 24,300 cfs during late May and early June when cyclic peaking for endangered species was taking place.

Releases at Fort Randall averaged 7,600 cfs in April, 13,300 cfs in May, 13,900 cfs in June and 2,600 cfs in July. Releases during May and July were new record lows. Daily average releases varied between 26,000 cfs in late May and 600 cfs in July. At the beginning of the navigation season, the pool level was near elevation 1357.0 feet msl, climbing to a crest of 1361.0 by the end of July.

Lake Sharpe was maintained between elevations 1420.2 and 1421. 2 feet msl. At Oahe, the pool was near elevation 1592 at the start of the year. It climbed to a crest of 1611.6 feet msl in September, gaining nearly 20 feet and reaching 4.1 feet into the flood control pool.

Garrison releases averaged only 10,300 cfs during April, setting a new record low for the month. Beginning in mid-May the daily average release from Garrison was set at 16,000 cfs to establish a base flow condition for authorized purposes and endangered birds nesting below the project. In mid-July, releases were reduced to the 12,000 to 15,000 cfs range to safeguard threatened and endangered birds and to help balance intra-system storage. The July monthly average release of

14,800 cfs was also a new record low. Lake Sakakawea rose gradually from elevation 1819.5 feet msl at the beginning of the navigation season to a crest of 1837.8 feet msl in November, 0.3 feet into the annual flood control pool.

Releases from Fort Peck averaged 6,000 cfs in April, increased to 7,000 cfs during May and June, then lowered in July to 4,000 cfs to safeguard threatened and endangered birds. Near the beginning of the navigation season, the Fort Peck pool was at elevation 2211.3 feet msl. It rose to a crest of 2228.4 feet msl in September, still 5.6 feet below the base of the annual flood control pool.

REGULATION OF 1995 RUNOFF

Runoff above Sioux City during 1995 totaled 37.6 maf, the third highest year on record (1898-1997). System storage was at the desired 57.2 maf, the top of the carryover multiple use zone on November 1, 1994. During the winter months, inflows to the system were below normal and the system storage fell slightly to 55.9 maf. System storage made its most impressive gains of the year in June from the cold and wet spring that caused a month delay in the melt of the mountain snow. The May storage gain of 4.4 maf was the highest June gain since the system filled in 1967. Peak system storage of 68.1 maf occurred on July 27. End of July storage was the highest since 1978. Record high pool elevations occurred at Gavins Point, Fort Randall and Oahe. Flood damages prevented exceeded 1.8 billion dollars.

Gavins Point releases were held near 17,000 cfs until mid-March, when flow support for the navigation season began as releases were gradually increased to 26,500 cfs. In April, Gavins Point releases were reduced to 12,000 cfs to reduce the threat of flooding downstream. By the end of May, releases were increased to 25,000 cfs as downstream flooding subsided. By the end of June releases from Gavins Point were increased to 35,000 cfs (power plant capacity). This was the first time since 1988 that full power plant release was made from Gavins Point. Spillway releases were added near the end of July and gradually increased to a total release of about 54,000 cfs in August. Releases were maintained near this level through the fall. In November, the maximum daily release of 56,100 cfs occurred. These high releases were made to evacuate the accumulated flood storage. Lewis and Clark Lake was targeted for elevation 1206 feet msl throughout the spring and summer of 1995. The pool elevation ranged from 1205.8 to a record high pool elevation of 1209.5 feet msl in May. This elevation was within 0.5 foot of overtopping the spillway gates as the May runoff in the reach from Fort Randall to Gavins Point was the highest of record.

Releases from Fort Randall generally paralleled those from Gavins Point. However, during the flood control operation from mid-April through early June, daily average releases were less than 10,000 cfs for all but 9 days. Releases from Fort Randall were completely shut off on May 30. By June 1, Lake Francis Case rose to an elevation of 1367.9 feet msl, the highest elevation since closure of the dam in 1952 (2.9 feet into the ten foot exclusive flood control zone). Lake Francis Case pool elevation gradually decreased reaching 1359.4 feet msl by the end of July and 1338.3 by the end of November as releases were increased to a maximum of 53,000 cfs by November.

At Oahe and Big Bend, daily average releases were well below normal during April through June to prevent flooding downstream. Oahe's releases averaged only 1,900 cfs in May, a record low. In June releases averaged 11,100 cfs. These low releases in conjunction with high inflows resulted in a record high pool level of 1618.7 feet msl on June 25. Releases were increased through the remainder of the summer and into the fall with a maximum daily release of 48,500 cfs in August. Evacuation of the flood storage gradually brought the pool elevation down to 1608.2 by the end of December. Big Bend pool levels were maintained between elevations 1419.4 and 1421.8 feet msl during this period.

Garrison releases averaged 12,300 cfs for the month of April, the fourth lowest on record. Releases were cycled from mid-May through early July to prevent endangered and threatened birds from nesting too low below Garrison. During May, the cycle was 1 day at 16,000 cfs followed by two days of 13,000 cfs. The cycling pattern was modified as Oahe's pool continued to climb. By June the cycle was 2 days at 10,000 cfs followed by 1 day at 13,000 cfs. During 1995 the pool at Lake Sakakawea climbed over 15 feet to elevation 1851.9 feet msl in August, the third highest pool elevation on record. Releases to evacuate flood control storage began in August. In September, the maximum daily release of 37,500 cfs was made and releases were maintained near power plant capacity through the fall.

Releases from Fort Peck averaged 5,800 cfs in April to support fish spawning below the dam. In May, releases were increased to near 7,000 cfs and remained at this level through the end of July. At the beginning of the navigation season, the elevation of the Fort Peck pool was 2231.5 feet msl. It rose gradually to a peak elevation of 2244.2 feet msl in August, which is 10 feet into the annual flood control and multiple use zone. Releases near power plant capacity were made through the fall with a maximum daily release of 14,900 cfs in October to gradually draw the pool down to elevation 2238.3 by the end of December.

REGULATION OF 1996 RUNOFF

Runoff in the Missouri River basin above Sioux City in 1996 was 35.6 MAF, very near the total runoff experienced in 1975 and 45 percent above normal. Although the runoff was less than in 1993 and 1995, peak stages on the river below the main stem system were higher in many cases than the 1993 and 1995 peaks. The high river stages were the result of both a very large snowmelt runoff and high flows on tributaries downstream of the system from rainfall events.

Evacuation of 1995's high runoff continued throughout the winter months of 1995-1996 and the system storage was on target to be at the base of the annual flood control pool by the first of March. However, an early, rapid melt of the heavy plains snowpack on frozen ground resulted in a record February runoff in the upper basin, 340 percent of normal. And while runoff was pouring into the main stem dams, snow was continuing to build in the mountains. The mountain snowpack continued to accumulate into early May peaking nearly 20 percent above the normal peak accumulation.

System storage declined to as low as 58.1 MAF in late January and early February, but was 60.2 MAF on March 1, nearly 3 MAF above the base of the annual flood control pool. Despite record releases from February to April, high inflows from the rapid melt of the mountain snowpack poured tremendous amounts of water into the system. The peak system storage occurred on July 7 at 68.5 MAF, 0.4 MAF higher than 1995's maximum.

Near the end of April, very heavy rain fell across southeastern Missouri, marking the end of a relatively dry period in the lower basin, and the beginning of a series of very heavy rainfall events below the main stem system. The heavy rains began in Missouri and gradually moved upstream as the summer progressed with much of the heaviest rain, including several events with as much as 6 to 12 inches, falling along the Missouri River in eastern Nebraska and western Iowa.

Gavins Point releases were held near 20,000 cfs until early February and then gradually increased to full power plant capacity by mid-March. Spillway flows were initiated in early April, and by early May releases had hit 45,000. Releases were reduced several times during May, June and July as significant downstream rainfall events occurred. Between storms in June, releases reached 50,000 cfs and by July 1, they reached 52,000 cfs where they remained until late fall. The releases reached their maximum of the year, 55,000 cfs, in early November after tributary flows had declined and cooler water temperatures made the additional increases possible without increasing stages downstream.

Releases from Fort Randall generally paralleled those from Gavins Point. Average daily releases during the year varied between 9,100 cfs in late May while system releases were cut back for downstream flood control, to 53,000 cfs in November for flood storage evacuation. Lake Francis Case peaked out for the year on June 28 at 1361.49 feet msl, 3.5 feet below the base of the exclusive flood control pool.

Lake Oahe was drawn down to within 0.4 feet of the base of the annual flood control pool prior to February's record runoff, then gained 3.5 feet, to 1611.1 feet msl by March 1. The pool continued on a steady rise through the early part of the summer as the mountain snow melt poured into the upper reservoirs and system releases were restricted due to downstream flooding. The pool crested at elevation 1618.67 feet msl on June 23, nearly identical to 1995's record crest and 1.7 feet into the exclusive flood control pool. Flood storage evacuation continued through the fall and before being cutback prior to the winter freeze-in. The pool ended the year at 1607.5 feet msl, the base of the annual flood control pool.

Lake Sakakawea reached the base of its annual flood control pool in early February, but high inflows during the month caused the lake elevation to climb to 1839.6 feet msl by March 1, 2.1 feet in to the annual flood control pool. The largest gains of the year, though occurred during June as the snowmelt runoff entered the system. Lake Sakakawea crested at elevation 1849.56 feet msl on July 23, just 0.4 feet from the exclusive flood control zone. High releases through the summer and fall lowered the pool to 1838.9 feet msl by the end of December, 1.4 feet into the annual flood control pool.

Fort Peck Lake was drawn down to within 2.6 feet of the base of the annual flood pool prior to February's high inflow, but rose to 2238.0, four feet into the annual flood control pool by March 1. The lake peaked out for the year at 2247.3 feet msl, 1.3 feet into the exclusive flood control pool. Releases varied between 3,000 cfs, due to flooding in the Williston, ND area during March, and 16,400 cfs for flood storage evacuation during July. Fort Peck Lake ended the year at 2236.0 feet msl, still 2 feet into the annual flood control pool.

REGULATION OF 1997 RUNOFF

Following three of four near record runoff years, 1997 was yet another year of record runoff, breaking all previous runoff records in the upper basin.

Unprecedented winter snows accumulated over the plains during the winter months. Snow accumulations began in October and the winter was extremely harsh throughout the upper basin both in relation to cold temperatures and snow accumulation. In the mountains, fall accumulations were also ahead of schedule, but the heavy January accumulation was the first indicator of a much above normal winter mountain snow pack. Winter snows continued and by April 15, when the maximum mountain snowpack normally occurs, total accumulation was between 35 and 40 percent above normal in the reaches upstream from Fort Peck and Garrison.

Runoff into the reservoir system resulting from the large winter snow accumulation was unusually large. Record and near record inflows occurred during each of the first 7 months of the year. The January-February runoff exceeded the maximum set just one year earlier and the March-April total runoff exceeded the 1952 historic maximum. May and June runoff were the fourth and third largest runoffs respectively in the 100 years for which runoff records have been developed and the May-June-July runoff was second only to the record 1975 runoff. Only two of the months, January and March, were by themselves maximum of records. The combined runoff for the March through July period, commonly the greatest runoff period, totaled 36.8 maf, 17 percent greater than the previous maximum set in 1978. The total annual runoff was 49.0 maf, 199 percent of average and 21 percent greater than the previous annual maximum which was experienced in 1978.

Water control personnel forecasted near record reservoir inflows. In response to the expected large inflows, system releases were increased to record levels early in the year and were maintained at rates significantly higher than previous levels. January releases were near historic highs and, beginning in February, record high releases began and continued throughout the remainder of the year. For the January-July period, system releases were 183 percent of average and 32 percent greater than the previous record for the period set just one year earlier. The Oahe and Fort Randall projects climbed into their exclusive flood control pools during March and April respectively, in response to the unprecedented runoff from the record plains snowpack whose melt was speeded by warmer than normal temperatures. Fort Peck and Garrison releases were minimized early in the runoff period, to the extent possible, to stem the rise in Oahe and Fort Randall pools.

The reservoirs formed by the Oahe and Fort Randall dams climbed rapidly, Oahe entering its

exclusive flood control pool on March 28th. Fort Randall soon followed, reaching its exclusive pool on April 5th. Oahe climbed from a winter minimum level of 1607.5 to 1618.6 by early May, rising a total of 8 feet during the month of March alone. Fort Randall climbed from a late winter level of 1353 to a maximum of 1372.2 on May 7 (7.2 feet into its ten foot exclusive flood control zone), a level 4.3 feet higher than the previous maximum, set in 1995.

The melt of the mountain snowpack began in earnest during May, nearly a month later than normal, and occurred over a shorter than normal period due to relatively warm temperatures. Releases from both Fort Peck and Garrison Dams were increased significantly. Garrison's release was set at 59,000 cfs, the second highest rate of record. The historic maximum of 65,200 cfs occurred in 1975. Increases at Fort Peck were made later and were at a lower rate to help evacuate Garrison. Both were set at a rate that would result in the evacuation of the flood pool by the beginning of the upcoming flood season. Fort Peck releases were the fourth highest of record and the highest since 1979.

Fort Peck and Garrison reservoirs filled to the top of the their exclusive flood control zones and infringed slightly into their surcharge pools while performing significant flood control during the unprecedented runoff period. Garrison reservoir was peaking near elevation 1853 when a 6 inch rainfall in the reservoir area occurred which resulted in the pool reaching 1854.4 feet msl on July 4, 1997, slightly overtopping the spillway gates. This elevation was slightly less than 1854.8 feet msl experienced in 1975. Fort Peck reached an elevation of 2250.31 feet msl on July 23, 1997, 1.3 feet less than the 2251.6 feet msl record peak which occurred in July 1975. Some of the rise in Fort Peck was due to release reductions to stem the rise at Garrison. In addition, evacuation of flood storage in USBR tributary reservoirs was also delayed to halt Garrison's pool rise.

System releases were maintained at record levels beginning in early February in order to maintain, to the extent possible, sufficient flood storage space to store the forecasted large runoffs. In spite of high downstream river stages, reservoir releases were continued at unprecedented rates throughout the period, reaching 58,000 cfs by late April. Flows were gradually increased, as downstream runoff and river stage forecasts permitted, to 70,000 cfs, the highest on record. The January through July system release was 83 percent greater than normal and was 32 percent higher than the record set just one year earlier. The record high releases are scheduled to continue throughout the open water period to evacuate the stored flood waters in preparation for the 1998 flood season.

The 1997 runoff was the greatest flood control test of the main stem system to date. Early releases precluded extensive basin damage but the high flows resulted in nearly 70,000 crop land acres not planted from Sioux City to St. Joseph along the Missouri River. Also, extensive erosion damage between and on the reservoirs occurred. Annual flood damages prevented were 5.2 billion, the largest to date.

DAILY ROUTING MODEL (DRM)

Computer model simulation studies have been used by the Reservoir Control Center since the 1960's to simulate the operation of the main stem reservoir system using a long-term hydrologic record. Prior to 1997, the Reservoir Control Center had used the Long Range Study Model (LRS) to simulate Missouri River Main stem reservoir operations. The LRS model was developed to evaluate regulation criteria for operation of the main stem reservoirs for all authorized purposes under widely varying hydrologic conditions. Although the LRS model simulates the operating criteria for each of the main stem projects, it utilizes only historical monthly data and is not used for real-time day-to-day regulation. Development of a Daily Routing Model (DRM) was completed in 1997. The DRM uses historical daily data and is being used for the Master Water Control Manual Update Study. Model results have been evaluated for this analysis and found to be of value with the recently added ability to integrate forecasted runoff. The DRM was used in the analysis presented in this report.

Simulation in the DRM model consists of 20 nodes, including the six main stem dams and 14 gaging stations located at; Wolf Point and Culbertson, Montana; Williston and Bismarck, North Dakota; Sioux City, Iowa; Omaha, Nebraska City, and Rulo, Nebraska; St. Joseph, Kansas City, Waverly, Boonville, and Hermann, Missouri. Input data consist of historic reach inflows, stream flow depletions, evaporation data, downstream flow targets, reservoir characteristics including operational levels, routing factors, operational guide curves, power generation criteria, navigation guide criteria, and endangered species flow criteria.

Depletions for each reach upstream from Sioux City were estimated by the Bureau of Reclamation in 1987. These data were reviewed by the Reservoir Control Center and adjusted using data from the "Missouri River Basin Hydrology Study -Final Report" by the Missouri Basin States Association. Depletions upstream from Sioux City were estimated to average 4.8 million acre feet (MAF) per year, exclusive of main stem reservoir evaporation estimated at 1.7 maf per year. At the mouth, depletions were estimated to average 12 MAF per year without main stem reservoir evaporation.

Navigation guide criteria determines the flows and season length for navigation based on the system storage on March 15 and July 1. Four specific downstream navigation flow target locations are used: Sioux City, Omaha, Nebraska City, and Kansas City. Determination of whether navigation flows will be full service, minimum service, or an intermediate level is based on system storage values on March 15. For the current water control plan, if the system storage is above 54.5 MAF on March 15, full service navigation flows are provided. If the system storage value is below 46.0 MAF on March 15, minimum service navigation flows are provided. If the system storage value is between 54.5 and 46.0 MAF on March 15, a linear interpolation between the system storage value and the navigation service level is used to determine the navigation flow targets. On July 1, both the navigation service level and navigation season length are determined. For the current water control plan, if the system storage value is at or above the 41 MAF on July 1, the navigation season length is set at 8 months. When the system storage on July 1 is below 25 MAF, a 5.5 month navigation season is determined. Between these two levels, the navigation season length is determined by linear

interpolation.

Based on the discussion presented previously, it was reasoned that frequency estimates should be based on both the historical record of actual system regulation experience and on the long-term reservoir operation studies. The most recent long-term study reflecting current operation utilizing the DRM model is referred to as study CWCP(Current Water Control Plan). This study was completed as part of the Missouri River Master Water Control Manual Review and Update studies and is documented in Volume 24: Reservoir Regulation Studies-Daily Model Studies dated August 1998. That study contains the experienced hydrologic record extending from 1898 through 1997 and reflects, to the degree possible in long-term studies of this type, regulation criteria at the current (1997) level, as well as Missouri Basin water resource development current to the last year of the study which is 1993. The results of the daily model (DRM) were reviewed for this analysis as well. Significant short term differences have been noted between model results and actual operations for the recent flood years. Hydrologic data for the DRM model was extended to include daily reach inflows through 1997.

FORT PECK

HISTORICAL RECORDS

Historical records for Fort Peck pool elevations and releases date back to 1937, when the dam was first closed. It was not until the main stem system filled in June of 1967 that the records reflected normal system operation. During the period of 1967 through 1997, the pool elevation has ranged from a low of 2208.7 ft msl in April of 1991 to a maximum of 2251.6 ft msl in July of 1975, a range of almost 43 feet. The average annual pool elevation since 1967 is 2234.9 ft msl with a standard deviation of the annual means being 9.8 feet. Daily releases from Fort Peck have ranged from a low of zero cfs for one day in April of 1978 to a high of 35,400 cfs in July of 1975. Daily release has averaged 10,100 cfs since 1967 with a standard deviation in the annual mean discharge of 3,900 cfs. Figure 2 shows the ovserved daily pool elevations and releases from Fort Peck for the period since the main stem system was first filled. Daily maximum, minimum and mean values of pool elevation and releases for each month are listed in Table 2.

Table 2
Fort Peck Pool & Release Historical Records (06/1967-12/1997)

Month	Pool Elevation (ft msl)			Daily Release (cfs)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Jan	2245.1	2209.3	2233.0	15,600	6,500	11,600
Feb	2244.4	2208.8	2231.9	15,500	4,800	12,200
Mar	2246.2	2208.8	2232.0	15,600	1,000	9,000
Apr	2247.3	2208.7	2233.2	25,100	0	8,100
May	2247.7	2209.3	2234.5	28,900	2,800	9,600
Jun	2250.0	2212.5	2236.9	35,100	3,000	10,600
Jul	2251.6	2212.5	2238.5	35,400	3,000	10,900
Aug	2250.1	2211.4	2237.8	35,200	3,800	10,800
Sep	2248.5	2211.4	2236.8	20,500	2,700	9,900
Oct	2248.0	2211.4	2236.1	21,800	2,700	9,300
Nov	2246.3	2210.9	2235.3	22,300	2,700	9,600
Dec	2245.4	2209.6	2234.2	16,000	4,500	10,200
Annual	2251.6	2208.7	2234.9	35,400	0	10,100

POOL & RELEASE DURATION

Pool duration and release duration relationships were developed using the DRM which used data from 1898 to 1997. Figure 3 shows the pool duration relationship for Fort Peck, while Figure 4 shows the release duration relationship. Both Figure 3 and Figure 4 show the DRM data along with the observed data. Table 3 shows the pool elevation and release for various percentages of time in which the values are equaled or exceeded.

Table 3
Fort Peck Pool & Release Duration Characteristics

Percent of Time Equaled or Exceeded	Pool Elevation (ft msl) DRM	Release (cfs) DRM
Maximum	2250.0	35,000
1	2245.5	22,000
5	2243.2	17,500
10	2242.1	15,000
20	2238.0	12,500
50	2234.9	9,500
80	2219.9	3,500
90	2201.9	3,100
95	2177.6	3,000
99	2165.7	2,800
100	2160.4	2,400

POOL PROBABILITY

In 1975, the maximum pool elevation of 2251.6 feet msl was recorded at Fort Peck. Results of the DRM indicate that the peak daily pool for 1975 would be 2248.3 feet msl which would rank as the sixth highest out of the 100 years of simulated record. DRM results also indicate that the maximum daily pool elevation of 2250.0 feet msl during the simulation period would occur during 1997. Extrapolation of the eye-fit curve between the observed and simulated data based on the shape of the curve from the observed data indicates a reasonable pool-probability relationship. Therefore, this curve was adopted for the Fort Peck Pool Probability relationship. Results are shown in Table 4 and on Figure 5.

Table 4
Fort Peck Pool Probability Relationship
Pool Elevations in Feet MSL

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Simulated (1898-1997)	Adopted
50	2240.0	2242.0	2240.0	2241.5
20	2246.5	2246.5	2244.9	2246.5
10	2249.0	2249.0	2247.5	2249.0
2	2251.0	2252.7*	2249.5	2251.0
1	2252.0	2254.0*	2250.0	2252.0
0.2	2253.0	2256.5*	2251.0*	2253.0

* extrapolated: Max Observed is 2251.6

RELEASE PROBABILITY

The maximum observed release from Fort Peck was 35,400 cfs in 1975. Results of the DRM indicate that the maximum daily outflow of 35,000 cfs would be reached during eleven years, 1898, 1908, 1909, 1913, 1916, 1917, 1927, 1948, 1953, 1975, and 1997. The actual maximum for 1997 was 22,300 cfs. The difference stems from the lack of runoff forecasting by the DRM and as a result cannot prerelease water. Both the observed and simulated curves indicated a relatively flat curve with a discharge near 15,000 cfs (near power plant capacity) from the 70 percent chance exceedance to the 20 percent chance exceedance range. The observed remained flat until the 20 percent chance exceedance while the simulated moved to the 30,000 cfs range in a somewhat linear fashion. For events less frequent, both curves showed an abrupt breakpoint at 10 percent value. Values of 35,000 cfs occurred near the 3 percent chance of exceedance for the observed, and 10 percent for the simulated data. A straight line was assumed from the 20 percent to the 0.2 percent and slope steepened between the 2 and 0.2. This curve was used to define the adopted release-probability relationship. Results are shown in Table 5 and on Figure 6.

Table 5
Fort Peck Release Probability Relationship
Discharges in CFS

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Simulated (1898-1997)	Adopted
50	15,000	14,700	16,300	15,000
20	15,000	15,400	18,400	17,000
10	15,000	24,000	24,400	22,000
2	28,000	40,000*	34,800	29,000
1	35,000	50,000*	34,900	35,000
0.2	50,000	70,000*	35,000*	50,000

* extrapolated: Max Observed is 35,200

GARRISON

HISTORICAL RECORDS

Historical records for Garrison pool elevations and releases date back to 1953, when the dam was first closed. It was not until the main stem system filled in June of 1967 that the records reflected the system operation. During the period of 1967 through 1997, the pool elevation has ranged from a low of 1815.0 ft msl in May of 1991 to a maximum of 1854.8 ft msl in July of 1975, a range of almost 40 feet. The average annual pool elevation since 1967 is 1838.2 ft msl with a standard deviation of the annual means being 8.6 feet. Daily releases from Garrison have ranged from a low of 4,100 cfs in March of 1997 to a high of 65,200 cfs in July of 1975. Daily release has averaged 22,800 cfs since 1967 with a standard deviation in the annual mean discharge of 8,400 cfs. Figure 7 shows the observed daily pool elevations and releases from Garrison for the period since the main stem system was first filled. Daily maximum, minimum and mean values of pool elevation and releases for each month are listed in Table 6.

Table 6
Garrison Pool & Release Historical Records (06/1967-12/1997)

Month	Pool Elevation (ft msl)			Daily Release (cfs)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Jan	1845.3	1816.9	1835.8	34,200	12,700	24,500
Feb	1843.6	1815.7	1834.3	36,000	11,000	25,800
Mar	1847.9	1815.5	1834.4	37,800	4,100	20,800
Apr	1847.7	1815.3	1836.0	39,100	8,700	19,900
May	1848.0	1815.0	1836.7	41,200	9,100	22,400
Jun	1853.7	1817.9	1839.7	50,100	9,500	24,000
Jul	1854.8	1822.0	1842.9	65,200	9,500	25,900
Aug	1854.6	1821.1	1842.4	65,100	12,100	25,600
Sep	1851.3	1820.9	1840.9	50,100	6,000	22,000
Oct	1848.2	1820.9	1840.0	49,700	9,200	20,900
Nov	1847.4	1821.2	1839.1	50,100	9,300	21,600
Dec	1846.8	1818.8	1837.6	39,100	12,500	21,600
Annual	1854.8	1815.0	1838.2	65,200	4,100	22,800

POOL & RELEASE DURATION

Pool duration and release duration relationships were developed using the DRM which used data from 1898 to 1997. Both Figure 8 and Figure 9 show the DRM data along with the observed data. Figure 8 shows the pool duration relationship for Garrison, while Figure 9 shows the release duration relationship. Table 7 shows the pool elevation and release for various percentages of time in which the values are equaled or exceeded.

Table 7
Garrison Pool & Release Duration Characteristics

Percent of Time Equaled or Exceeded	Pool Elevation (ft msl) DRM	Release (cfs) DRM
Maximum	1854.2	60,000
1	1851.6	52,500
5	1849.2	42,300
10	1846.6	38,100
20	1844.3	32,000
50	1838.6	24,000
80	1822.2	18,100
90	1814.3	14,000
95	1794.4	12,700
99	1784.5	11,300
100	1776.5	5,100

POOL-PROBABILITY

The maximum pool elevation recorded for Lake Sakakawea was 1854.8 ft msl during 1975. In 1997, the second highest pool of record occurred with an elevation of 1854.4 ft msl. Results of the DRM simulation indicated that the 1975 event would rank seventh out of 100 years of record with a maximum daily pool elevation of 1852.9 ft msl. The DRM also indicated that the maximum daily pool elevation would be 1854.2 ft msl based on the 1997 event. Pool probability curves were eye-fit through the observed, and simulated data. The curves had similar shapes which compared favorably with the results of the 1976 study. Results of this analysis are shown in Table 8 and on Figure 10.

Table 8
Garrison Pool-Probability Relationship
Pool Elevations in Feet MSL

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Simulated (1898-1997)	Adopted
50	1845.0	1847.0	1845.3	1848.0
20	1850.0	1850.5	1849.2	1850.5
10	1852.0	1852.0	1850.6	1852.0
2	1853.5	1854.3	1852.2	1854.0
1	1854.0	1855.0*	1854.2	1854.5
0.2	1855.0	1856.0*	1855.0*	1855.5

*extrapolated: Max Observed is 1854.8

RELEASE-PROBABILITY

The maximum release from Garrison was 65,200 cfs during 1975. In 1997, a release of 59,100 cfs was made. Results of the DRM indicated that the 1975 discharge would tie 189 other days for the highest release of 60,000 cfs. Both the eye fit curves for the observed and simulated events showed a negatively skewed curve becoming asymptotic to the full power plant capacity discharge of about 40,000 cfs in the range of about 50 to 20 percent chance exceedance. The simulated values show a distinct breakpoint occurring between the 20 and 10 percent chance exceedance range with a negative skew becoming asymptotic to the maximum release assumed in the model of 60,000 cfs for events less frequent than a 1 percent chance of exceedance. The 60,000 cfs limit imposed on the model is the channel capacity downstream from Garrison Dam. The adopted release probability curve was based on a straight line eye-fit favoring the observed over the simulated data for events less frequent than 20 percent, transitioning to the full power plant capacity at the 50 percent event. Results are shown in Table 9 and on Figure 11.

Table 9
Garrison Release Probability
Discharge in CFS

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Simulated (1898-1997)	Adopted
50	38,000	32,000	39,700	39,000
20	39,000	39,000	51,200	42,000
10	43,000	45,000	59,600	45,000
2	61,000	55,000	59,800	68,000
1	70,000	60,000	60,000	76,000
0.2	90,000	70,000*	60,000*	90,000

* extrapolated: Max Observed is 65,200

OAHE

HISTORICAL RECORDS

Historical records for Oahe pool elevations and releases date back to 1958, when the dam was first closed. It was not until the main stem system filled in June of 1967 that the records reflected the system operation. During the period of 1967 through 1997, the pool elevation has ranged from a low of 1580.7 ft msl in November of 1989 to a maximum of 1618.7 ft msl in June of 1995, a range of almost 38 feet. The average annual pool elevation since 1967 is 1604.8 ft msl with a standard deviation of the annual means being 8.7 feet. Daily releases from Oahe have ranged from a low of zero cfs during many years to a high of 59,300 cfs in July of 1997. Daily release has averaged 25,400 cfs since 1967 with a standard deviation in the annual mean discharge of 12,600 cfs. Figure 12 shows the observed daily pool elevations and releases from Oahe for the period since the main stem system was first filled. Daily maximum, minimum and mean values of pool elevation and releases for each month are listed in Table 10.

Table 10
Oahe Pool & Release Historical Records (06/1967-12/1997)

Month	Pool Elevation (ft msl)			Daily Release (cfs)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Jan	1609.5	1582.0	1601.1	54,000	800	21,800
Feb	1611.2	1583.5	1602.7	45,600	0	19,000
Mar	1617.9	1585.9	1605.1	57,400	0	18,800
Apr	1618.4	1586.6	1607.1	59,100	0	22,800
May	1618.6	1587.1	1607.8	52,500	0	24,000
Jun	1618.7	1588.1	1608.1	54,300	0	26,400
Jul	1618.6	1587.5	1607.8	59,300	0	31,400
Aug	1618.3	1584.5	1606.4	58,900	0	34,600
Sep	1617.5	1583.2	1604.4	54,500	200	31,100
Oct	1616.9	1580.9	1602.8	57,500	0	26,400
Nov	1615.9	1580.7	1601.8	57,700	0	24,500
Dec	1612.5	1582.1	1601.3	56,700	0	22,500
Annual	1618.7	1580.7	1604.8	59,300	0	25,400

POOL & RELEASE DURATION

Pool duration and release duration relationships were developed using the DRM which used data from 1898 to 1997. Both Figure 13 and Figure 14 show the DRM data along with the observed data. Figure 13 shows the pool duration relationship for Oahe, while Figure 14 shows the release duration relationship. Table 11 shows the pool elevation and release for various percentages of time in which the values are equaled or exceeded.

Table 11
Oahe Pool & Release Duration Characteristics

Percent of Time Equaled or Exceeded	Pool Elevation (ft msl) DRM	Release (cfs) DRM
Maximum of record	1619.5	60,000
1	1618.3	58,600
5	1615.8	48,200
10	1613.2	40,000
20	1610.2	34,200
50	1604.3	24,300
80	1593.6	15,900
90	1583.7	9,900
95	1565.3	4,200
99	1555.6	3,300
100	1549.5	3,000

POOL-PROBABILITY

During 1995 and 1996, the maximum pool of record, elevation 1618.7 ft msl, occurred at Oahe. The third highest observed pool of 1618.6 ft msl occurred in 1997. Fourth and fifth highest observed pools of 1618.5 ft msl and 1618.3 ft msl occurred in 1986 and 1984, respectively. Based on the DRM, 161 days equaled or exceeded an elevation 1619.0 ft msl during the 100 year simulation, 1915, 1927, 1984, 1986, 1995, and 1997. Eye fit curves were quite similar for the observed and simulated pool elevations and compared quite favorably to the results of the 1976 study at higher pool levels. Results of this analysis are shown in Table 12 and on Figure 15.

Table 12
Oahe Pool-Probability Relationship
Pool Elevations in Feet MSL

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Simulated (1898-1997)	Adopted Average Daily
50	1610.0	1613.0	1610.7	1613.0
20	1615.0	1617.0	1617.3	1617.0
10	1617.0	1618.0	1618.7	1618.1
2	1619.0	1619.1*	1619.4	1619.5
1	1620.0	1619.5*	1619.5	1620.0
0.2	1621.0	1620.0*	1619.6*	1621.0

* extrapolated: Max Observed is 1618.7

RELEASE-PROBABILITY

The maximum daily release from Oahe was 59,300 cfs in 1997. The second highest daily release of 57,500 cfs occurred in 1975. Results of the DRM indicate that the 1975 event would tie with 388 other days for the maximum daily release of 60,000 cfs. In some years, maximum daily and maximum hourly releases can vary significantly, since Oahe is operated to meet peak power demands. It is not likely that releases greater than power plant capacity would be made at Oahe unless required for emergency evacuation of storage, or to prevent overtopping of the spillway tainter gates. Since the pool-probability relationship indicated that the 1 percent chance exceedance pool would equal the top of the spillway tainter gates, it is not likely that the spillway gates or outlet works would be open under this condition. If all the gates were opened one foot, the spillway discharge would be about 12,000 cfs. Adding this discharge to the full power plant capacity would yield a total discharge near 70,000 cfs for the 1 percent chance exceedance event, which is consistent with the 1976 study assumptions. Therefore, 70,000 cfs was adopted for the 1 percent chance exceedance event and the adopted curve transitioned through the curve developed from maximum hourly releases. Although the annual event results in a discharge higher than the listed power plant capacity of 54,000 cfs, releases in excess of the rated capacity can occur during periods of higher than normal pool elevations or for short durations of high releases not sufficient to fill downstream channel storage and increase the tailwater significantly. Results of this analysis are shown in Table 13 and on Figure 16. For the last nine years, the maximum hourly flow, peak flow, has been collected. Oahe is a big power generating facility and as a result, the hourly discharge can very significantly to meet peak power demands. This change in hourly discharge is normally around 30,000 to 40,000 cfs but can be as high as 58,000 cfs above the average daily release.

Table 13
Oahe Release Probability Relationship
Discharge in CFS

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Simulated (1898-1997)	Adopted
50	57,500	50,000	50,300	56,000
20	57,500	54,000	58,500	57,000
10	57,500	55,000	59,500	57,500
2	65,000	60,000*	59,800	65,000
1	70,000	62,000*	60,000	70,000
0.2	85,000	67,000*	61,000*	85,000

* extrapolated: Max Observed is 59,300

BIG BEND

HISTORICAL RECORDS

Historical records for Big Bend pool elevations and releases date back to 1963, when the dam was first closed. It was not until the main stem system filled in June of 1967 that the records reflected the system operation. During the period of 1967 through 1997, the pool elevation has ranged from a low of 1414.7 ft msl in September of 1967 to a maximum of 1422.1 ft msl in June of 1991, a range of about 7 feet. The average annual pool elevation since 1967 is 1420.3 ft msl with a standard deviation of the annual means being 0.5 feet. Daily releases from Big Bend have ranged from a low of zero cfs during most years to a high of 74,300 cfs in July of 1997. Daily release has averaged 25,400 cfs since 1967 with a standard deviation in the annual mean discharge of 14,500 cfs. Figure 17 shows the observed daily pool elevations and releases from Big Bend for the period since the main stem system was first filled. Daily maximum, minimum and mean values of pool elevation and releases for each month are listed in Table 14.

Table 14
Big Bend Pool & Release Historical Records (06/1967-12/1997)

Month	Pool Elevation (ft msl)			Daily Release (cfs)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Jan	1421.7	1419.0	1420.4	56,500	0	21,800
Feb	1421.4	1419.4	1420.4	57,300	0	19,300
Mar	1421.6	1417.8	1420.3	69,200	0	19,800
Apr	1421.9	1417.7	1420.4	68,000	0	23,100
May	1421.8	1418.9	1420.4	55,700	0	24,400
Jun	1422.1	1418.2	1420.3	71,000	0	26,700
Jul	1421.2	1418.7	1420.3	74,300	0	30,600
Aug	1421.2	1417.8	1420.2	67,100	0	33,900
Sep	1421.8	1414.7	1420.3	66,100	0	30,600
Oct	1421.7	1414.9	1420.3	65,700	0	25,900
Nov	1421.5	1418.8	1420.4	63,700	0	24,500
Dec	1421.4	1418.1	1420.4	58,600	0	22,400
Annual	1422.1	1414.7	1420.3	74,300	0	25,400

POOL & RELEASE DURATION

Pool duration was developed using the DRM which used data from 1898 to 1997. Figure 18 shows the DRM data along with the observed data. Pool duration and release duration relationships were developed using historical daily records for the period of June 1967 through December 1997. Figure 19 shows the release relationship based only upon observed data. Table 15 shows the pool elevation and release for various percentages of time in which the values are equaled or exceeded.

Table 15
Big Bend Pool & Release Duration Characteristics

Percent of Time Equaled or Exceeded	Pool Elevation (ft msl) DRM	Release (cfs) Based on Observed
Maximum of record	1421.8	74,300
1	1421.1	57,700
5	1420.9	49,400
10	1420.8	44,600
20	1420.6	37,500
50	1420.2	25,400
80	1419.6	11,600
90	1419.5	4,700
95	1419.4	0
99	1419.2	0
100	1418.4	0

POOL-PROBABILITY

Annual maximum pool elevations at Big Bend have fluctuated only 1.7 feet during the period of 1967 through 1997, with the maximum pool recorded of 1422.1 ft msl in 1991. The maximum pool based upon simulation would have occured in 1996 at an elevation 1421.8. A pool probability relationship was not developed for Big Bend as part of the 1976 study. However, the 1976 study assumed the 1 percent chance exceedance pool elevation would be the maximum operating pool at elevation 1423 ft msl. The adopted pool probability curve was based on the observed curve transitioning through an assumed 0.2 percent exceedance pool near the maximum operating pool elevation. Results of this analysis are shown in Table 16 and on Figure 20.

Table 16
Big Bend Pool-Probability Relationship
Pool Elevations in Feet MSL

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Adopted
50	--	1421.4	1421.3
20	--	1421.5	1421.5
10	--	1421.8	1421.8
2	--	1422.2*	1422.2
1	1423.0	1422.4*	1422.4
0.2	--	1422.7*	1423.0

* extrapolated: Max Observed is 1422.1

RELEASE-PROBABILITY

The observed maximum daily release from Big Bend was 74,300 cfs in 1997. Since Big Bend is operated as a peaking hydropower plant, daily releases are not representative of the maximum releases. In the 1976 study it was assumed that outflows in excess of the power plant capacity would be very rare while the full release capability of the power units would be frequently utilized for short durations or portions of the day. Therefore, it was assumed that the 1 percent chance exceedance event would be equal to the power plant capacity of 103,000 cfs. For this study, a maximum release of 110,000 cfs was adopted for the 0.2 percent event. Results of this analysis are shown in Table 17 and on Figure 21. The peak on the curve represents the peak hourly discharge from Big Bend.

Table 17
Big Bend Release-Probability Relationship
Discharge in CFS

Percent Chance Exceedance	1976 Study	Observed Average Daily (1967-1997)	Adopted Average Daily	Adopted Peak Hourly
50	110,000	55,000	55,000	103,000
20	110,000	61,000	61,000	105,000
10	110,000	65,000	65,000	107,000
2	110,000	72,000	72,000*	109,000
1	110,000	75,000*	75,000*	110,000
0.2	110,000	80,000*	80,000*	110,000

* extrapolated: Max Observed is 74,300

FORT RANDALL

HISTORICAL RECORDS

Historical records for Fort Randall pool elevations and releases date back to 1952, when the dam was first closed. It was not until the main stem system filled in June of 1967 that the records reflected the system operation. During the period of 1967 through 1997, the pool elevation has ranged from a low of 1317.9 ft msl in December of 1968 to a maximum of 1372.1 ft msl in May of 1997, a range of over 50 feet. Since 1971, the pool has drawn down to 1337 ft msl each fall making the range approximately 33 feet. Prior to 1971, the annual fall drawdown was to 1320 feet msl. The average annual pool elevation since 1967 is 1351.4 ft msl with a standard deviation of the annual means being 8.1 feet. Daily releases from Fort Randall have ranged from a low of zero cfs during May of 1995 to a high of 67,500 cfs in November of 1997. Daily release has averaged 26,300 cfs since 1967 with a standard deviation in the annual mean discharge of 12,900 cfs. Figure 22 shows the observed daily pool elevations and releases from Fort Randall for the period since the main stem system was first filled. Daily maximum, minimum and mean values of pool elevation and releases for each month are listed in Table 18.

Table 18
Fort Randall Pool & Release Historical Records (06/1967-12/1997)

Month	Pool Elevation (ft msl)			Daily Release (cfs)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Jan	1350.5	1324.7	1344.5	27,600	4,500	15,600
Feb	1356.4	1338.7	1349.9	25,400	900	13,800
Mar	1362.4	1345.1	1355.3	40,500	600	16,500
Apr	1370.8	1352.0	1357.3	53,000	1,400	23,500
May	1372.2	1352.5	1358.1	55,500	0	26,900
Jun	1371.4	1352.3	1357.9	56,000	500	28,900
Jul	1368.8	1351.9	1357.4	60,100	600	32,900
Aug	1369.3	1350.7	1356.2	62,000	3,100	35,900
Sep	1365.9	1343.2	1353.8	64,300	8,600	35,900
Oct	1357.0	1333.2	1347.5	67,000	6,100	35,300
Nov	1349.9	1318.0	1339.4	67,500	3,200	31,700
Dec	1348.3	1317.9	1338.6	63,000	900	18,300
Annual	1372.2	1317.9	1351.4	67,500	0	26,300

POOL & RELEASE DURATION

Pool duration and release duration relationships were developed using the DRM which used data from 1898 to 1997. Both Figure 23 and Figure 24 show the DRM data along with the observed data. Figure 23 shows the pool duration relationship for Fort Randall, while Figure 24 shows the release duration relationship. Table 19 shows the pool elevation and release for various percentages of time in which the values are equaled or exceeded based on the DRM.

Table 19
Fort Randall Pool & Release Duration Characteristics

Percent of Time Equaled or Exceeded	Pool Elevation (ft msl) DRM	Release (cfs) DRM
Maximum of record	1374.5	65,000
1	1364.1	60,900
5	1356.4	52,600
10	1355.6	42,800
20	1354.8	34,400
50	1352.8	26,800
80	1343.5	13,300
90	1340.1	9,900
95	1338.2	5,500
99	1337.4	800
100	1336.3	0

POOL-PROBABILITY

During 1997, the Fort Randall pool reached elevation 1372.2, the maximum of record. Results of the DRM indicated little correlation between observed and simulated pools. Some of this lack of correlation can be attributed to daily model constraints and parameters. The model does not utilize this project to maximize downstream flood control as is done in actual practice. Therefore, the adopted curve was based primarily on an eye-fit of the observed data. The 100 year pool has increased from 1370 feet msl in the previous study to 1372 which is the adopted primarily because the 30 year operational history now includes an actual elevation of 1372.17 due to melt of a heavy

plains snow pack. This magnitude of an event also occured in 1952 and would have had similar results if this project had been in operation. Also, a comparison of maximum daily and maximum monthly pool elevations indicated an average difference of 1.8 feet with a maximum difference of 4.9 feet due to the fall drawdown. Results of this analysis are shown in Table 20 and on Figure 25.

Table 20
Fort Randall Pool Probability Relationship
Pool Elevations in Feet MSL

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Simulated (1898-1997)	Adopted
50	1361.5	1360.0	1355.5	1360.0
20	1364.5	1363.0	1358.7	1364.0
10	1366.0	1365.0	1363.2	1366.0
2	1369.0	1369.0	1373.3	1372.0
1	1370.0	1370.8	1374.5	1375.0
0.2	1372.0	1374.0*	1376.5*	1377.0

* extrapolated: Max Observed is 1372.2

RELEASE-PROBABILITY

The maximum observed release from Fort Randall of 67,500 cfs was experienced in 1997. Based on the DRM, there are 82 releases that tie for the highest release out of 100 years with a maximum daily release of 65,000 cfs. The adopted curve was based on the simulated curve transitioning to the power plant capacity at the annual event. Results of this analysis are shown in Table 21 and on Figure 26.

Table 21
Fort Randall Release Probability Relationship
Discharge in CFS

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Simulated (1898-1997)	Adopted
50	48,000	40,000	47,400	41,000
20	49,000	47,000	59,000	50,000
10	55,000	52,000	60,000	55,000
2	69,000	61,000	64,000	69,000
1	75,000	65,000	65,000	75,000
0.2	88,000	74,000*	65,000*	88,000

* extrapolated: Max Observed is 67,500

GAVINS POINT

HISTORICAL RECORDS

Historical records for Gavins Point pool elevations and releases date back to 1955, when the dam was first closed. It was not until the main stem system filled in June of 1967 that the records reflected the system operation. During the period of 1967 through 1997, the pool elevation has ranged from a low of 1199.8 ft msl in March of 1969 to a maximum of 1209.5 ft msl in May of 1995, a range of about 10 feet. The average annual pool elevation since 1967 is 1206.8 ft msl with a standard deviation of the annual means being 1.2 feet. Daily releases from Gavins Point have ranged from a low of 6,000 cfs during April of 1969, June 1983, March 1992 and March, April and July of 1993 to a high of 70,000 cfs in October and November of 1997. Daily release has averaged 29,000 cfs since 1967 with a standard deviation in the annual mean discharge of 12,100 cfs. Figure 27 shows the daily pool elevations and releases from Gavins Point for the period since the main stem system was first filled. Daily maximum, minimum and mean values of pool elevation and releases for each month are listed in Table 22.

Table 22
Gavins Point Pool & Release Historical Records (06/1967-11/1997)

Month	Pool Elevation (ft msl)			Daily Release (cfs)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Jan	1208.9	1205.2	1207.6	31,000	7,800	17,600
Feb	1208.4	1203.2	1206.9	34,700	7,500	18,000
Mar	1209.2	1199.8	1205.3	42,000	6,000	20,700
Apr	1208.2	1201.5	1205.5	58,000	6,000	27,300
May	1209.5	1204.2	1205.6	60,000	10,000	30,600
Jun	1208.8	1204.3	1205.8	60,100	6,000	31,800
Jul	1208.9	1204.4	1206.5	62,000	6,000	34,600
Aug	1209.4	1204.7	1207.3	65,100	7,000	37,200
Sep	1208.8	1203.9	1207.4	68,000	14,000	37,700
Oct	1209.2	1206.4	1207.8	70,100	7,600	37,400
Nov	1209.0	1204.5	1207.7	70,100	7,500	34,100
Dec	1209.1	1203.9	1207.5	68,000	8,000	20,500
Annual	1209.5	1199.8	1206.8	70,100	6,000	29,000

POOL & RELEASE DURATION

Pool duration and release duration relationships were developed using the DRM which used data from 1898 to 1997. Both Figure 28 and Figure 29 show the DRM data along with the observed data. Figure 28 shows the pool duration relationship for Gavins Point, while Figure 29 shows the release duration relationship. Table 23 shows the pool elevation and release for various percentages of time in which the values are equaled or exceeded based on the observed data.

Table 23
Gavins Point Pool & Release Duration Characteristics

Percent of Time Equaled or Exceeded	Pool Elevation (ft msl) DRM	Release (cfs) DRM
Maximum of record	1209.3	75,600
1	1207.9	63,600
5	1207.4	51,500
10	1207.2	43,100
20	1207.1	34,900
50	1206.4	27,900
80	1205.9	16,100
90	1205.7	12,000
95	1205.5	9,500
99	1205.1	6,200
100	1200.8	5,600

POOL-PROBABILITY

Historically, the observed maximum daily pool elevations at Gavins Point have varied only 1.4 feet during the period of 1967 through 1997 with the maximum pool elevation of 1209.5 being reached in 1995. A pool-probability relationship was not derived for Gavins Point in the 1976 study. However, it was assumed that in 1976 the 1 percent chance exceedance pool elevation would be 1213 ft msl, based on incremental runoff occurring coincident with a starting Gavins Point pool exceeding elevation 1204.5 and Fort Randall releases exceeding 30,000 cfs. Results of the DRM model indicate that the Gavins Point pool elevations would have exceeded 1209 feet msl eight days during

the 100 year simulation. The simulated 1995 event ranked 17 out of the 100 year of simulation with a pool elevation of 1208.7. The adopted curve was based on a straight line connection of the 2 percent pool elevation of 1209.6 ft msl with the maximum pool elevation of 1211 ft msl assumed to be a 0.02 percent event. This results in a one percent pool elevation about three feet lower than that assumed in the 1976 study. The major factor influencing the change is the 30 years of operational history with major runoffs. Results of this analysis are shown in Table 24 and on Figure 30.

Table 24
Gavins Point Pool Probability Relationship
Pool Elevations in Feet MSL

Percent Chance Exceedance	1976 Study	Observed (1967-1996)	Adopted
50	--	1208.8	1208.8
20	--	1209.0	1209.0
10	--	1209.2	1209.2
2	--	1209.6*	1209.6
1	1213.0	1209.7*	1210.0
0.2	--	1210.0*	1211.0

* extrapolated: Max Observed is 1209.5

RELEASE-PROBABILITY

The maximum daily release from Gavins Point during the 1967 through 1997 period was 70,100 cfs in 1997. Simulation of the 1997 year produced a discharge of 71,300 cfs. Some reasoning for the difference in the discharge can be attributed to the fact the DRM cannot forecast precipitation such as snow melt and as a result will release more. Based on the DRM, the maximum daily release of 75,600 cfs would have occurred in 1952. Emergency releases in the reservoir regulation manual call for minimum releases of 100,000 cfs when the pool is above elevation 1212 ft msl. Therefore, the adopted curve was based on the simulated curve transitioning through a release of 80,000 cfs for the one percent event to a discharge of 100,000 cfs for the 0.2 percent event. Results of this analysis are shown in Table 25 and on Figure 31.

Table 25
Gavins Point Release-Probability Relationship
Discharge in CFS

Percent Chance Exceedance	1976 Study	Observed (1967-1997)	Simulated (1898-1996)	Adopted
50	37,000	38,000	40,800	38,000
20	47,000	46,000	56,700	47,000
10	54,000	53,000	63,700	54,000
2	72,000	69,000	75,000	72,000
1	80,000	80,000*	75,600	80,000
0.2	100,000	100,000*	80,000*	100,000

* extrapolated: Max Observed is 70,100

SUMMARY

This report presented historical data, duration curves, and probability curves for pool elevations and releases from the Missouri River Main Stem Reservoirs. Pool probability and release probability relationships were developed from historical records reflecting actual regulation experience for a 29 year period and from long term model simulation studies reflecting current system regulation criteria. Table 26 shows the adopted pool probability relationships for each of the projects, while Table 27 shows the adopted release probability relationships.

Table 26
Missouri River Main Stem Reservoir System
Adopted Pool-Probability Relationships
Pool Elevations in Feet MSL

Project	50%	20%	10%	2%	1%	0.2%
Fort Peck	2241.5	2246.5	2249.0	2251.0	2252.0	2253.0
Garrison	1848.0	1850.5	1852.0	1854.0	1854.5	1855.5
Oahe	1613.0	1617.0	1618.1	1619.5	1620.0	1621.0
Big Bend	1421.3	1421.5	1421.8	1422.2	1422.4	1423.0
Ft Randall	1360.0	1364.0	1366.0	1372.0	1375.0	1377.0
Gavins Pt	1208.8	1209.0	1209.2	1209.6	1210.0	1211.0

Table 27
Missouri River Main Stem Reservoir System
Adopted Release-Probability Relationships
Discharge in CFS

Project	50%	20%	10%	2%	1%	0.2%
Fort Peck	15,000	17,000	22,000	29,000	35,000	50,000
Garrison	39,000	42,000	45,000	68,000	76,000	90,000
Oahe	56,000	57,000	57,500	65,000	70,000	85,000
Big Bend	55,000	61,000	65,000	72,000	75,000	80,000
Ft Randall	41,000	50,000	55,000	69,000	75,000	88,000
Gavins Pt	38,000	47,000	54,000	72,000	80,000	100,000

Missouri River Basin

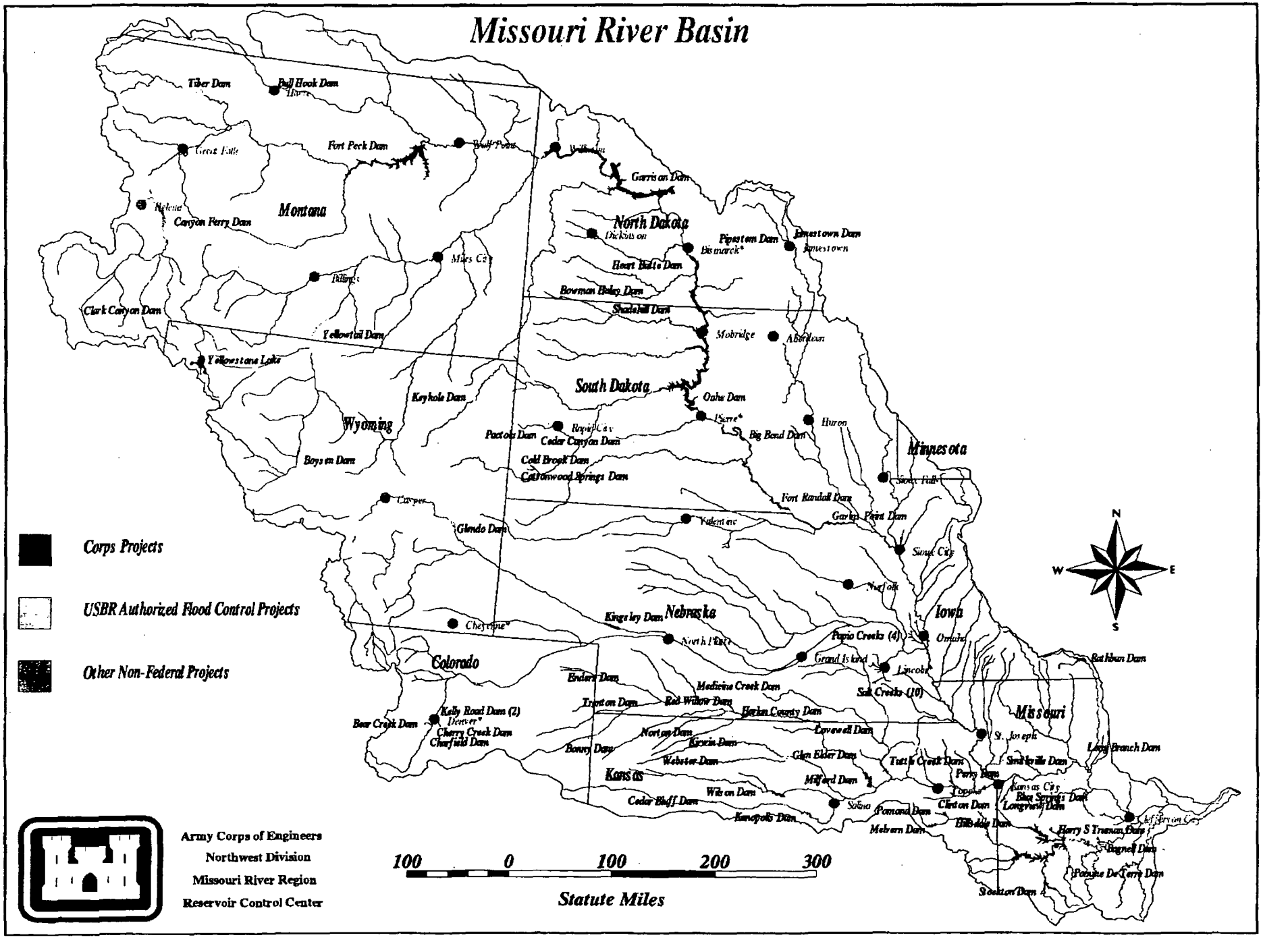


Figure 1

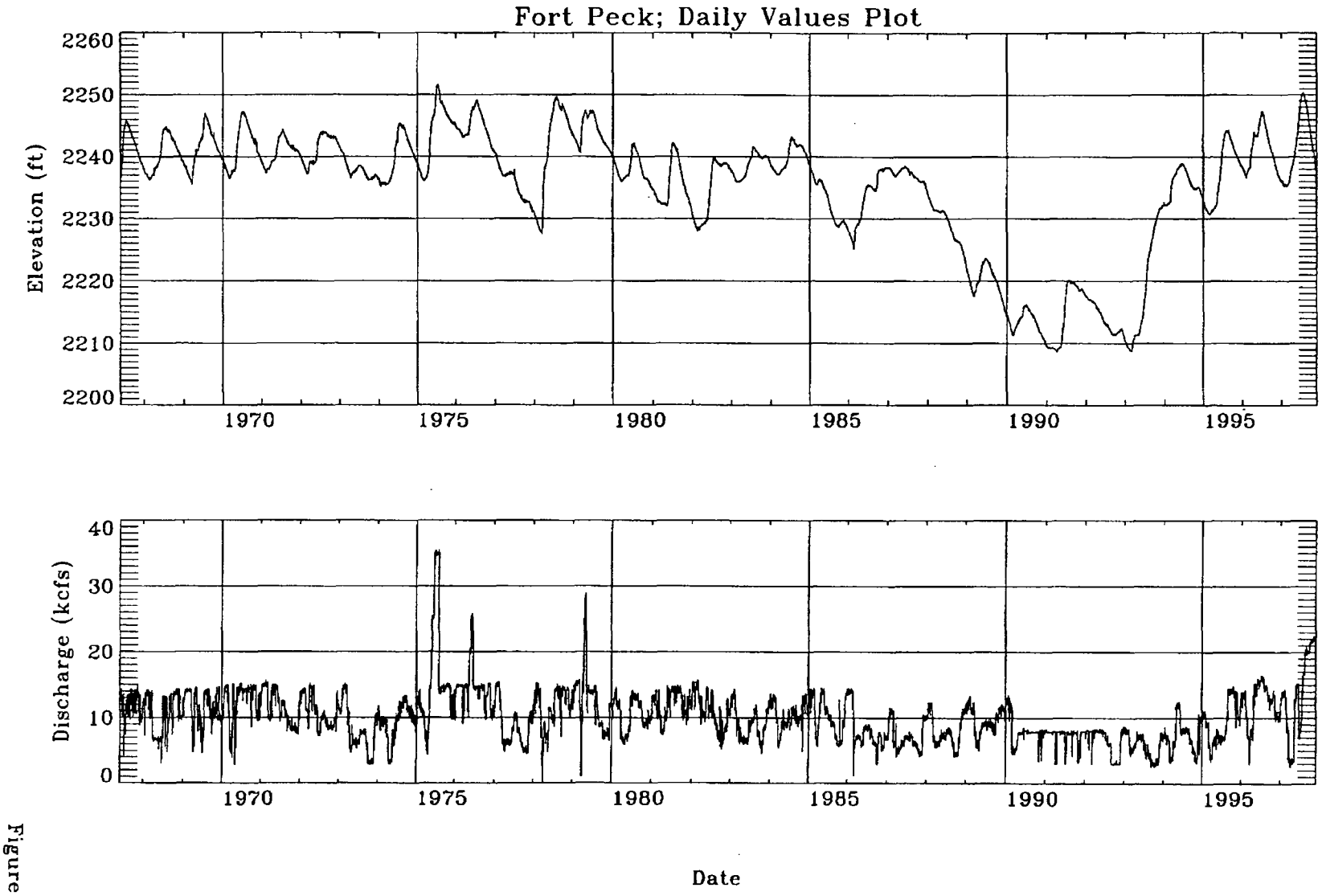

Fort Peck; Daily Values Plot
Elevation (ft)
2260
2250
2240
2230
2220
2210
2200
1970
1975
1980
1985
1990
1995
Discharge (kcfs)
40
30
20
10
0
1970
1975
1980
1985
1990
1995
Date

Figure 2

FORT PECK LAKE

POOL DURATION RELATIONSHIP

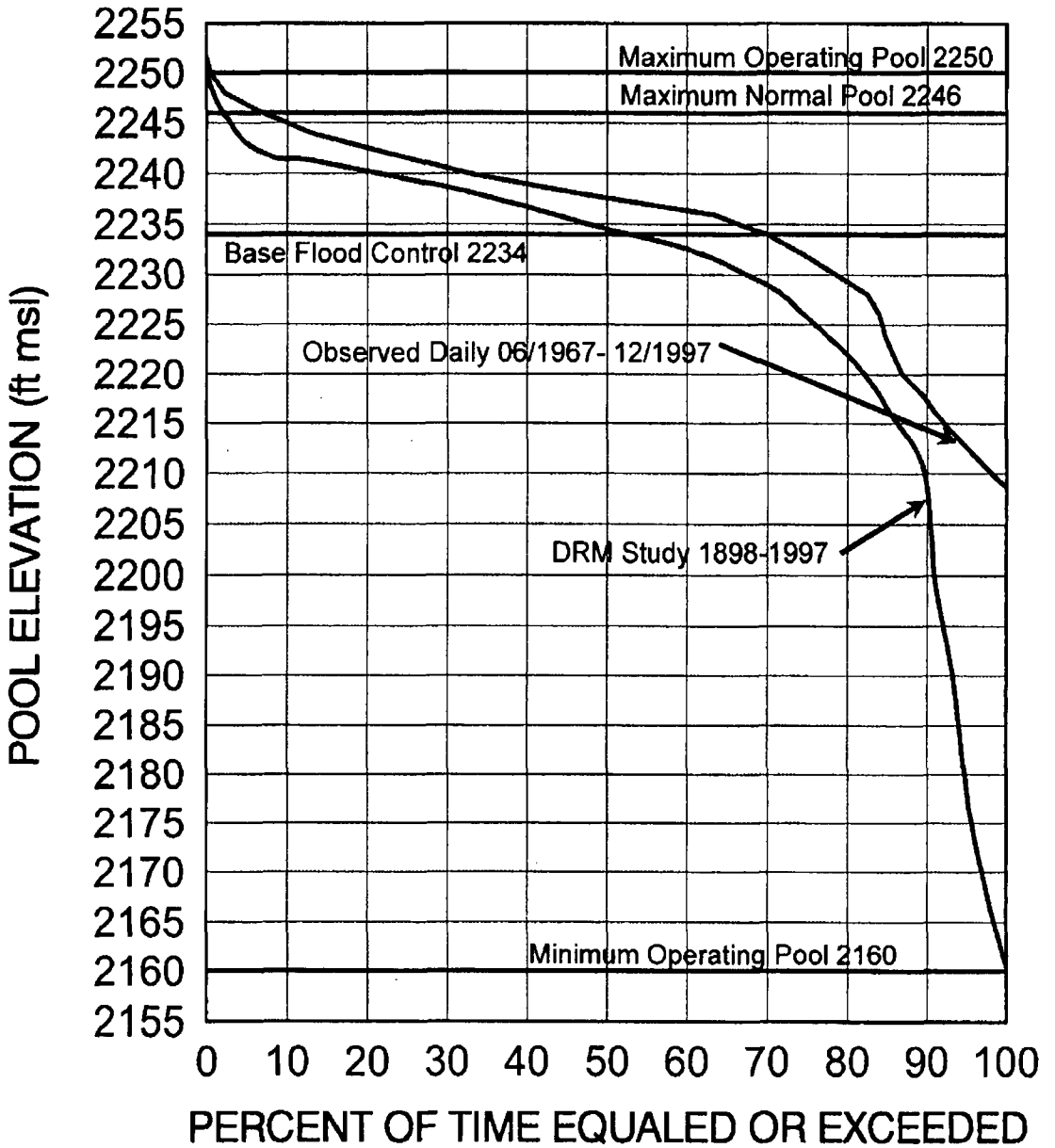


FIGURE 3

FORT PECK DAM

RELEASE DURATION RELATIONSHIP

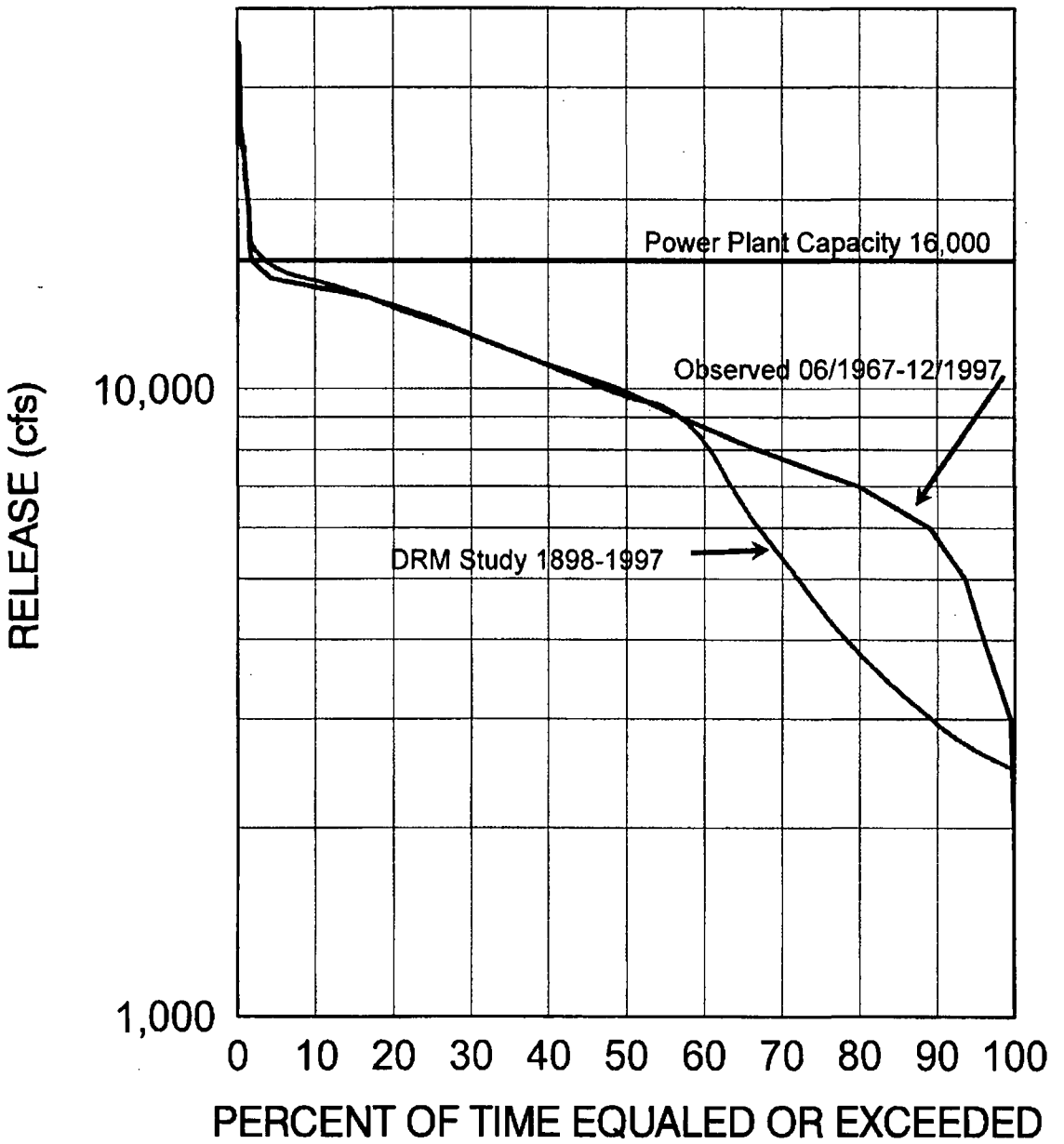
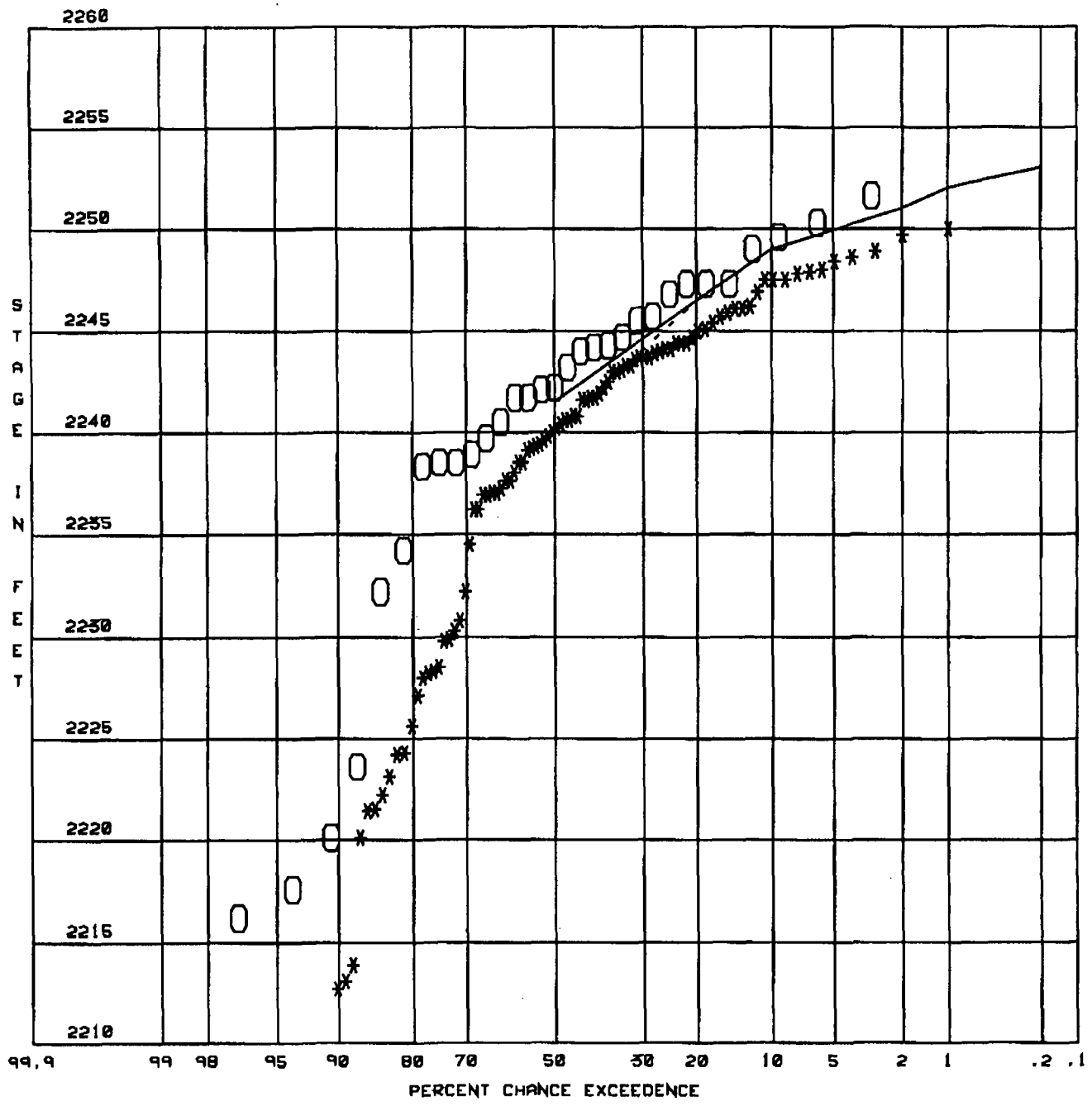


FIGURE 4

FILE:PECKEL.LP3

DATE:02/08/99

FORT PECK LAKE



LEGEND:

O OBSERVED

* SIMULATED

——— ADOPTED

- - - - 1976 STUDY

MAX POOL ELEVATION = 2256.1

MAX OP. POOL ELEV = 2250.0

MAX NORMAL POOL ELEV = 2246.0

BASE FLOOD CONTROL = 2234.0

MISSOURI RIVER MAIN STEM RESERVOIRS

POOL-PROBABILITY RELATIONSHIP

FORT PECK

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

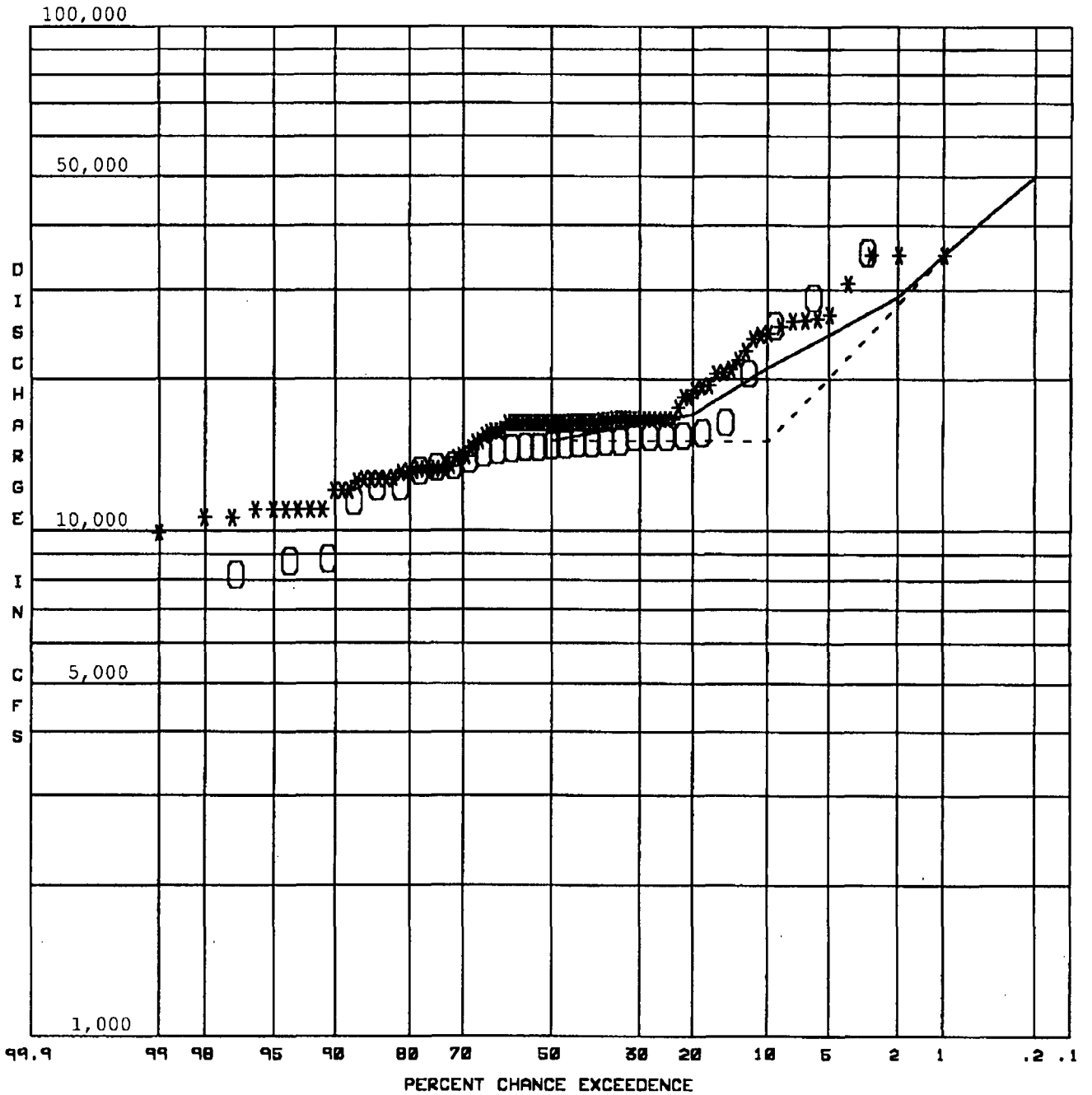
FEBRUARY 1999

FIGURE 5

FILE:PECKRE.LP3

FORT PECK DAM

DATE:12/22/98



LEGEND:

0 OBSERVED

* SIMULATED

——— ADOPTED

- - - - 1976 STUDY

POWER PLANT CAPACITY - 16,000

OUTLET CAPACITY - 45,000

SPILLWAY CAPACITY - 275,000

MISSOURI RIVER MAIN STEM RESERVOIRS

RELEASE-PROBABILITY RELATIONSHIP

FORT PECK

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

FEBRUARY 1999

FIGURE 6

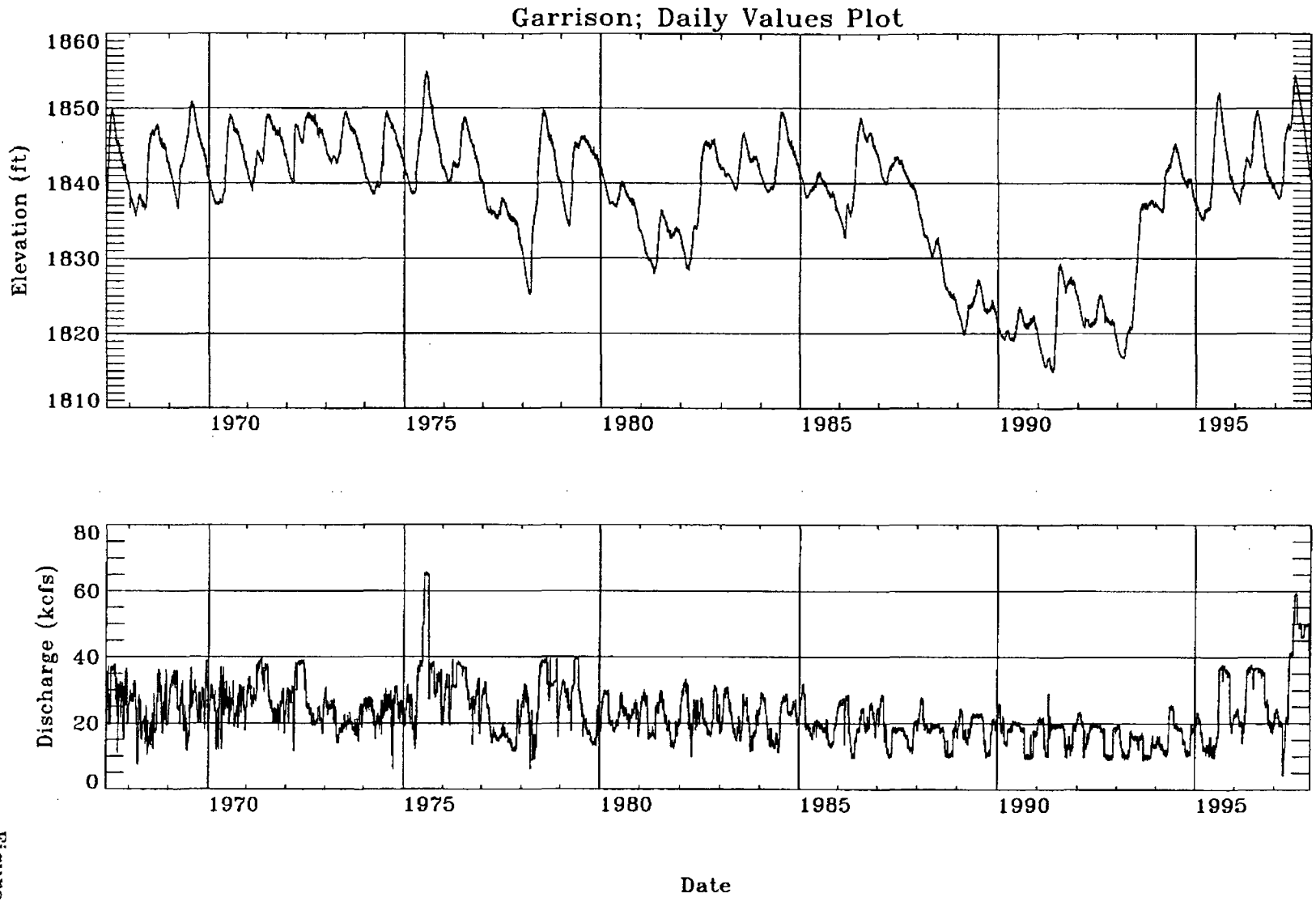

Garrison; Daily Values Plot
Elevation (ft)
1860
1850
1840
1830
1820
1810
1970
1975
1980
1985
1990
1995
Discharge (kcfs)
80
60
40
20
0
Date

Figure 7

LAKE SAKAKAWEA

POOL DURATION RELATIONSHIP

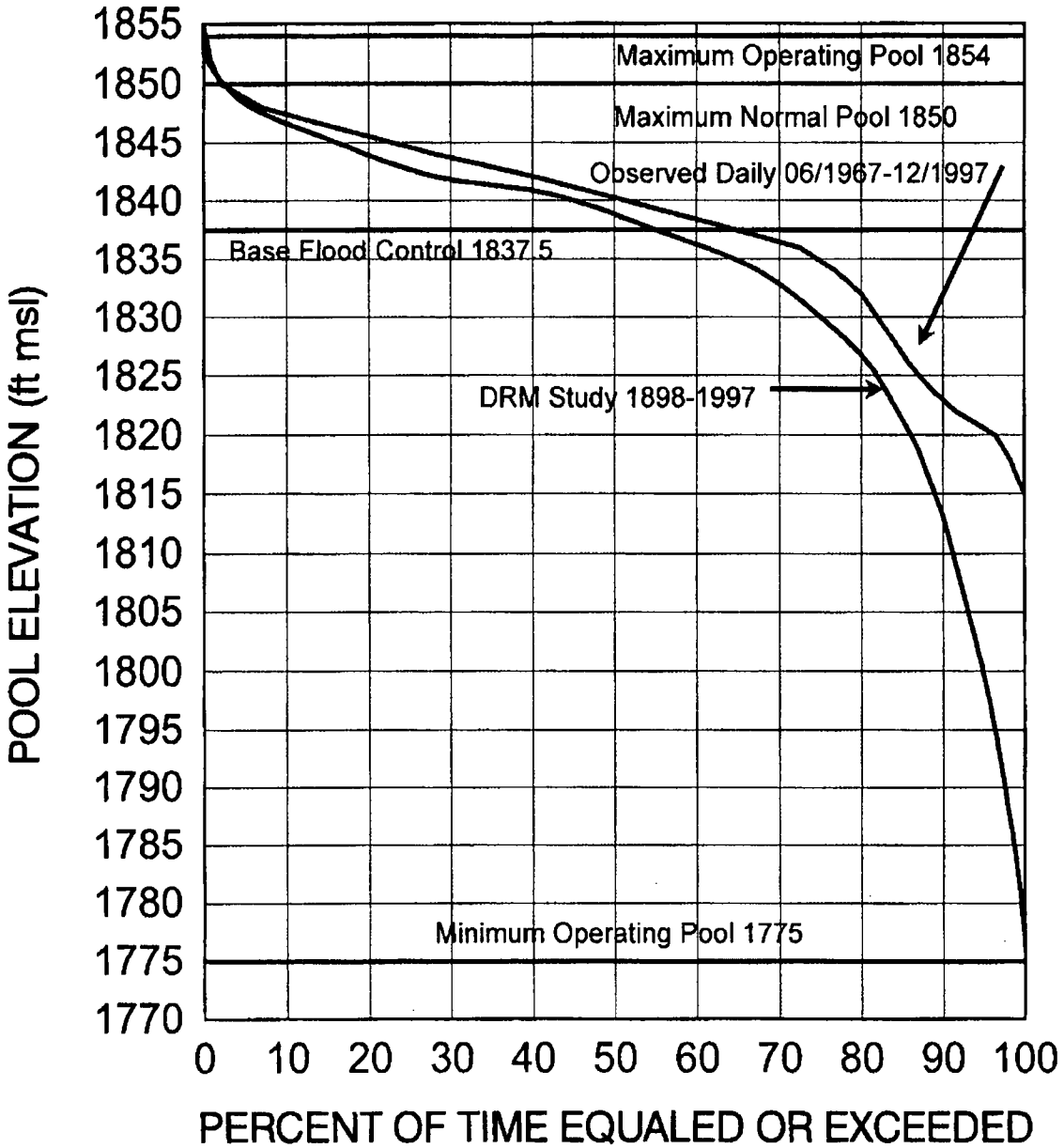


FIGURE 8

GARRISON DAM

RELEASE DURATION RELATIONSHIP

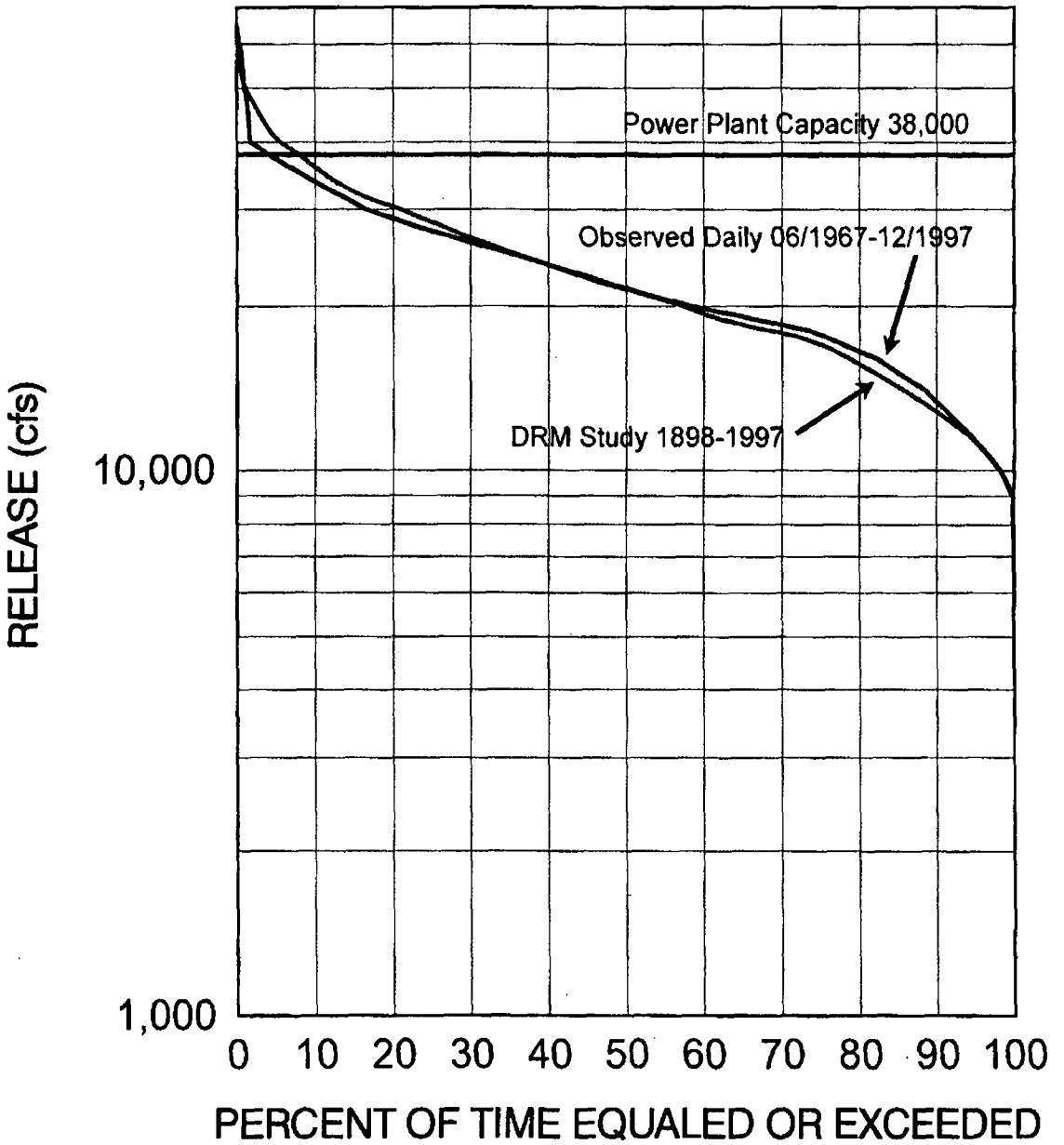
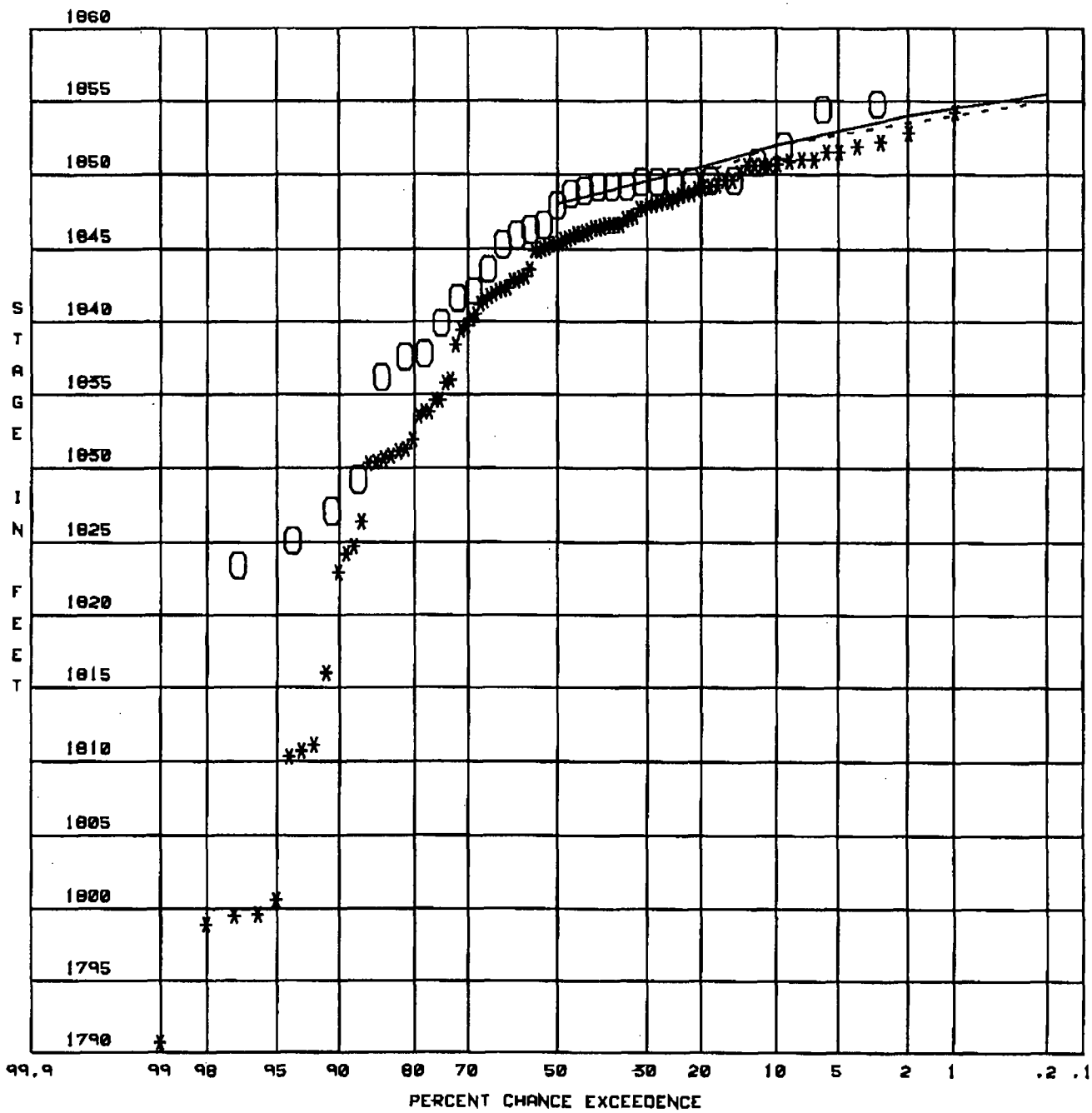


FIGURE 9

FILE:GARREL.LP3

DATE:12/22/98

LAKE SAKAKAWEA



LEGEND:

O OBSERVED

* SIMULATED

——— ADOPTED

- - - - 1976 STUDY

MAX POOL ELEVATION - 1858.5

MAX OP. POOL ELEV - 1854.0

MAX NORMAL POOL ELEV - 1850.0

BASE FLOOD CONTROL - 1837.5

MISSOURI RIVER MAIN STEM RESERVOIRS

POOL-PROBABILITY RELATIONSHIP

GARRISON

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

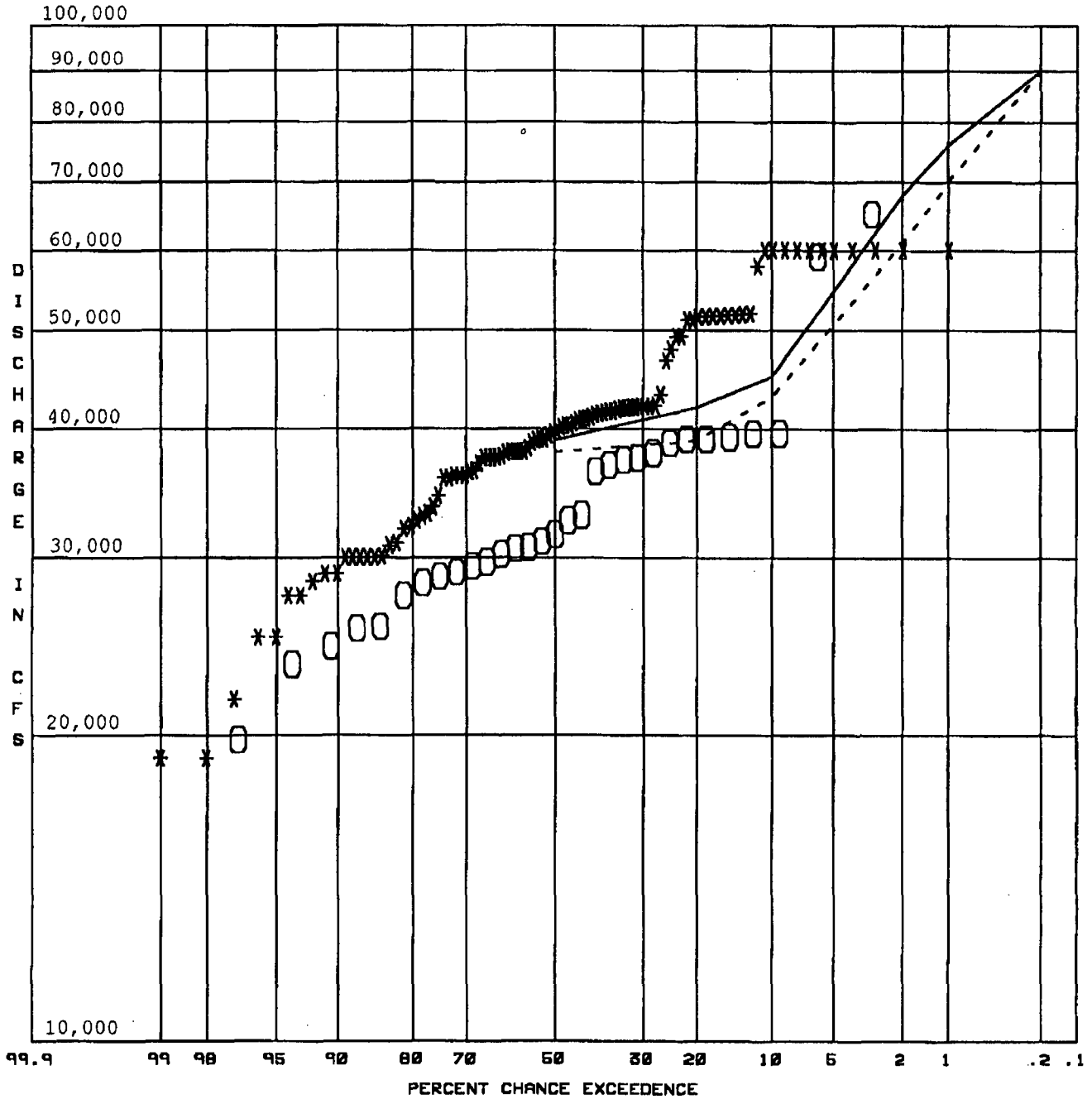
FEBRUARY 1999

FIGURE 10

FILE:GARRRE.LP3

DATE:12/22/98

GARRISON DAM



LEGEND:

O OBSERVED

* SIMULATED

——— ADOPTED

- - - - 1976 STUDY

POWER PLANT CAPACITY - 38,000

OUTLET CAPACITY - 98,000

SPILLWAY CAPACITY - 827,000

MISSOURI RIVER MAIN STEM RESERVOIRS

RELEASE-PROBABILITY RELATIONSHIP

GARRISON

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

FEBRUARY 1999

FIGURE 11

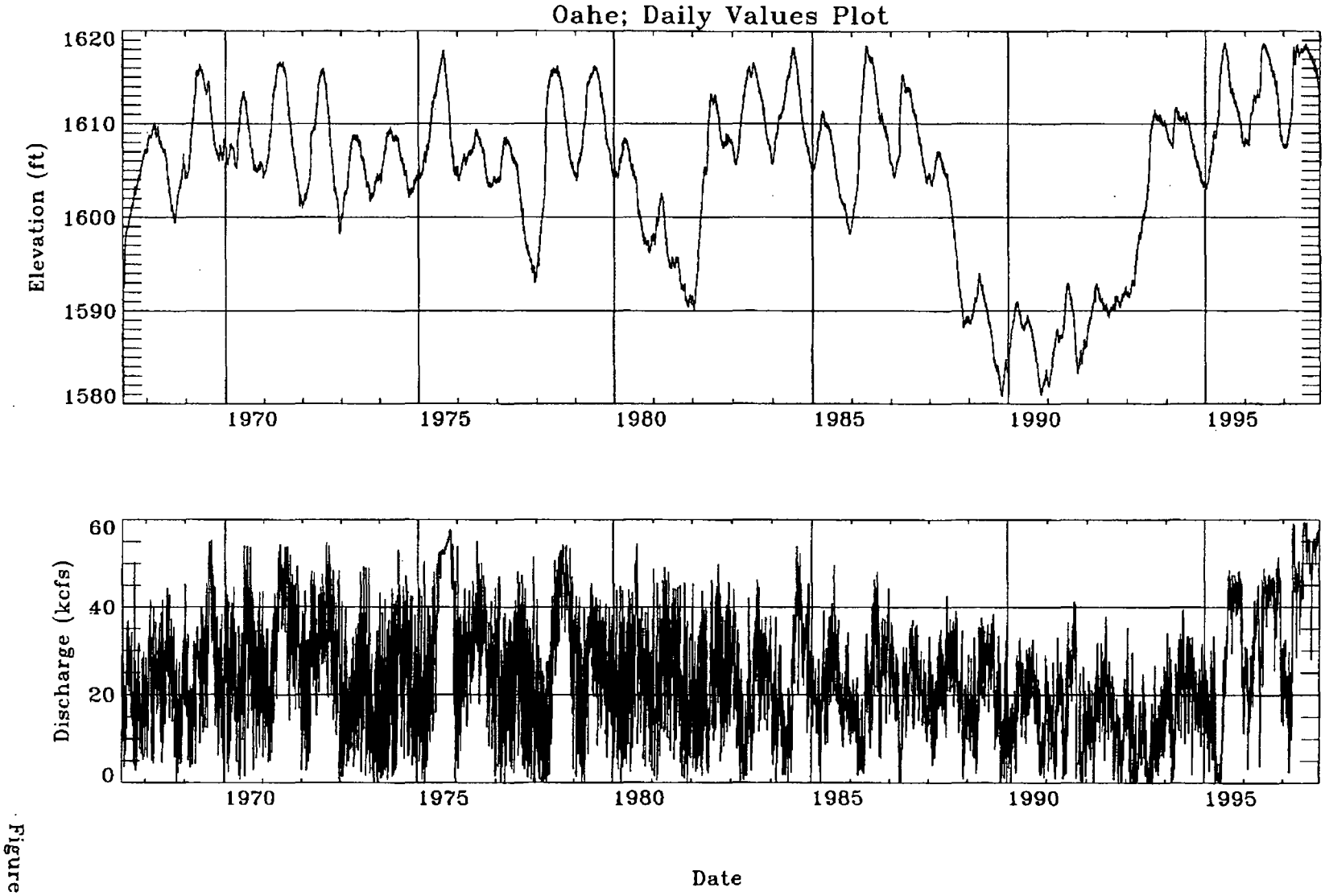

Oahe; Daily Values Plot
Elevation (ft)
1620
1610
1600
1590
1580
1970
1975
1980
1985
1990
1995
Discharge (kcfs)
60
40
20
0
Date

Figure 12

LAKE OAHE

POOL DURATION RELATIONSHIP

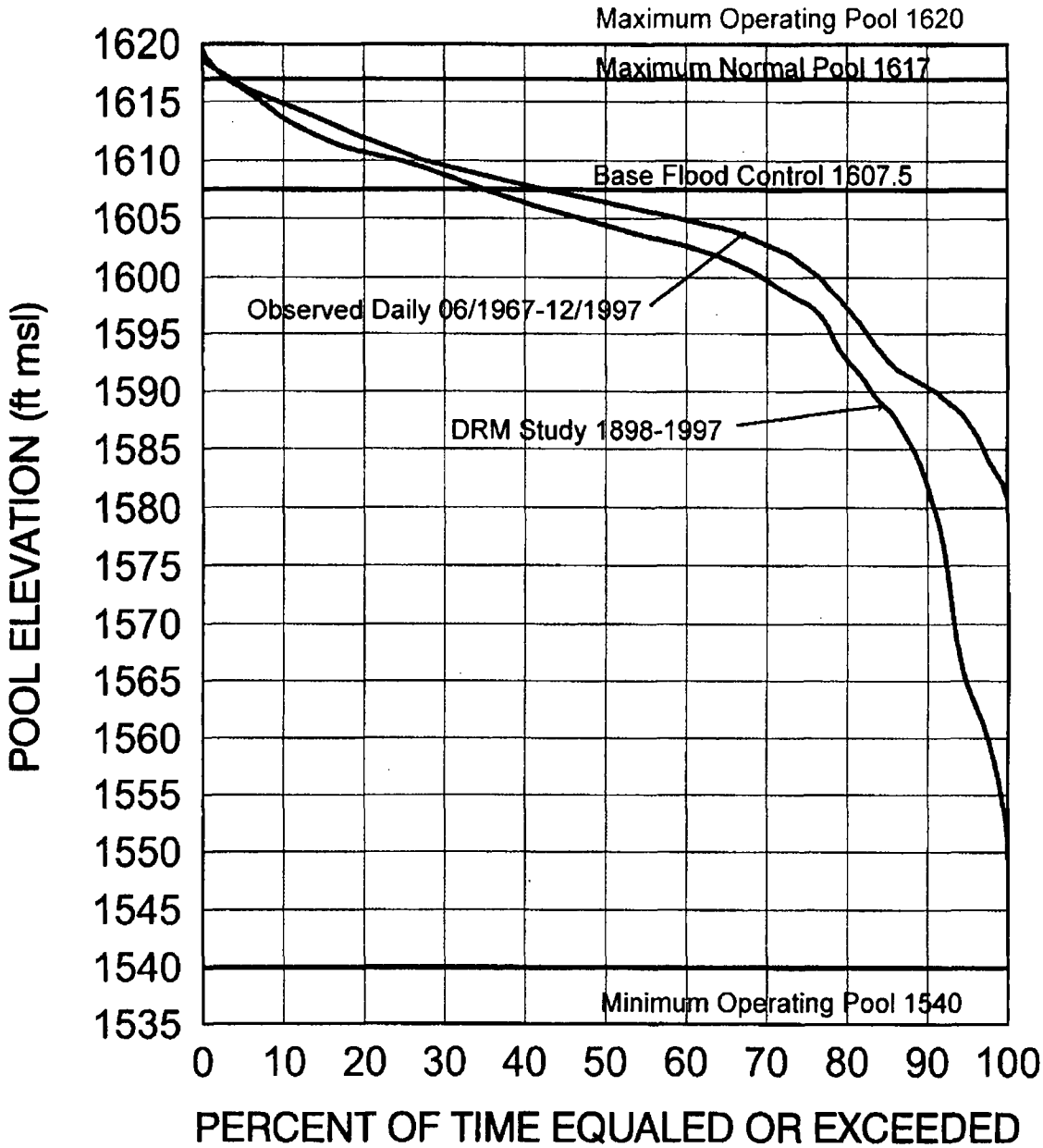


FIGURE 13

OAHE DAM

RELEASE DURATION RELATIONSHIP

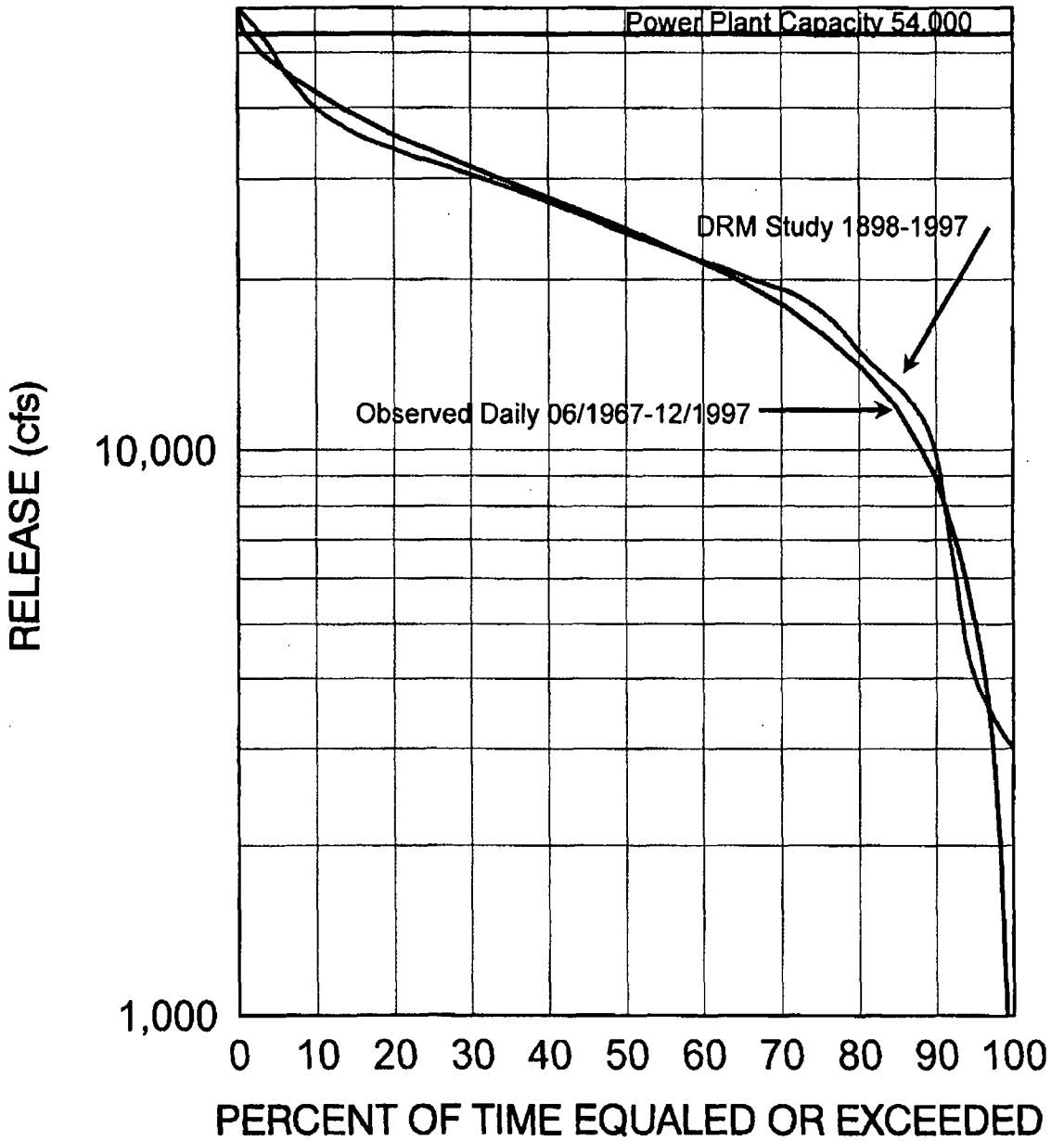
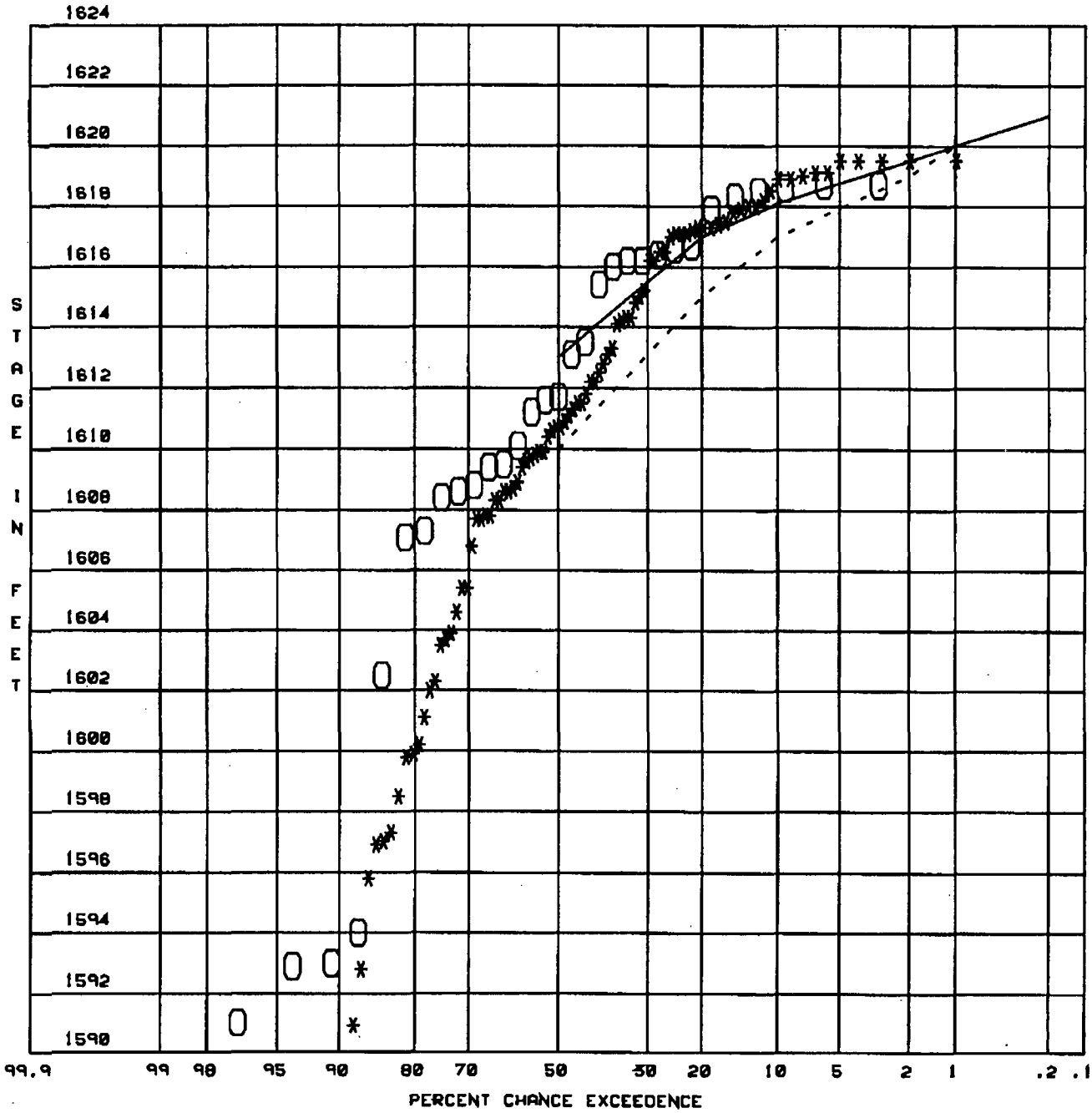


FIGURE 14

FILE:OAHEEL.LP3

DATE:02/08/99

LAKE OAHE



LEGEND:

O OBSERVED

* SIMULATED

——— ADOPTED

- - - - 1976 STUDY

MAX POOL ELEVATION - 1644.4

MAX OP. POOL ELEV - 1620.0

MAX NORMAL POOL ELEV - 1617.0

BASE FLOOD CONTROL - 1607.5

MISSOURI RIVER MAIN STEM RESERVOIRS

POOL-PROBABILITY RELATIONSHIP

OAHE

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MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

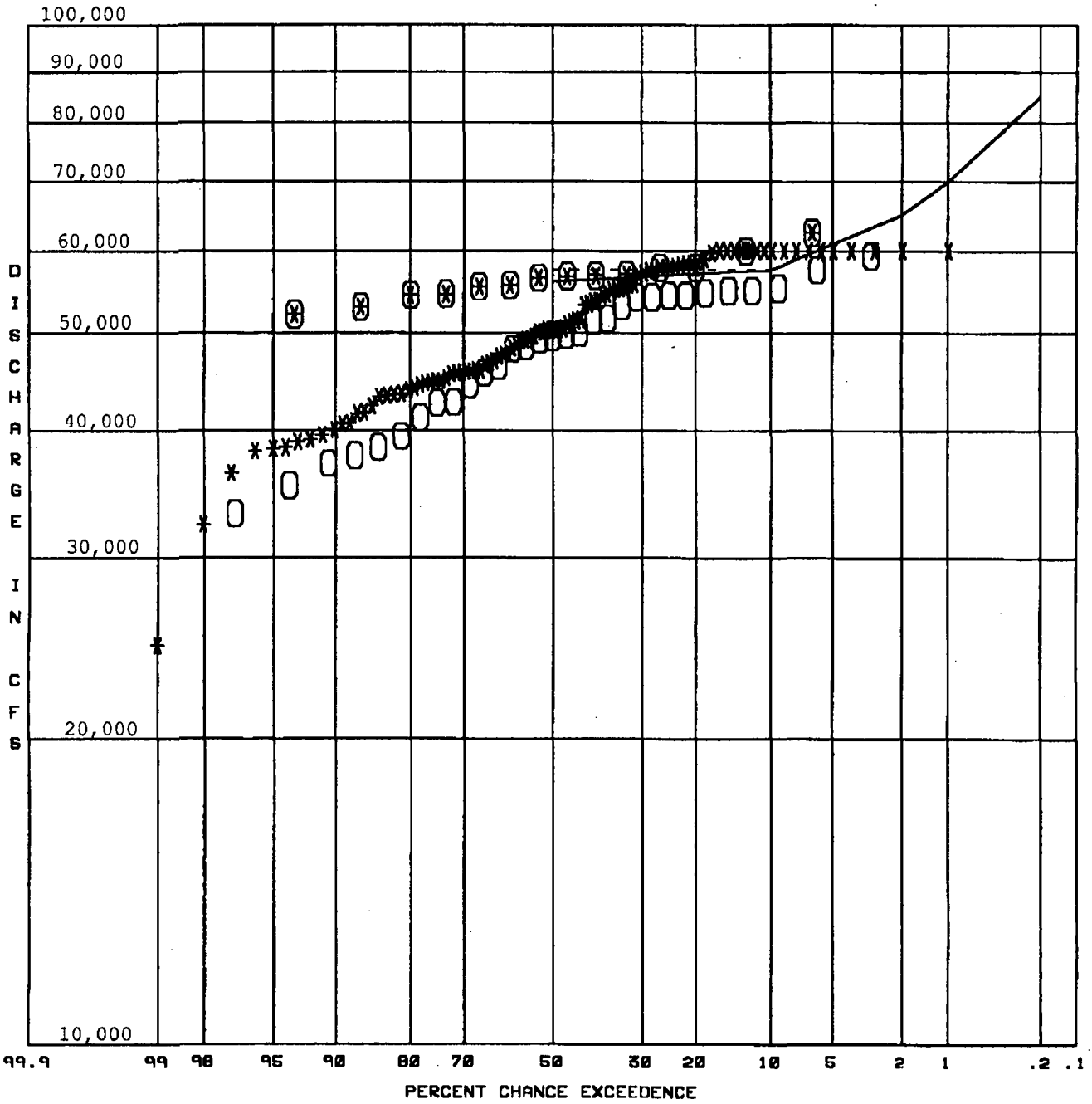
FEBRUARY 1999

FIGURE 15

FILE:OAHERE.LP3

DATE:12/22/98

OAHE DAM



LEGEND:

- OBSERVED
- SIMULATED
- MAX HOURLY
- ADOPTED
- 1976 STUDY

POWER PLANT CAPACITY - 54,000
OUTLET CAPACITY - 111,000
SPILLWAY CAPACITY - 304,000

MISSOURI RIVER MAIN STEM RESERVOIRS
RELEASE-PROBABILITY RELATIONSHIP

OAHE

RESERVOIR CONTROL CENTER
MISSOURI RIVER REGION
U.S. ARMY CORPS OF ENGINEERS
FEBRUARY 1999

FIGURE 16

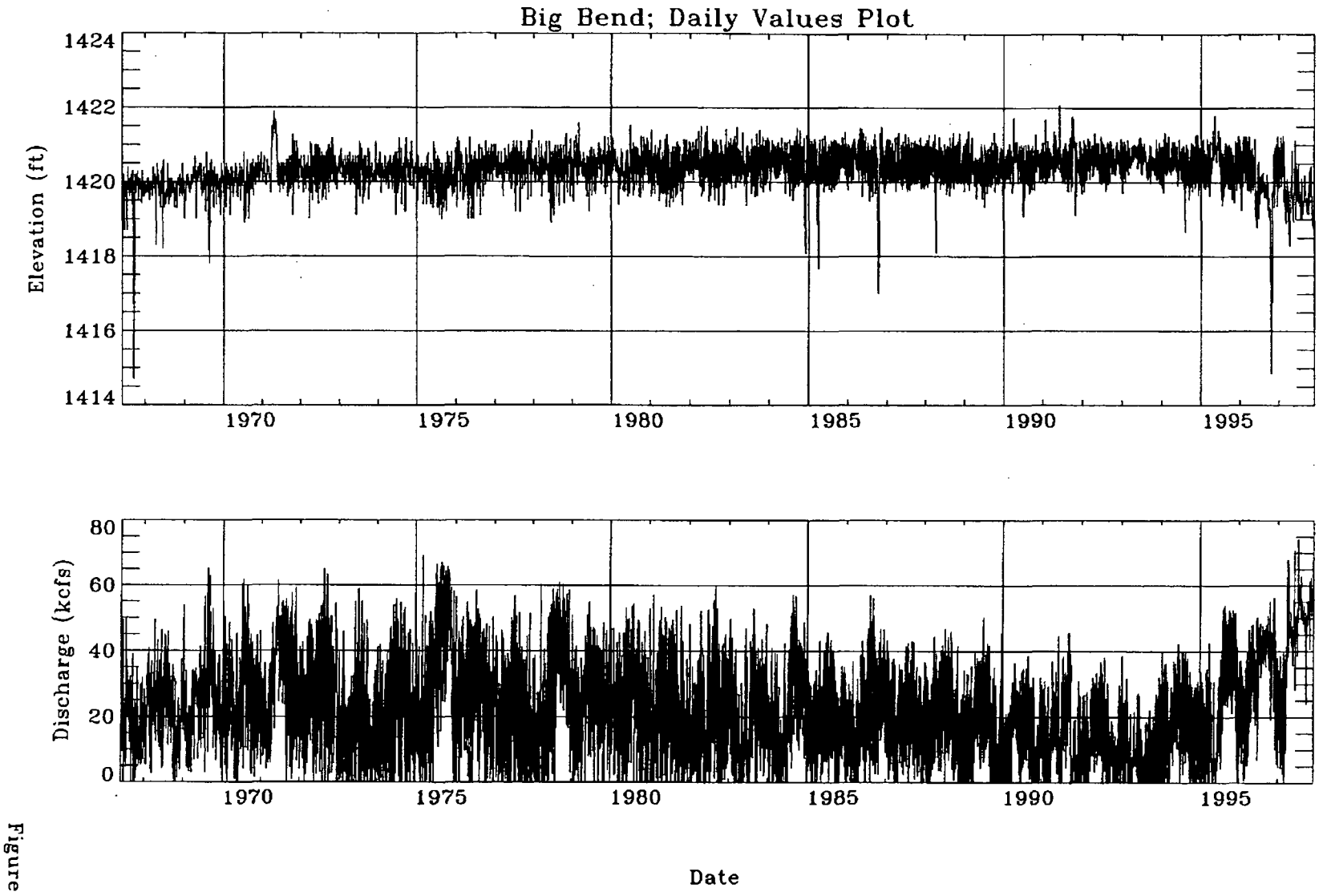

Big Bend; Daily Values Plot
Elevation (ft)
1424
1422
1420
1418
1416
1414
1970
1975
1980
1985
1990
1995
Discharge (kcfs)
80
60
40
20
0
1970
1975
1980
1985
1990
1995
Date

Figure 17

LAKE SHARPE

POOL DURATION RELATIONSHIP

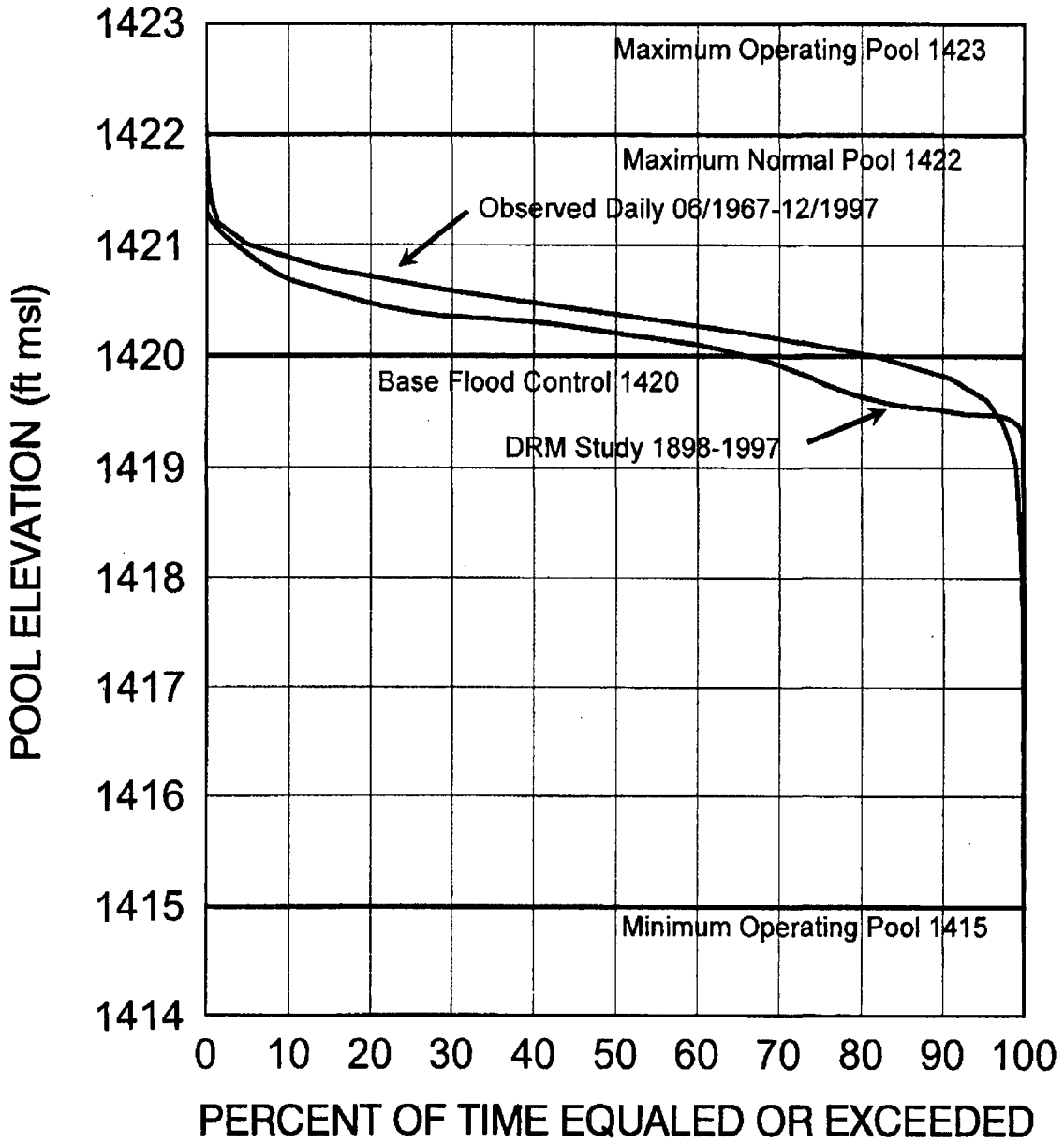


FIGURE 18

BIG BEND DAM

RELEASE DURATION RELATIONSHIP

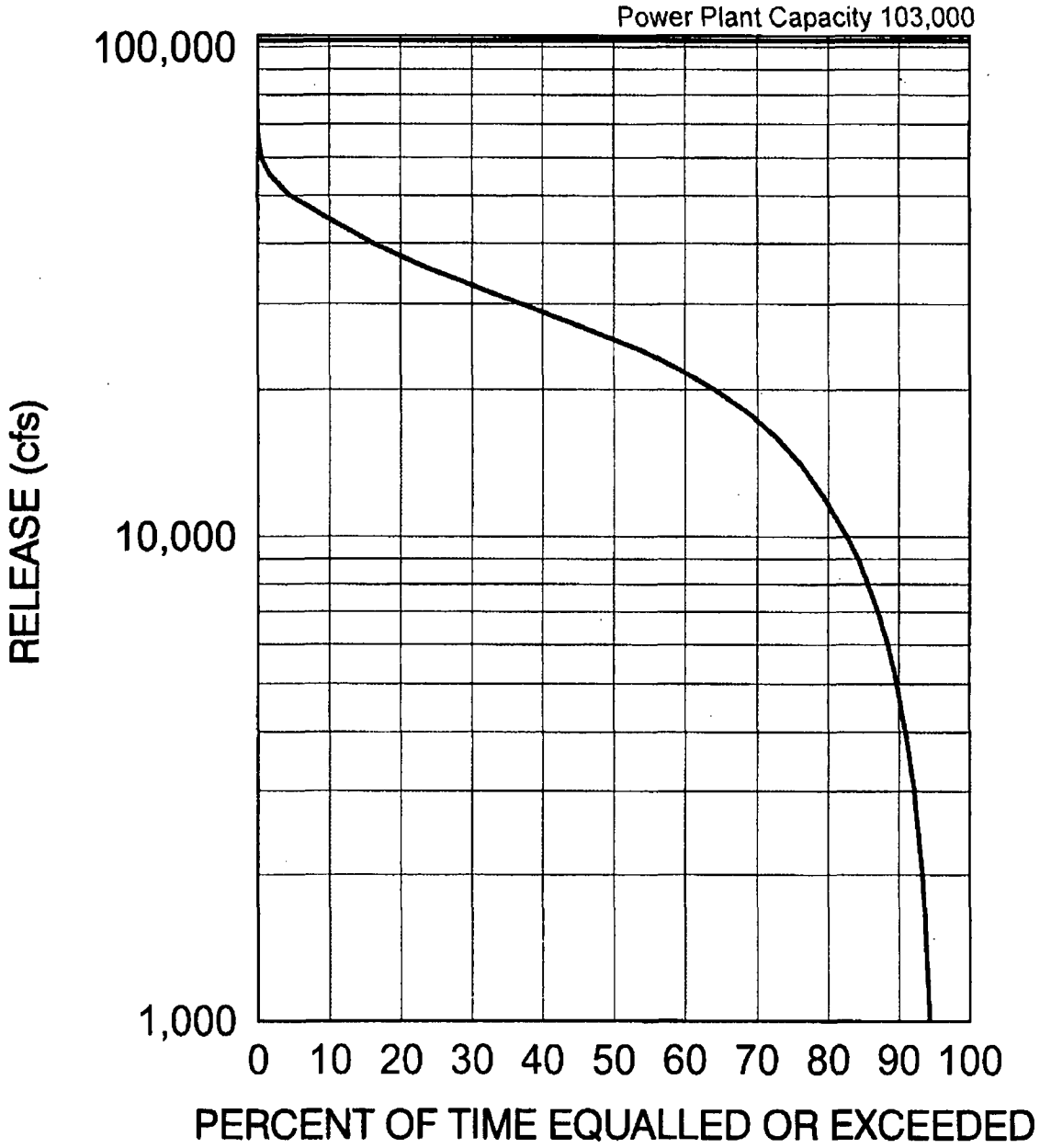
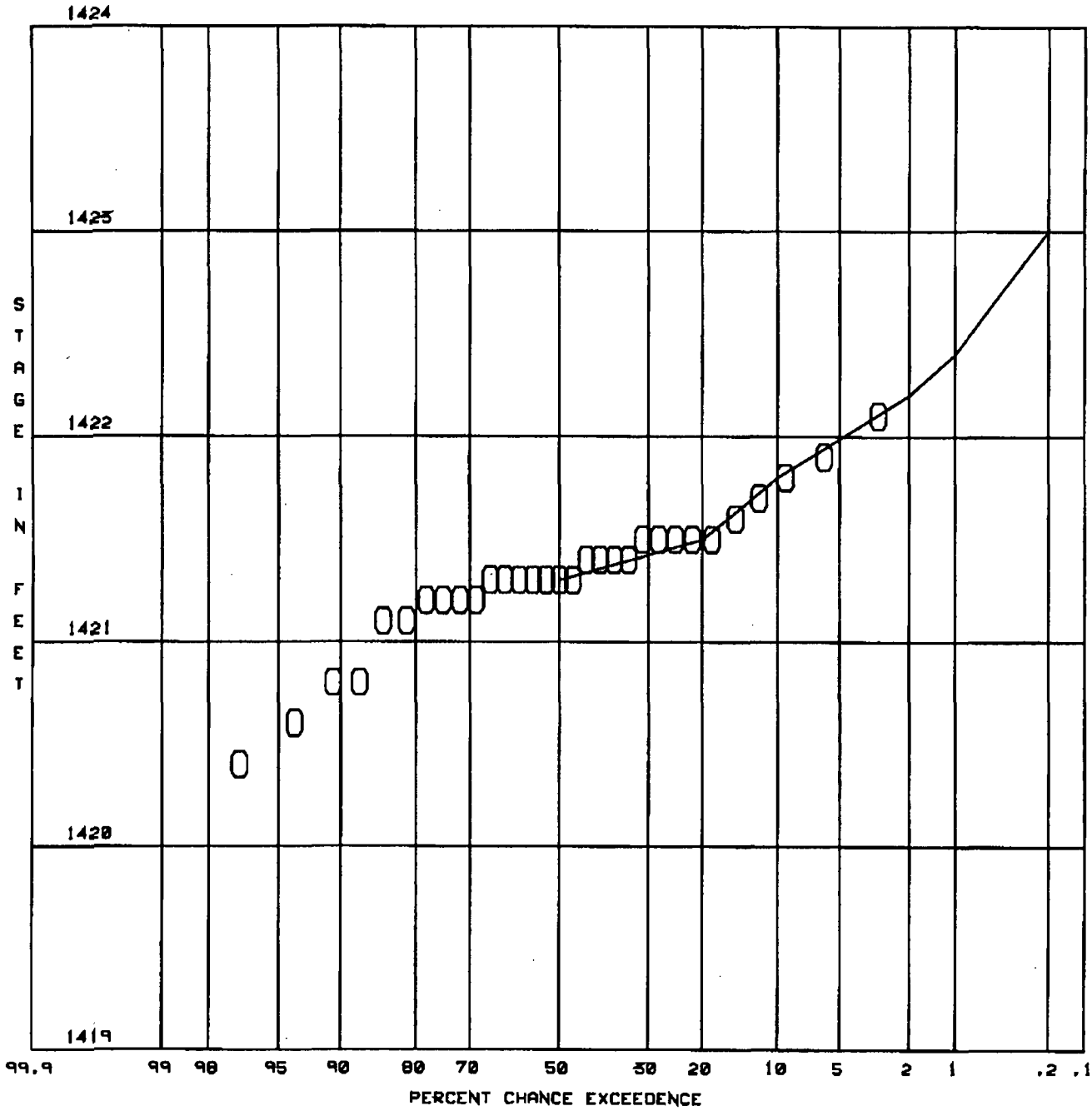


FIGURE 19

FILE:BENDEL.LP3

DATE:12/22/98

LAKE SHARPE



LEGEND:

O OBSERVED

——— ADOPTED

MAX POOL ELEVATION • 1423.6
MAX OP. POOL ELEV • 1423.0
MAX NORMAL POOL ELEV • 1422.0
BASE FLOOD CONTROL • 1420.0

MISSOURI RIVER MAIN STEM RESERVOIRS

POOL-PROBABILITY RELATIONSHIP

BIG BEND

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

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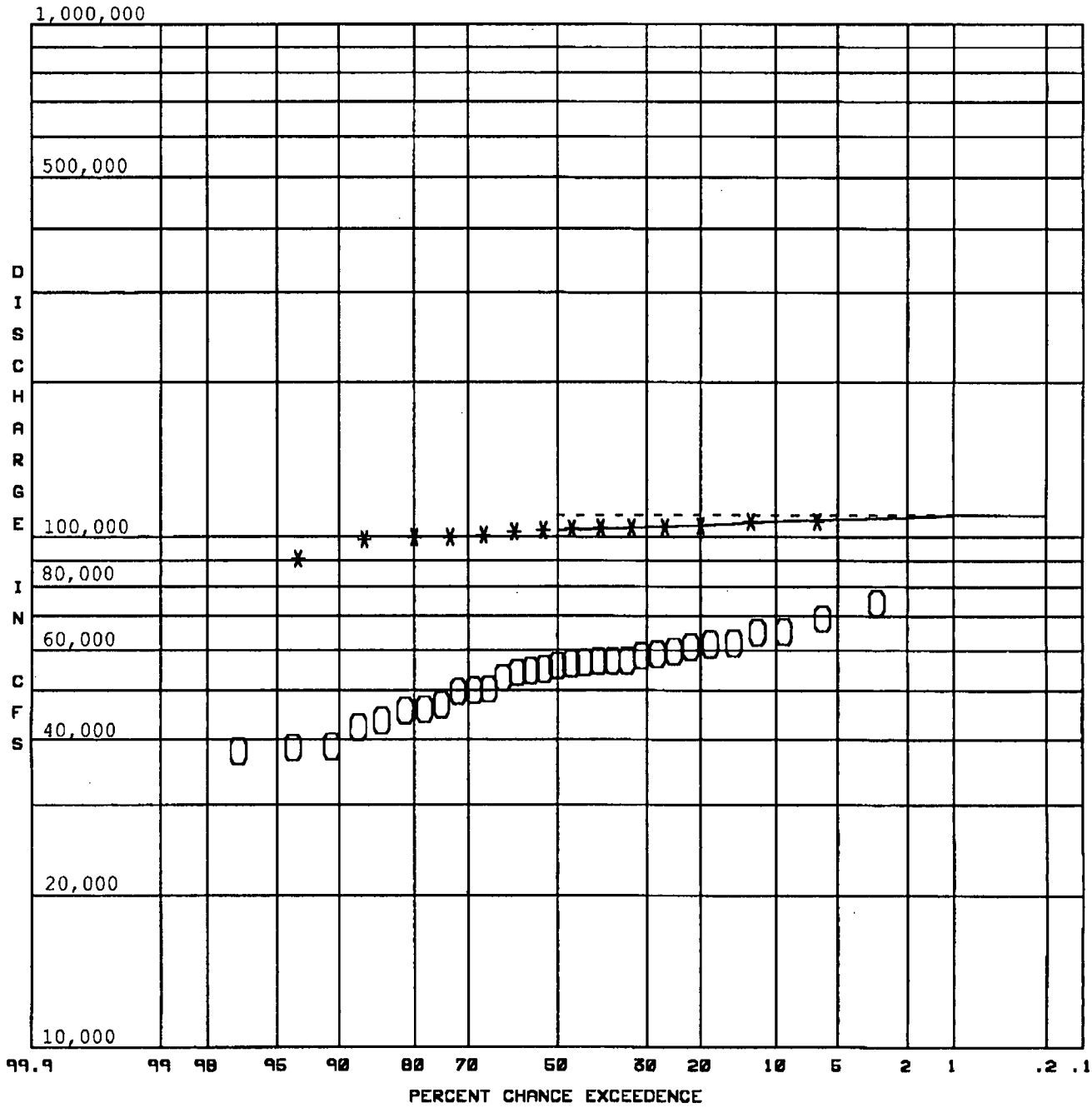
FIGURE 20

FILE:BENDRE.LP3

DATE:12/22/98

BIG BEND DAM



LEGEND:

0 OBSERVED

* MAX HOURLY

——— ADOPTED

- - - - 1976 STUDY

POWER PLANT CAPACITY - 103,000

OUTLET CAPACITY - 0

SPILLWAY CAPACITY - 390,000

MISSOURI RIVER MAIN STEM RESERVOIRS

RELEASE-PROBABILITY RELATIONSHIP

BIG BEND

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

FEBRUARY 1999

FIGURE 21

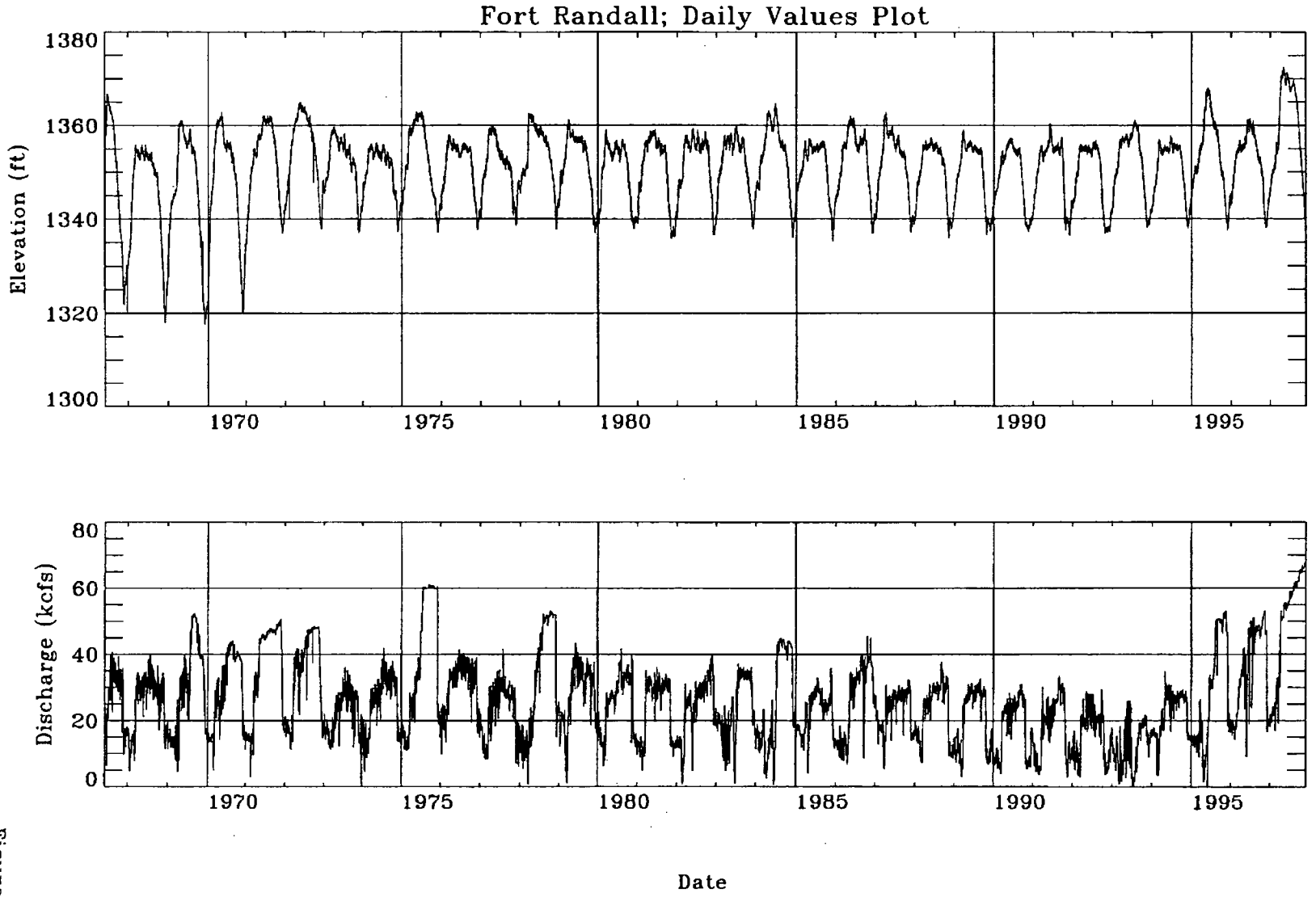

Fort Randall; Daily Values Plot
Elevation (ft)
1380
1360
1340
1320
1300
1970
1975
1980
1985
1990
1995
Discharge (kcfs)
80
60
40
20
0
1970
1975
1980
1985
1990
1995
Date

Figure 22

LAKE FRANCIS CASE

POOL DURATION RELATIONSHIP

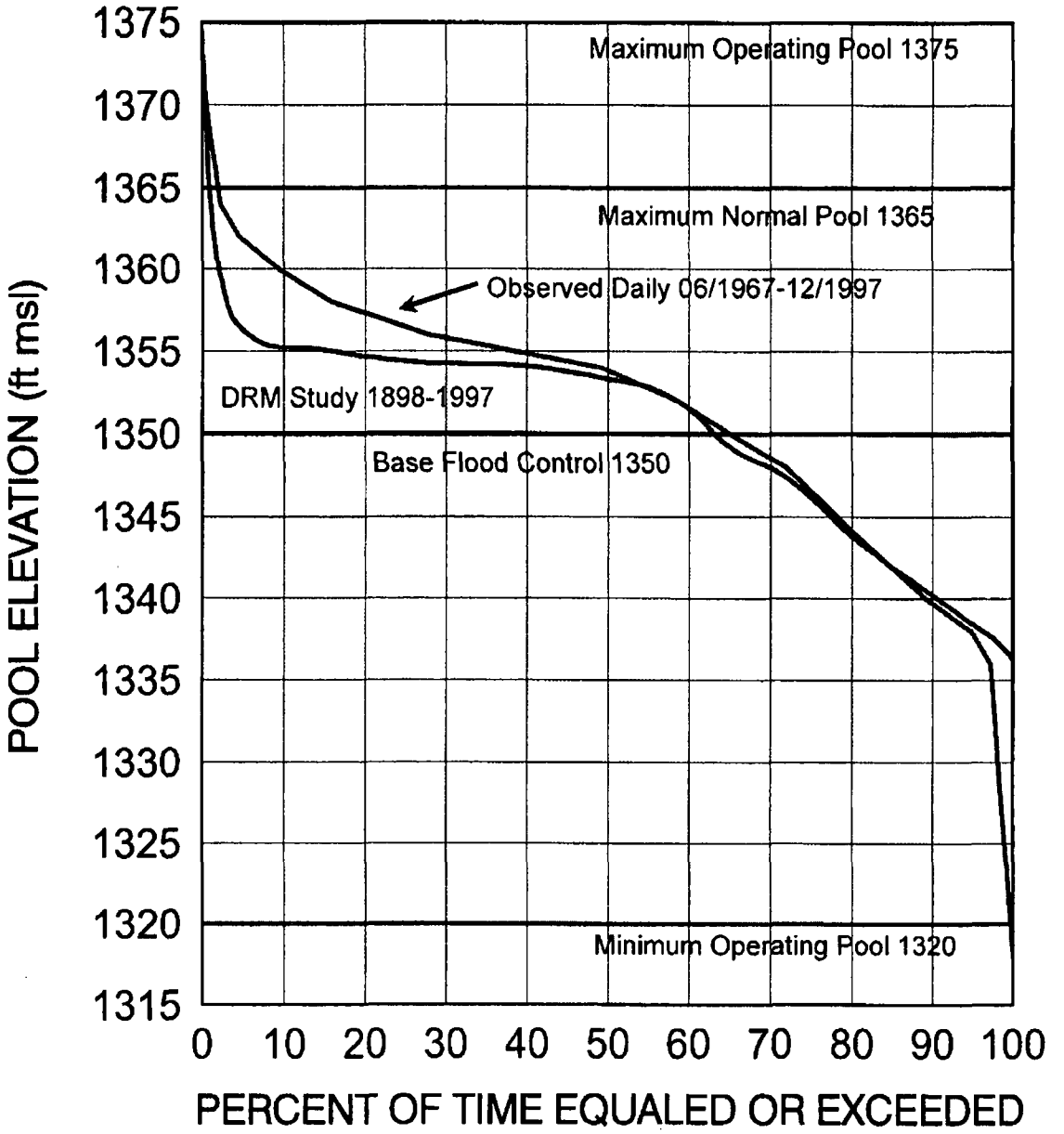


FIGURE 23

FORT RANDALL DAM

RELEASE DURATION RELATIONSHIP

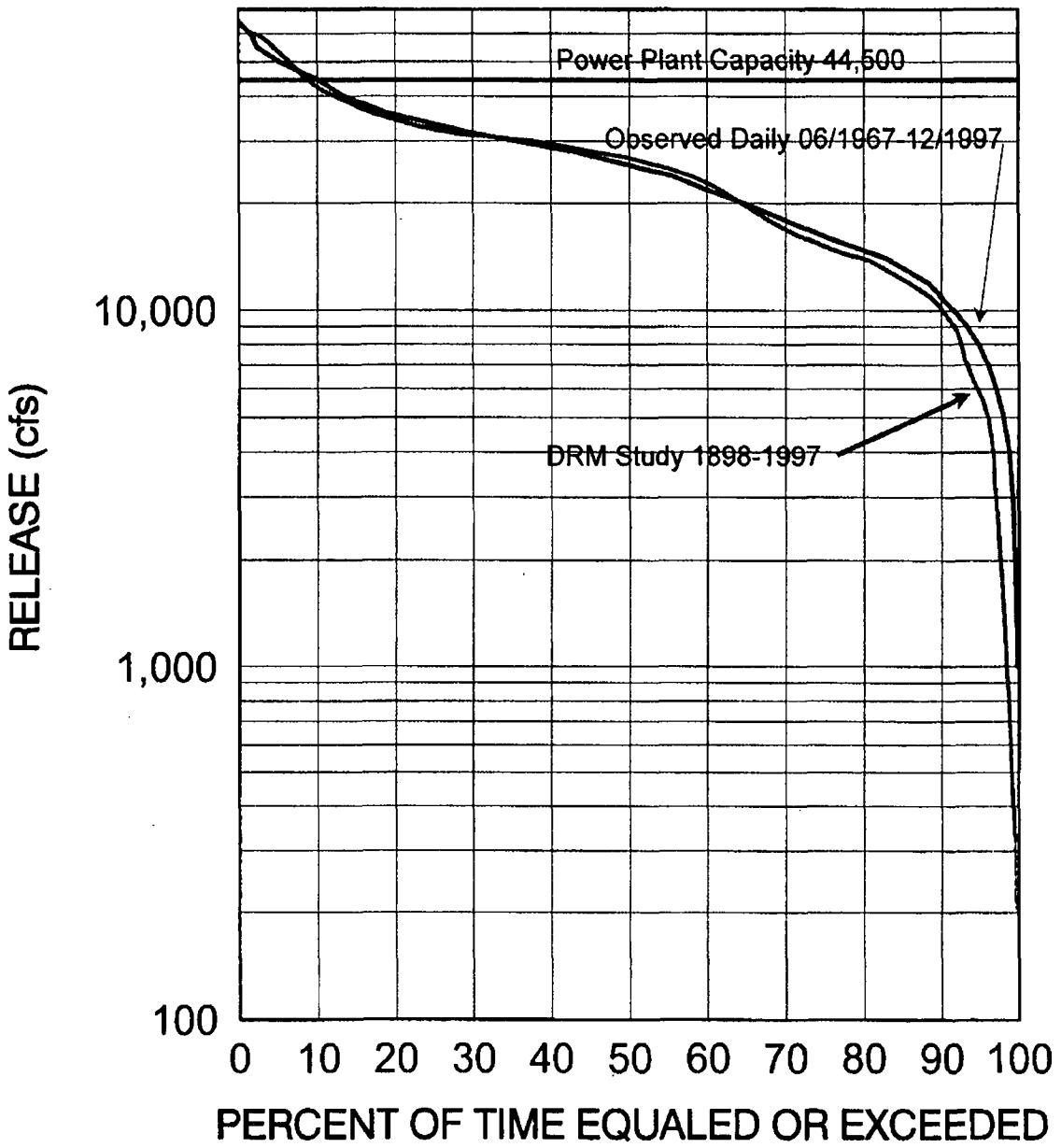
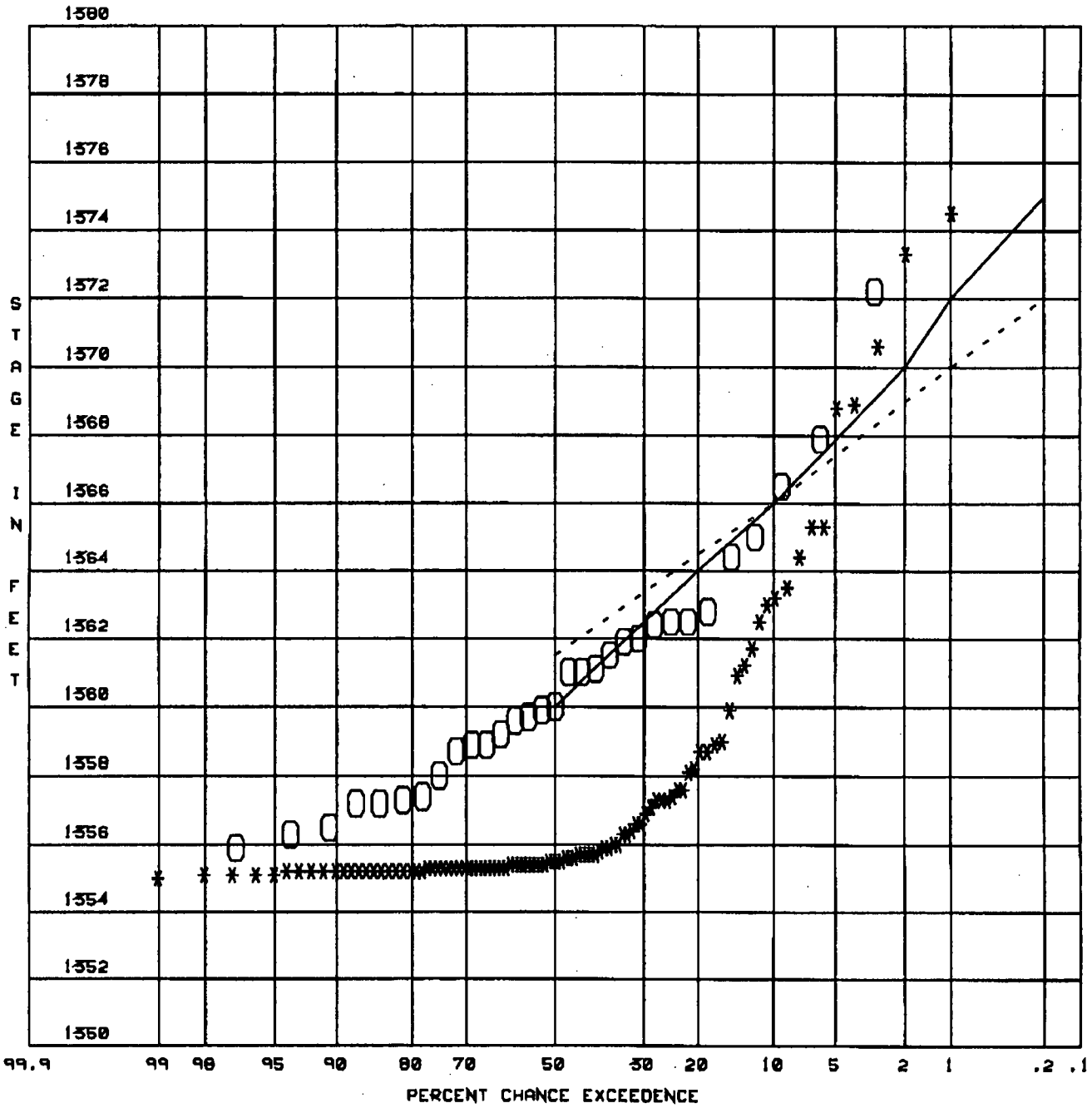


FIGURE 24

FILE:RANDEL.LP3

DATE:12/22/98

LAKE FRANCIS CASE



LEGEND:

O OBSERVED

* SIMULATED

——— ADOPTED

- - - - 1976 STUDY

MAX POOL ELEVATION - 1579.3

MAX OP. POOL ELEV - 1575.0

MAX NORMAL POOL ELEV - 1565.0

BASE FLOOD CONTROL - 1550.0

MISSOURI RIVER MAIN STEM RESERVOIRS

POOL-PROBABILITY RELATIONSHIP

FORT RANDALL

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

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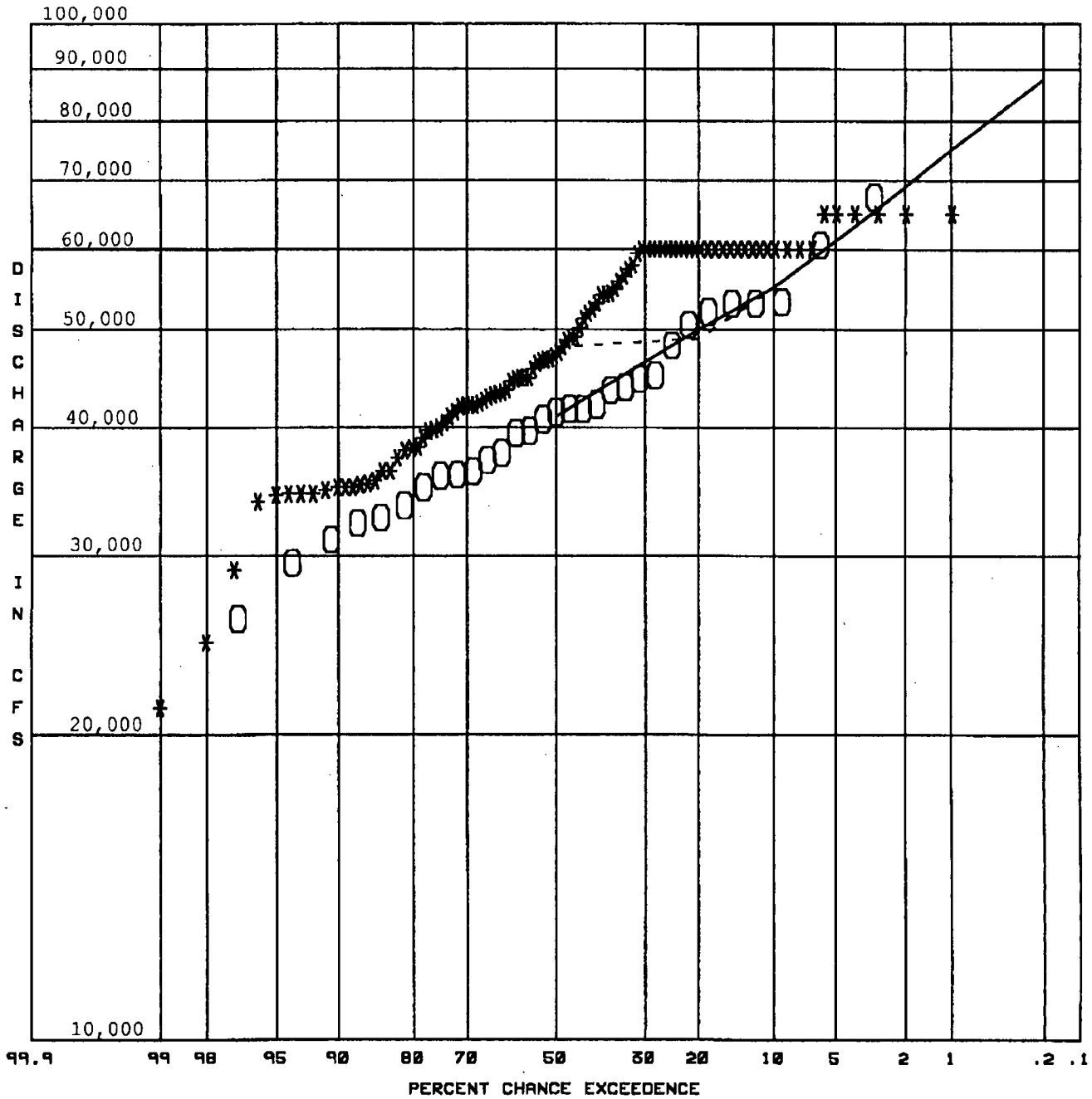
FIGURE 25

FILE:RANDRE.LP3

DATE:12/22/98

FORT RANDALL DAM



LEGEND:

O OBSERVED

* SIMULATED

——— ADOPTED

- - - - 1976 STUDY

POWER PLANT CAPACITY - 44,500

OUTLET CAPACITY - 128,000

SPILLWAY CAPACITY - 620,000

MISSOURI RIVER MAIN STEM RESERVOIRS

RELEASE-PROBABILITY RELATIONSHIP

FORT RANDALL

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

FEBRUARY 1999

FIGURE 26

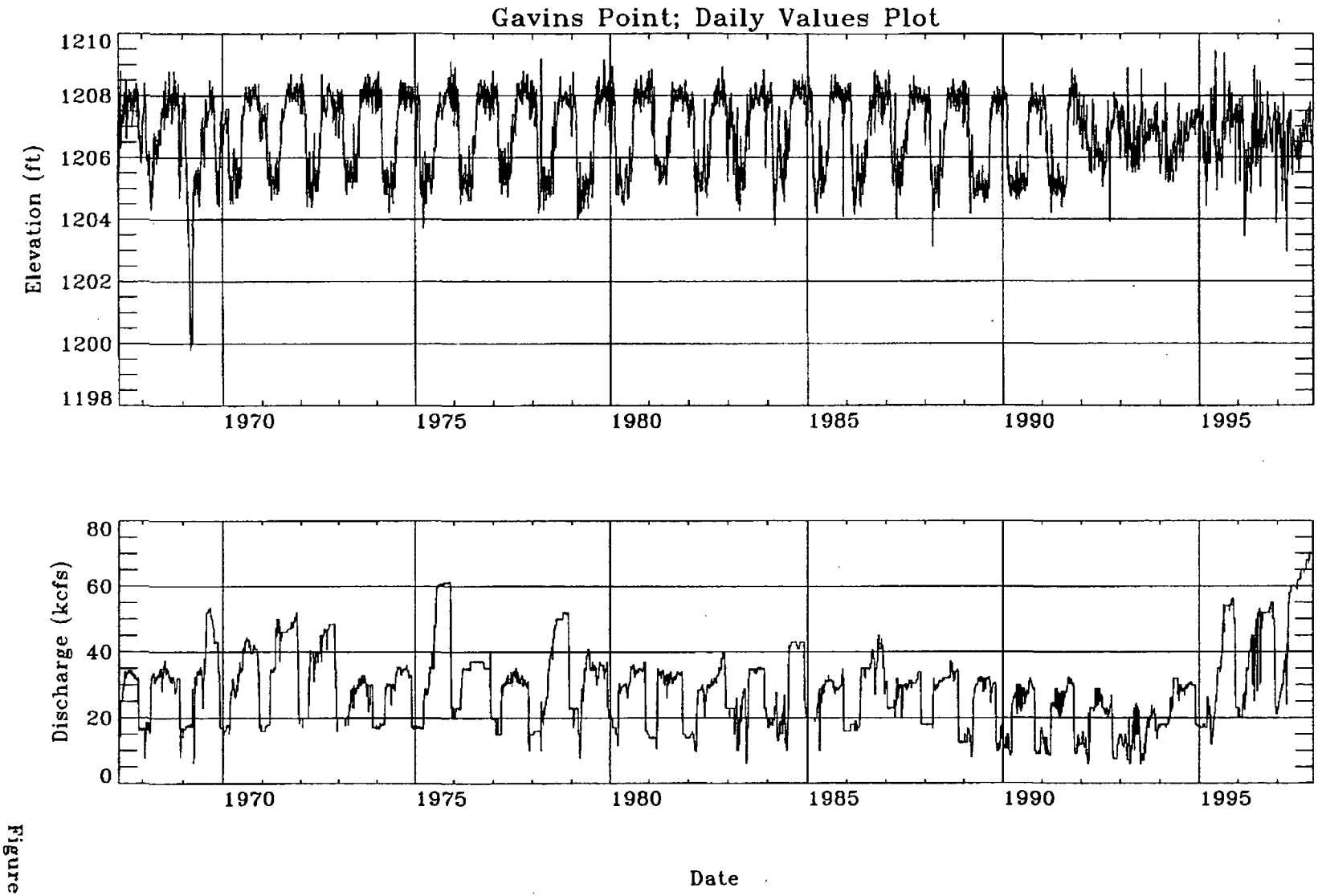

Gavins Point; Daily Values Plot
Elevation (ft)
1210
1208
1206
1204
1202
1200
1198
1970
1975
1980
1985
1990
1995
Discharge (kcfs)
80
60
40
20
0
1970
1975
1980
1985
1990
1995
Date

Figure 27

LEWIS & CLARK LAKE

POOL DURATION RELATIONSHIP

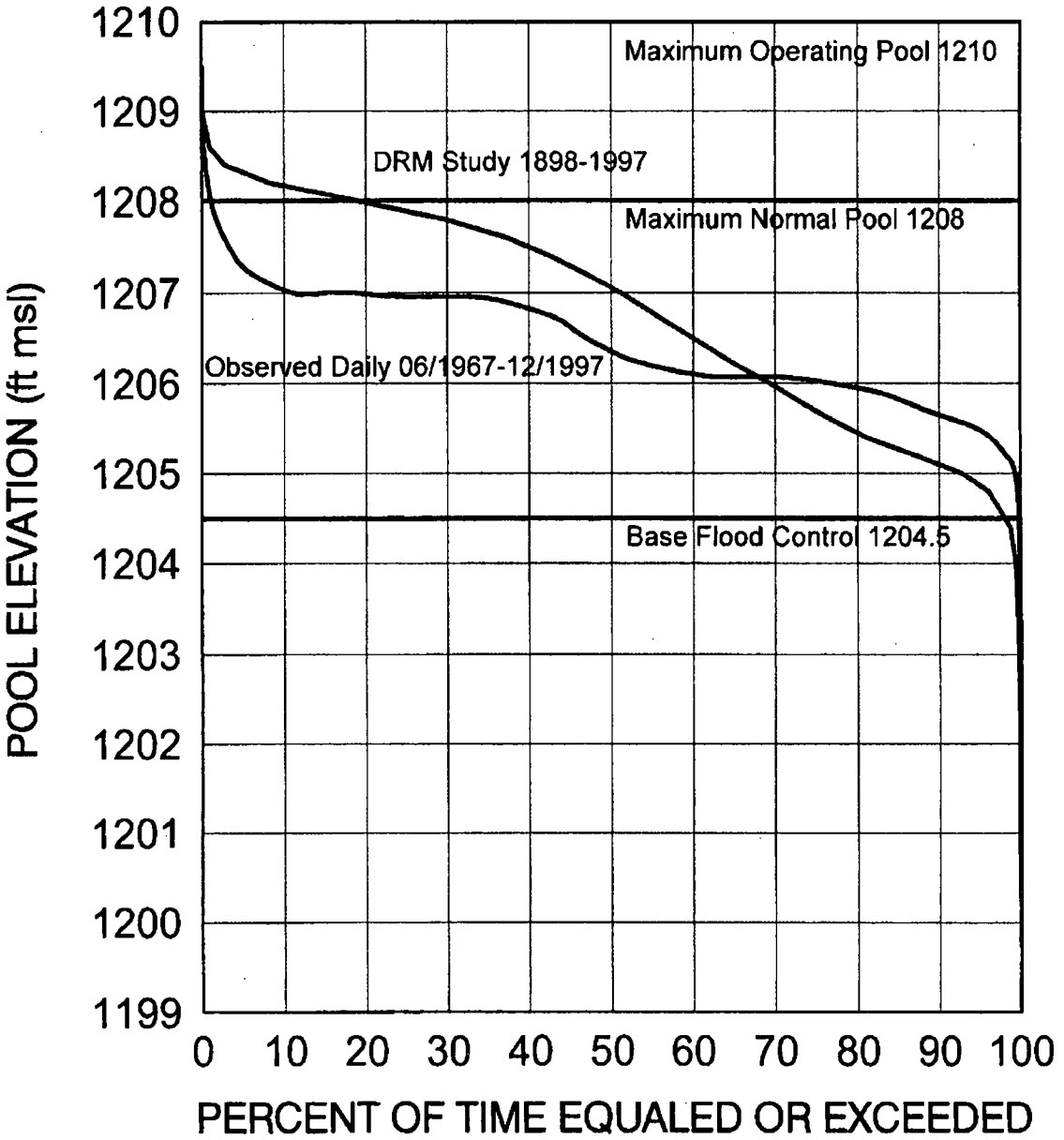


FIGURE 28

GAVINS POINT DAM

RELEASE DURATION RELATIONSHIP

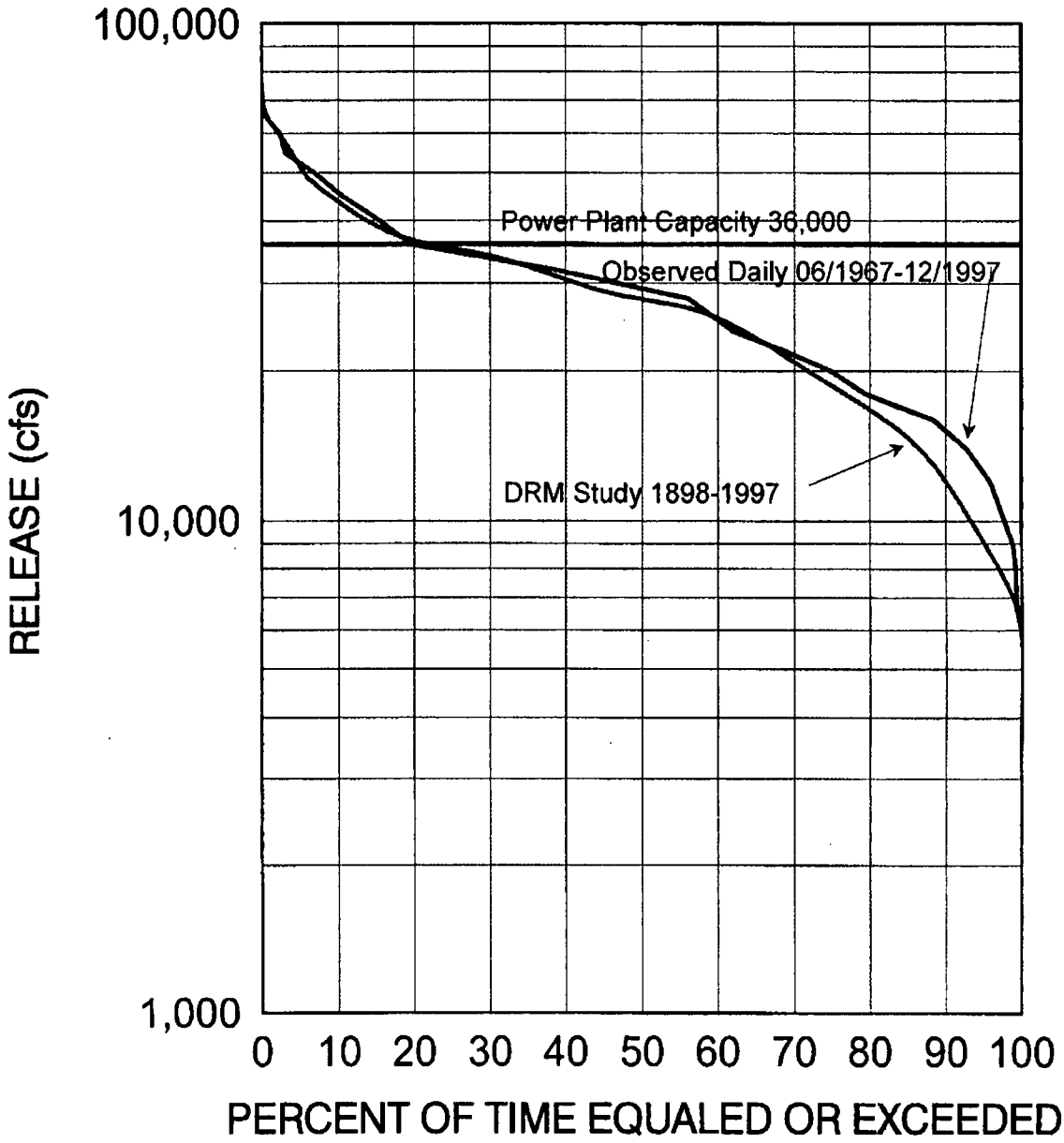
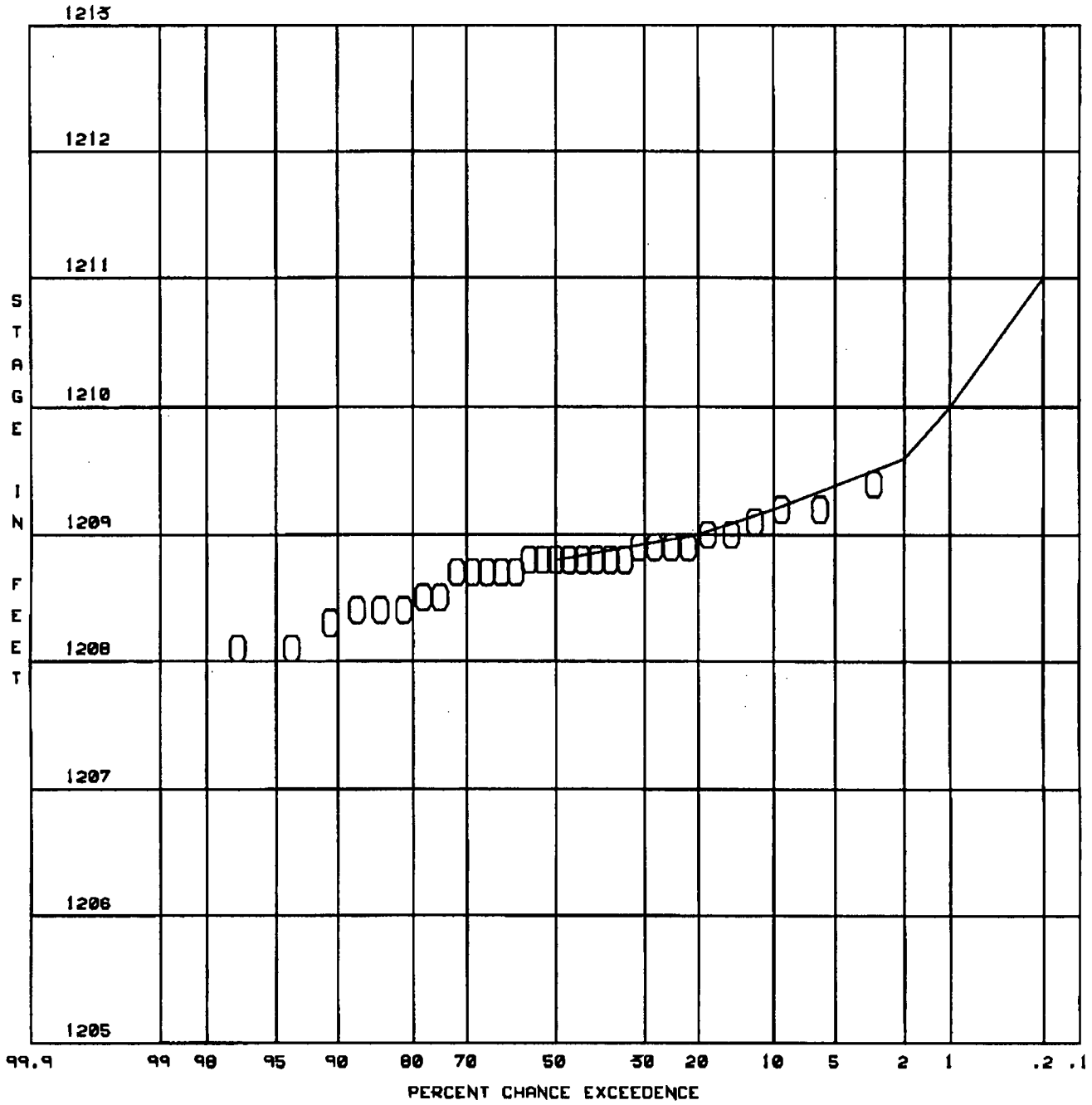


FIGURE 29

FILE:GAVNEL.LP3

DATE:12/22/98

LEWIS & CLARK LAKE



LEGEND:

0 OBSERVED

——— ADOPTED

MAX POOL ELEVATION = 1221.4

MAX OP. POOL ELEV = 1210.0

MAX NORMAL POOL ELEV = 1208.0

BASE FLOOD CONTROL = 1204.5

MISSOURI RIVER MAIN STEM RESERVOIRS

POOL-PROBABILITY RELATIONSHIP

GAVINS POINT

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

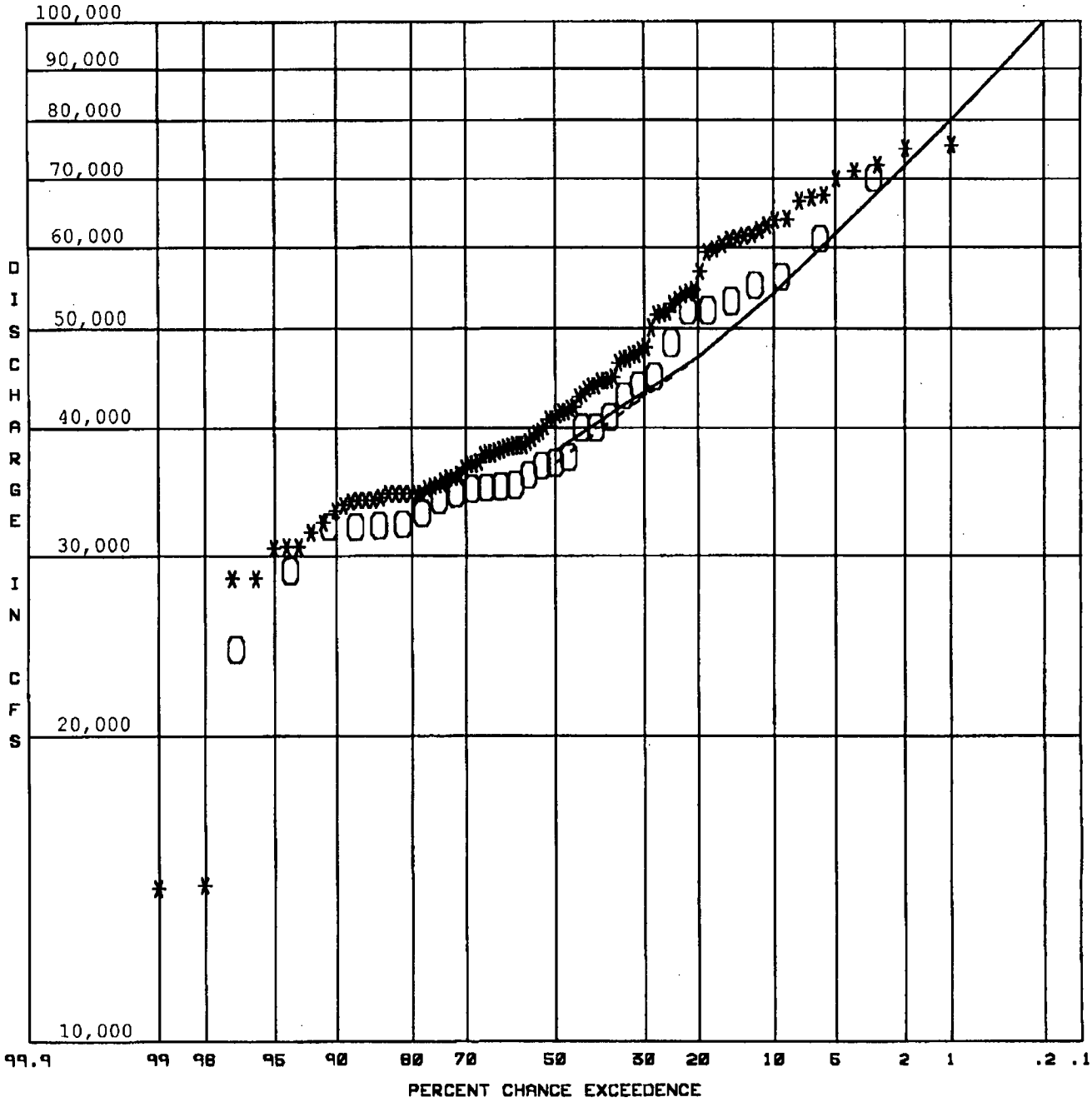
FEBRUARY 1999

FIGURE 50

FILE:GAVNRE.LP5

GAVINS POINT DAM

DATE:02/08/99



LEGEND:

O OBSERVED

* SIMULATED

——— ADOPTED

- - - - 1976 STUDY

POWER PLANT CAPACITY - 36,000

OUTLET CAPACITY - 0

SPILLWAY CAPACITY - 584,000

MISSOURI RIVER MAIN STEM RESERVOIRS

RELEASE-PROBABILITY RELATIONSHIP

GAVINS POINT

RESERVOIR CONTROL CENTER

MISSOURI RIVER REGION

U.S. ARMY CORPS OF ENGINEERS

FEBRUARY 1999

FIGURE 31

Perkins, Richard

From: Perkins, Richard
Sent: Friday, December 16, 2011 9:25 AM
To: Beasley, Benjamin
Subject: FW: GI-204 Status Update
Attachments: Declaration Timeline.pptx

From: Perkins, Richard
Sent: Wednesday, December 14, 2011 4:37 PM
To: Barker, Allan; Bartley, Jonathan; Beasley, Benjamin; Beaulieu, David; Bensi, Michelle; Burnell, Scott; Cahill, Christopher; Caverly, Jill; Chaput, Peter; Coe, Doug; Compton, Keith; Correia, Richard; Emche, Danielle; Erlanger, Craig; Felsher, Harry; Ferrante, Fernando; Gaddy, Vincent; Hills, David; Hilton, Nick; Hollian, Brian; Ibarra, Jose; Imboden, Andy; Kauffman, John; Khanna, Meena; Logaras, Harral; Maier, Bill; Marcano, Jonathan; McNamara, Nancy; Meghani, Vijay; Miller, Chris; Mitman, Jeffrey; Mrowca, Lynn; Perkins, Richard; Philip, Jacob; Pohida, Marie; Raione, Richard; Riley (OCA), Timothy; Rosenberg, Stacey; Ruland, William; Sancaktar, Selim; Schmidt, Wayne; Screnci, Diane; See, Kenneth; Sheehan, Neil; Tifft, Doug; Trojanowski, Robert; Virgilio, Rosetta; Wilson, George; Wilson, Peter; Woodruff, Gena; Wray, John
Subject: GI-204 Status Update

GI-204 Communication Team,

The proposed GI-204 recommendation is currently with the RES Director for review and consideration. If GI-204 is approved, we will proceed in accordance with the coordinated declaration timeline. For your convenience, I have attached a copy of that timeline. Please take a look at it if you have any questions. I will send out another update if there is any change in the status.

Regards,

Richard H. Perkins, P.E.
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch
Phone - 301/251-7479

GI-204 Declaration Timeline – ~~Internal Information – Not for Public Release~~

Documents Required for GI Declaration:	Status
Recommendation Memo from GI Review Panel	Approved by GI Review Panel.
Communication Plan (non public)	Approved and available for use
Screening Analysis Report (enclosure)	Completed and final (not released)
OPA Press Release	Approved by Chairman's Office – awaiting release Subject to continuing edits in real time

Significant Critical Path Tasks:

With RES Director for review and consideration for approval

Sequence and Timeline: [Organization responsible for action]

---	Formal coordination of Communication Plan is completed
---	RES Director: Signs out Communication Plan (non public)
---	Approved Communication Plan is distributed to communication team [RES]
-3 work days	RES Director: Approves GI Recommendation Memo (release clock begins)
-3 work days	Public release day (not Friday) and time is selected with OPA [OPA & RES]
-3 work days	'Heads up' notification to Regional State Liaison Officers (RSLOs) and OCA [RES]
-2 work days	Communication Team is notified of release day and time [RES]
-2 work days	Communication Team notifies internal stakeholders [Communication Team Members]
As appropriate	RSLO actions and communications with States [RSLOs]
0 time	OPA Press Release [OPA]
+1 hour	Recommendation Memo and Screening Analysis Report become publicly available in ADAMS [RES]
+1 hour	Communication Team is notified of press release and document status [RES]

POC: Richard Perkins,
NRC/RES/DRA/OEGIB
richard.perkins@nrc.gov
301-251-7479

Perkins, Richard

From: Perkins, Richard
Sent: Monday, December 19, 2011 11:19 AM
To: ADAMS IM
Cc: Siu, Carolyn
Subject: RE: Add to package

Thanks for the info.
Richard

From: Rathje, M. Jean **On Behalf Of** ADAMS IM
Sent: Monday, December 19, 2011 11:17 AM
To: Perkins, Richard
Cc: Siu, Carolyn
Subject: RE: Add to package

Richard,

The documents will become available to the public the same day of the release date unless we receive the request after four in the afternoon. Anything after four is release the next morning around nine o'clock. There is no guaranty that a document can be released at a particular time but we can request DPC for an immediate release. I suggest that you send your e-mail at the start of your time frame for release and request immediate replication to the public servers. This should accomplish your request.

Jean Rathje
OIS/IRSD
ADAMS Support Center
415-1234, press 1

From: Perkins, Richard
Sent: Friday, December 16, 2011 1:54 PM
To: ADAMS IM
Cc: Siu, Carolyn
Subject: RE: Add to package

Thanks. I have one more ADAMs question. In the near future we will be making some high-profile documents (which are currently non-public, pre-decisional) public. There is a desire for these document to be available shortly after a press release is issued. My understanding is that documents usually become available to the public approximately 24 hours after the status is changed in-house. Management is asking if we can make the docs available at a particular time (plus or minus a few hours is fine). We would be able to tell you that day and time about 3 days before hand. Does ADAMS have the ability to do that?

Thanks,
Richard Perkins
301-251-7479

From: ADAMS IM
Sent: Friday, December 16, 2011 1:45 PM
To: Perkins, Richard

L/22

Cc: Siu, Carolyn
Subject: RE: Add to package

It will not be a problem to replace/exchanged your updates to the Draft file ML113500172. And as long as it remains Draft – owners will be able to perform the exchange.

Thanks
Susie Hicks
OIS/IRSD
On behalf of ADAMS Support

From: Perkins, Richard
Sent: Friday, December 16, 2011 11:41 AM
To: ADAMS IM
Cc: Siu, Carolyn
Subject: RE: Add to package

Thanks. We would like to be able to continue to modify this document over the next few weeks / months. We are using it as a "living" document, but I wanted to put this living document in the original communication plan package so people would see it when they went to look there for the communication plan. Will that be a problem? If it is a problem – or if it will become locked – we could pull it out of the package and place it as a stand-alone document.

Richard Perkins
301-251-7479

From: ADAMS IM
Sent: Friday, December 16, 2011 11:19 AM
To: Siu, Carolyn
Cc: Perkins, Richard
Subject: RE: Add to package

Document ML113500172 has been added to ADAMS Package ML112220477.

Please keep in mind that currently document ML113500172 is not an Official Record. Once the file is placed in the DocProcessing Center folder, they will finalize/declare the document. ADAMS IM does not Declare files.

Thanks
Susie Hicks
OIS/IRSD
On behalf of ADAMS Support

From: Siu, Carolyn
Sent: Friday, December 16, 2011 10:33 AM
To: ADAMS IM

Cc: Perkins, Richard
Subject: Add to package

Good morning,

Please add attached document ML113500172 to package ML112220477. **Please note that while the package is an official record, the attached document needs to remain in draft format.** Thank you!

Carolyn Siu
Contract Administrative Assistant II
Office of Nuclear Regulatory Research
Division of Risk Analysis
U.S. Nuclear Regulatory Commission
CSB-4A06
division line: 301-251-7430
direct line: 301-251-7568
fax: 301-251-7424
Carolyn.Siu@nrc.gov

some stories are true that never happened.

Perkins, Richard

From: Coe, Doug
Sent: Wednesday, December 21, 2011 1:07 PM
To: Lee, Samson; Hiland, Patrick; Cheok, Michael; McGinty, Tim; Nelson, Robert; Bahadur, Sher; Ruland, William; Ader, Charles; Lombard, Mark; Chokshi, Nilesh; Flanders, Scott; Camper, Larry; Persinko, Andrew; Piccone, Josephine; Jackson, Deborah; Kinneman, John; Bailey, Marissa; Weaver, Doug; Roberts, Darrell; Ayres, David; Miller, Chris; Wilson, Peter; Croteau, Rick; Jones, William; Munday, Joel; Christensen, Harold; Reynolds, Steven; OBrien, Kenneth; West, Steven; Shear, Gary; Kennedy, Kriss; Pruett, Troy; Vegel, Anton; Blount, Tom; Brenner, Eliot; Schmidt, Rebecca; Powell, Amy; Campbell, Andy; Doane, Margaret; Moore, Scott; Skeen, David; Taylor, Robert; Clifford, James; Stapleton, Bernard
Cc: Perkins, Richard; Barker, Allan; Bartley, Jonathan; Beasley, Benjamin; Beaulieu, David; Bensi, Michelle; Burnell, Scott; Cahill, Christopher; Caverly, Jill; Chaput, Peter; Compton, Keith; Correia, Richard; Emche, Danielle; Erlanger, Craig; Felsher, Harry; Ferrante, Fernando; Gaddy, Vincent; Hills, David; Hilton, Nick; Holian, Brian; Ibarra, Jose; Imboden, Andy; Kauffman, John; Khanna, Meena; Logaras, Harral; Maier, Bill; Marcano, Jonathan; McNamara, Nancy; Meghani, Vijay; Miller, Chris; Mitman, Jeffrey; Mrowca, Lynn; Philip, Jacob; Pohida, Marie; Raione, Richard; Riley (OCA), Timothy; Rosenberg, Stacey; Ruland, William; Sancaktar, Selim; Schmidt, Wayne; Screnci, Diane; See, Kenneth; Sheehan, Neil; Tifft, Doug; Trojanowski, Robert; Virgilio, Rosetta; Wilson, George; Wilson, Peter; Woodruff, Gena; Wray, John; Holian, Brian; Sheron, Brian; Case, Michael; Richards, Stuart; Gibson, Kathy; Scott, Michael; Muessle, Mary; Littlejohn, Jennene; Siu, Carolyn
Subject: Generic Issue 204 (Upstream Dam Failure) - DEDO briefing slides
Attachments: GI-204 CommunicationPlan_WorkingDraft 2011_9_12_2011.pdf

All,

Briefing slides for this afternoon's briefing.

4:00pm in O-17B4.

Doug

L/23

Generic Issue #204

Flooding of Nuclear Power Plant Sites Following Upstream Dam Failure

Richard Perkins
Michelle Bensi

Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch

Visit our intranet website at
http://www.internal.nrc.gov/RES/projects/GIP

Objectives of briefing

- ✓ Review coordination activities (past & ongoing)
- ✓ Provide high-level overview of topic
- ✓ Describe content of screening analysis

Brief History

- Proposed by NRR in July 2010
- Accepted for review by GI Program in August 2010
- Screening Analysis essentially completed in March 2011
- Internal review of analysis slowed to address information sensitivity
- Generic Issue Review Panel and Office Director approval delayed to address scope of issue
- Ready for approval and currently preparing for release

Major Phases of GI-204 Coordination

- Development and concurrence:
  - Screening analysis
  - Review Panel recommendation
- Coordination of the communication plan
- Rollout coordination

GI-204 Declaration Timeline – Internal Information – Not for Public Release

Documents Required for GI Declaration:	Status
Recommendation Memo from GI Review Panel	Approved by GI Review Panel.
Communication Plan (non public)	Approved and available for use
Screening Analysis Report (enclosure)	Completed and final (not released)
OPA Press Release	Approved by Chairman's Office – awaiting release Subject to continuing edits in real time

Significant Critical Path Tasks:

With RES Director for review and consideration for approval

Sequence and Timeline: [Organization responsible for action]

---	Formal coordination of Communication Plan is completed
---	RES Director: Signs out Communication Plan (non public)
---	Approved Communication Plan is distributed to communication team [RES]
-3 work days	RES Director: Approves GI Recommendation Memo (release clock begins)
-3 work days	Public release day (not Friday) and time is selected with OPA [OPA & RES]
-2 work days	Communication Team is notified of release day and time [RES]
-2 work days	Communication Team notifies internal stakeholders [Communication Team Members]
As appropriate	RSLO actions and communications with States, Congress, and licensees per normal procedure [OCA, Regions]
0 time	OPA Press Release [OPA]
+1 hour	Recommendation Memo and Screening Analysis Report become publicly available in ADAMS [RES]
+1 hour	Communication Team is notified of press release and document status [RES]

POC: Richard Perkins,
NRC/RES/DRA/OEGIB
richard.perkins@nrc.gov
301-251-7479

High-level overview of topic: Key Messages

- No immediate safety concerns were identified
- Screening analysis was completed <u>before</u> events at Fukushima and Fort Calhoun Station
- Screening analysis was a limited scope assessment of whether issue should become a GI
- Reevaluation of the effect of dam failures is appropriate based on new information
- Evaluation of the issue will continue in the next stage of the Generic Issues Program

High-level overview of topic: Scope

- Generic Issue #204 applies to:
  - Operating nuclear power plants
  - Spent fuel pools
  - Sites undergoing decommissioning with spent fuel still in the spent fuel pools

- Related technical issues addressed as separately proposed Generic Issues:
  - Effect of downstream dam failures on availability of cooling water
    - Proposed & accepted (PreGI-011) – currently undergoing screening
  - Effect of upstream dam failures on fuel facilities
    - Issue has been proposed – currently undergoing acceptance review
  - Effect of external flooding on ISFSIs
    - Proposal is drafted but not yet submitted to Generic Issues Program

Interactions with other agencies

- Permission obtained from USACE for use of National Inventory of Dams data
- Presentation at meeting of Interagency Committee on Dam Safety
- Establishing points of contact at USACE, Bureau of Reclamation, and FERC for coordination of upcoming assessment
- NSIR discussions with FERC regarding release of screening analysis report
- Coordinating with NSIR on question of whether engagement with DHS is appropriate

High-level overview of topic: Potential sensitivities

- Public-availability
  - Report will be released publically with one paragraph redacted
  - Report references documents that are not publically available

- For some plants, the screening analysis calculated low or negative margin under certain flood events when using prescribed assumptions
  - Additional details about analysis provided later in presentation

- Report is expected to draw attention to several plants:
  - Oconee
  - Fort Calhoun
  - Other plants listed in the report

High-level overview of topic: Plant names appearing in screening analysis

- **Region 1**
  - Beaver Valley
  - Hope Creek
  - Indian Point
  - Peach Bottom
  - Three-Mile Island
  - Vermont Yankee
- **Region III**
  - Prairie Island
- **Region II**
  - Browns Ferry
  - McGuire
  - Oconee
  - H.B. Robinson
  - Sequoyah
  - Surry
  - Watts Bar
- **Region IV**
  - Arkansas Nuclear
  - Columbia
  - Cooper
  - Fort Calhoun
  - South Texas
  - Waterford

Main conclusions from screening analysis

- Questions have been raised regarding:
  - The accuracy of older flood estimates
  - Our understanding of dam failure frequency estimation
  - The reliability of flood protection

- A review of plant-specific documents indicates:
  - Inconsistencies in the treatment of dam failures and assumed coincident/antecedent conditions
  - For some plants, the maximum design-basis flood or the IPEEE beyond design basis flood is greater than the plant's mitigation capability when reduced by not crediting certain actions/components approved during licensing
  - Some flooding events were "screened out" in IPEEE, FSAR, etc. (reconsideration may be appropriate based on current knowledge)
  - Some plants rely on the placement of temporary barriers or submerged operation of components

- A review of regulatory documents indicates:
  - Regulatory guidance/standards related to dam failures have evolved over time and plants were licensed under different regulatory standards

- Further assessment as a Generic Issue is warranted

Current and Future Activities

- Next steps:
  - Continue coordination with NRC Offices and Regions
  - Consider document(s) to be included with the GI recommendation to:
    - Add context regarding the relationship between our licensing, oversight, backfit and Generic Issues processes
    - Provide an update on events and activities to date with respect to Oconee and Fort Calhoun
  - Hold a public meeting (if issue remains independent of JLD)
  - Perform Safety/Risk Assessment

Current and Future Activities (con'd)

- Preliminary activities for the safety/risk assessment have commenced:
  - Multiple "brainstorming" and planning sessions have been held
  - A preliminary project team with necessary technical expertise has been assembled
  - Work has begun to develop defensible dam failure frequency estimates
  - Coordination with JLD is underway
- If issue is absorbed by JLD work, Generic Issues Program will:
  - Confirm scope of Generic Issue is addressed
  - Document turnover clearly stating ownership
  - Continue to track issue until all agency actions are completed

Perkins, Richard

From: Beasley, Benjamin
Sent: Friday, December 23, 2011 9:41 AM
To: Cook, Christopher
Cc: Chokshi, Nilesh; Perkins, Richard
Subject: Re: Draft Recommendation for Transfer of GI-204 to JLD

Chris,

Michelle is starting a 3 month rotation to Region I (working with Wayne Schmidt) on January 4. But it will be great to engage Richard. You are welcome to send him invitations and get him involved.

Ben

Benjamin Beasley
Sent from an NRC Blackberry.

From: Cook, Christopher
To: Beasley, Benjamin
Cc: Chokshi, Nilesh
Sent: Fri Dec 23 08:53:59 2011
Subject: RE: Draft Recommendation for Transfer of GI-204 to JLD

Ben,
A technical group has been established to work on JLD Recommendations 2.1 and 2.3. The group meets approximately every 2 weeks, and also attends the public meetings. The group is also a key sounding board before we move forward on Rec 2.1/2.3 products.

I would like to request that Michelle Bensi and Richard Perkins get involved with this technical group and start attending the meetings. The next meeting is Jan 5. Please let me know if it's OK to send along the invitations and to get them in the loop.

Thanks,
Chris

From: Beasley, Benjamin
Sent: Thursday, December 22, 2011 4:13 PM
To: Cheok, Michael; Hiland, Patrick; Evans, Michele; Brown, Frederick; Chokshi, Nilesh; Flanders, Scott; Pascarelli, Robert; Miller, Ed; Hatchett, Gregory; Taylor, Robert; Skeen, David; Ruland, William; Giitter, Joseph; McGinty, Tim; Rosenberg, Stacey; Purnell, Blake; Cook, Christopher; Correia, Richard; Coe, Doug; Perkins, Richard; Bensi, Michelle; Peters, Sean; Sheron, Brian; Holian, Brian; Nicholson, Thomas
Subject: Draft Recommendation for Transfer of GI-204 to JLD
Importance: High

All,

Attached is a draft recommendation for incorporating Pre-GI-009 (GI-204) into the work being done by the JLD. Please use Track Changes to make your edits and comments in the draft. Also Reply to All with your

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comments to expedite the preparation of this recommendation. If the comments are substantial, I will generate another version and circulate it for your review. (You may get an out of office reply next week but I will be monitoring email.)

My understanding is that we would like to have the recommendation ready to present to the JLD Steering Committee at their January 4th meeting.

Regards,
Ben

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

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