Voluntary Environmental Assessment
FONSI 02-02

Interim Operation
of the
VARQ Flood Control Plan
At Hungry Horse Dam, MT

Bureau of Reclamation
Pacific Northwest Region
Boise Idaho

March 2002

United States Department of the Interior

BUREAU OF RECLAMATION
Pacific Northwest Region
1150 North Curtis Road, Suite 100
Boise, Idaho 83706-1234

IN REPLY REFER TO:

PN6510
ENV-6.00

MAR 2 2 2002

MEMORANDUM TO FILE

Subject: **Interim Operation of the VARQ Flood Control Plan at Hungry Horse Dam, MT Voluntary Environmental Assessment and Finding of No Significant Impact**

In December 2000, the National Marine Fisheries Service and U.S. Fish and Wildlife Service issued biological opinions (BiOp) on operation of the Federal Columbia River Power System (FCRPS). These BiOps call for the Corps of Engineers (Corps) and Bureau of Reclamation (Reclamation) to undertake various actions at their 14 main Federal Columbia River Power System (FCRPS) dams to assist in recovery of fish species listed under the Endangered Species Act (ESA) in the Columbia River basin. Among those actions is implementation of an alternative flood control strategy, called variable discharge (variable Q, or VARQ), required at Libby and Hungry Horse Dams. VARQ is a flood control operation that reduces wintertime reservoir drawdown at Libby and Hungry Horse for floodwater storage compared to existing operation, and provides better assurance of reservoir refill in summer, to meet multiple water uses.

The Bureau of Reclamation (Reclamation) has made a decision to implement the VARQ flood control plan at Hungry Horse Dam in 2002, 2003, and 2004--while a separate National Environmental Policy Act (NEPA) analysis is carried out and a subsequent decision is made on a combined Hungry Horse and Libby dam VARQ operation.

Reclamation deems that interim implementation of VARQ flood control operation at Hungry Horse Dam is not a major Federal action, in and of itself, nor is it a departure from historic operational limits or operational flexibility of the dam. The proposal is also clearly within Reclamation's authorized purposes. It is, therefore, Reclamation's position that formal NEPA analysis is not required. However, Reclamation has voluntarily prepared the attached Environmental Assessment (EA) to document the potential effects of the proposed interim or short-term implementation of the VARQ flood control plan at Hungry Horse Dam, alone.

Finding of No Significant Impact

Reclamation's analysis shows that implementation of the proposed interim VARQ flood control plan would result in small changes in seasonal hydrologic operations. All hydrologic changes would be within historic operating ranges. Minor to indiscernible impacts would be expected for all resource categories including aquatic, terrestrial, water quality and contaminants, cultural and sacred sites, hydropower, socioeconomic, Indian trust assets, and minority and low income populations. Trans-boundary effects would be insignificant. There would be immediate benefits to ESA listed resident and anadromous fish species in response to the reasonable and prudent alternatives and proposed actions identified in the 2000 BiOps.

Based on the analysis of environmental effects, Reclamation has concluded that implementation of the preferred alternative would not have a significant effect on the quality of the human environment or the natural and cultural resources of the area. Therefore, no further NEPA analysis will be conducted.

J. William McDonald — March 22, 2002

Regional Director, Boise, Idaho — Date

Attachment

bc: Power Manager, Grand Coulee Power Office, WA
Project Superintendent, Hungry Horse Field Office, MT
PN-1700 (McKown), PN-1730 (Fodrea), PN-6200 (McGrane), (w/att)

Voluntary Environmental Assessment
March 2002

Interim Operation of the VARQ Flood Control Plan
At Hungry Horse Dam, MT

Introduction

In December 2000, the National Marine Fisheries Service and U.S. Fish and Wildlife Service issued biological opinions (BiOp) on operation of the Federal Columbia River Power System (FCRPS). These BiOps call for the Corps of Engineers (Corps) and Bureau of Reclamation (Reclamation) to undertake various actions at their 14 main Federal Columbia River Power System (FCRPS) dams to assist in recovery of fish species listed under the Endangered Species Act (ESA) in the Columbia River basin. Among those actions is implementation of an alternative flood control strategy, called variable discharge (variable Q, or VARQ), required at Libby and Hungry Horse Dams. VARQ is a flood control operation that reduces wintertime reservoir drawdown at Libby and Hungry Horse for floodwater storage compared to existing operation, and provides better assurance of reservoir refill in summer, to meet multiple water uses. This strategy potentially impacts the operation of other downstream FCRPS facilities. For example, VARQ operations at Hungry Horse Dam can result in slightly more flood control draft downstream at Grand Coulee Dam; thus affecting elevations of Lake Roosevelt behind the dam.

The Corps and Reclamation are in the initiation stages of conducting a National Environmental Policy Act (NEPA) process to analyze the effects of long-term implementation of the VARQ flood control strategies at Hungry Horse and Libby dams. The joint NEPA effort will include the preparation of an Environmental Impact Statement (EIS). The Notice of Intent (NOI) to prepare the EIS was published in the Federal Register on October 1, 2000 (a copy of the NOI is attached to this document). Scoping of issues and alternatives for the EIS analysis has been initiated. The EIS is intended to analyze the coordinated and cumulative effects of proposed flood control operational changes at both dams as well as other operational actions at Libby, Hungry Horse, and Grand Coulee dams called for in the BiOp's. The draft EIS is scheduled for release in late 2003 or early 2004.

Basis for Voluntary Environmental Assessment

Reclamation deems that interim implementation of VARQ flood control operation at Hungry Horse Dam is not a major Federal action, in and of itself, nor is it a departure from historic operational limits or operational flexibility of the dam. The proposal is also clearly within Reclamation's authorized purposes. It is, therefore, Reclamation's position that formal NEPA analysis is not required. However, under '1501.3(b) of the Council on Environmental Quality's regulations[1], a Federal agency "...may prepare an environmental assessment on any action at any time in order to assist agency planning and decisionmaking." Therefore, Reclamation has voluntarily prepared this Environmental Assessment (EA) to document the potential effects of the proposed interim or short-term implementation of the VARQ flood control plan at Hungry Horse Dam, alone. The operation is proposed to be carried out in 2002, 2003, and 2004--while a separate NEPA analysis is carried out and a subsequent decision is made on a combined Hungry Horse and Libby dam VARQ operation.

Proposed Action

Purpose - To implement interim operational actions during calendar years 2002, 2003, and 2004 at Hungry Horse Dam that will help provide flow requirements for listed anadromous and resident fish, as recommended in the December 2000 BiOp's issued by USFWS and NMFS.

Need - Traditional flood control and hydropower operations at Hungry Horse and Grand Coulee dams have changed the natural river hydrology in the Columbia River Basin. These reservoirs store water in the spring to provide flood control protection and release higher-than-natural flows in the fall and winter for power production and minimum flows for the Flathead River at Columbia Falls. Listed fish populations in the Columbia basin (Columbia Basin bull trout and Columbia River salmon and steelhead) benefit from high spring flows, which historically were provided by snowmelt. Deep reservoir drafts for flood control at Hungry Horse limit biologic productivity in the reservoir.

The USFWS and the NMFS have recommended implementation of the VARQ flood control strategy in their 2000 BiOps. This would improve flows for the conservation and recovery of listed species. Therefore, in order to help recover listed fish populations and to better meet multiple resource needs in the upper Columbia Basin, Reclamation is proposing to implement the VARQ food control plan, on an interim basis, at Hungry Horse Dam with associated operational changes and effects at Grand Coulee Dam.

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[1]Council on Environmental Quality. 1978. Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.

Alternatives Considered

No Action Alternative - With the no action alternative, Hungry Horse Dam would continue to be operated under standard flood control (STDFC) rules. In general, STDFC involves operating Hungry Horse Reservoir to elevations no higher than those specified by flood control rule curves computed by the Corps of Engineers based on current storage reservation diagrams. This is the historic flood control operation of Hungry Horse Dam. Hungry Horse would continue to be operated to provide a number of other multiple use benefits in addition to providing the flood protection under the STDFC rules. Those uses would include power production (at site and downstream), water temperature releases, maintenance of minimum flows for local benefits, and releases for spring and summer flow augmentation for ESA-listed salmon and steelhead.

Preferred Alternative - Under the preferred alternative, Reclamation would implement the proposed action by performing VARQ flood control operations at Hungry Horse Dam in 2002, 2003, and 2004. VARQ operations were initiated in January 2001, but did not produce any benefits because of severe drought. In January 2002 it appeared unlikely that any benefits would result from implementing VARQ for 2002, because the 2001 drought has resulted in lake levels well below those normally needed to capture VARQ benefits. However, by March 2002, due to project operations and a more favorable runoff forecast, Reclamation has identified an opportunity for a partial VARQ operation.

VARQ is an alternative flood control strategy developed by the Corps of Engineers in collaboration with Reclamation, Bonneville Power Administration (BPA), and the State of Montana. The general flood control operation and philosophy remains the same as the No Action Alternative B flood control space will be provided based on the amount of the water supply forecast. However, the VARQ flood control rule curves and draft requirements would be computed by new storage reservation diagrams which allow Hungry Horse Reservoir to be more full during the winter months in some low and moderate runoff years. VARQ curves require slightly more flood control space on 31 December than the No Action Alternative to accommodate winter rain events. VARQ also relies less on flood control drafting in April when local runoff sometimes begins. VARQ could result in less spill and consequently less dissolved gas below Hungry Horse Dam during the flood control evacuation period in years when runoff begins in April. VARQ flood control curves generally require about the same 30 April space in years of high runoff as the No Action Alternative, they simply require the reservoir to draft earlier in the spring.

Environmental Consequences

The following analysis summarizes the effects of the proposed interim action (preferred alternative) as compared with the existing effects of the no action alternative. More in-depth analysis and cumulative effects will be presented in the EIS being prepared by the

Corps and Reclamation for the proposed long-term coordinated VARQ operation of Libby and Hungry Horse Dams.

Hydrology - The following is a summary of a hydrologic analysis describing the proposed effects of interim VARQ operation. The attached Hydrologic Analysis of the VARQ Flood Control Plan at Hungry Horse Dam provides the detail for this analysis and other resource analyses in the this EA, and is, therefore, is an integral part of this EA.

Hungry Horse Reservoir would continue to be operated within its historical and normal operating range of elevations and releases. VARQ allows Hungry Horse to be more full during the winter drawdown period in some low and moderate runoff years, which would result in the desired higher, more natural reservoir releases during the spring refill. VARQ would result in the Upper Rule Curves for the reservoir to be up to approximately 20 feet higher during the winter in some years. In high runoff years there would be no difference in end-of-April reservoir elevations because VARQ and STDFC require similar drafts for flood control.

The discharges from Hungry Horse Dam under the VARQ flood control rule curves would generally be higher in May and June and lower in April, and have less variability from month to month than the No Action Alternative. Under the VARQ operation there would be less likelihood of having to spill water in April to reach the target flood control elevation and then decreasing the discharge to minimum flows once the flood control target elevation is met. There would be no expected increase in flooding as a result of VARQ on the Flathead River at Columbia Falls, Montana, and no significant effects on the Pend Oreille River at Cusick, Washington (see page 8 of the attached analysis). Enough flood control space will remain in Hungry Horse Reservoir to drop discharges to minimums during high runoff events when natural, uncontrolled flow are causing flooding downstream.

It should be noted that in many years the operation for other uses would draft the reservoir well below the flood control space requirement under either alternative. For example, the Columbia Falls minimum flows in the Flathead River and system power demands will often draw the reservoir down to elevations more comparable to, or even lower than, STDFC. This is especially true under drought and power emergency conditions such as those which occurred in 2001.

VARQ operations at Hungry Horse, in and of itself, will not significantly impact Lake Roosevelt at Grand Coulee Dam. The storage reservation diagrams for Grand Coulee will not be changed by VARQ. However, the flood control draft of Hungry Horse can have a small effect on the flood control requirement at Grand Coulee because Grand Coulee's flood control curves and space requirements are calculated based the runoff forecast and the amount of upstream storage space, and VARQ operation at Hungry Horse can change the upstream storage space. Studies show that during most years there is no difference in end-of-month Lake Roosevelt elevations under STDFC and VARQ (see page 14 of the attached analysis). When comparing the two operations the 50-year average difference in Lake Roosevelt elevations under VARQ was 0.3 feet lower on April 10^{th} and the maximum was 2.2 feet lower. The most probable effect in 2002 would be for Lake Roosevelt to be about 1.1 feet lower under VARQ operation.

Water retention time is a measure of how quickly water moves through a reservoir. The water retention time in Lake Roosevelt during January through May is typically 30-40 days. Water retention time decreases with VARQ by less than half a day per month in the January through May period. This is a decrease of less than 2 percent.

Implementation of VARQ is expected to benefit the operation of Flathead Lake with respect to helping refill the lake and meeting the new Kerr Dam minimum outflow requirements. This is a direct result of having less space to refill at Hungry Horse that often increases the available water supply at Flathead Lake, especially in below-average water years.

Water Quality and Contaminants - There would sometimes be an improvement in total dissolved gases below Hungry Horse Dam from implementing the interim VARQ operation because most flood control draft would be completed by the end of March. The standard flood control operation depends heavily on drafting in April. Studies suggest that spill at Hungry Horse is primarily associated with drafting the reservoir for flood control in April. Occasionally spring snowmelt runoff begins in the Flathead Basin in April making it difficult to continue drafting Hungry Horse without spill. With VARQ, the reservoir is mostly drafted by the end of March making spill for flood control draft in April less likely. There would be no appreciable change in the temperature regime below Hungry Horse Dam because releases from Hungry Horse are temperature controlled.

Potential for exposing toxic materials in the upper end of the drawdown zone of Lake Roosevelt would not be significantly different from the existing, or no action, conditions - for most years studied, there is no difference between the two elevations for the January through April 10 periods. The average difference over the 50-year period of study is 0.3 foot--resulting in small differences in the amount of exposed sediments. The presence of toxic substances in the lake drawdown zone and their potential public health hazard (i.e. potential for becoming airborne) is being studied in more detail for the proposed long-term VARQ operation and will be analyzed in the EIS.

Hydropower - There would be no significant change on the power generating projects in either the United States or British Columbia from implementing VARQ at Hungry Horse Dam (see pg. 12 of attached Hydrologic Analysis)**.**

Terrestrial Resources - There would be no discernable change in vegetation, wildlife, or terrestrial landscapes from the proposed interim action.

Aquatic Resources - Higher over-winter elevations in Hungry Horse Reservoir would be beneficial to reservoir biota and would possibly improve overall productivity in the reservoir, but probably not significantly for the interim operation. The interim VARQ operation would be within historic drawdown limits at Hungry Horse and for most years there would be little to no change in the aquatic environment of Lake Roosevelt. Flows below Hungry Horse Dam could be higher during May and June (averaging 2000 cfs higher) which should produce conditions slightly better for resident trout production downstream in the Flathead River. Flows could also be slightly higher in June, depending on the year, in the lower Columbia River to the benefit of anadromous fish.

The 2 percent, or less, reduction in retention time would take place at Lake Roosevelt during the normal drawdown season. VARQ operations at either reservoir would not influence the late summer and early fall lake elevations which are the most productive times for aquatic organisms and the lake/reservoir fish populations.

See the following discussion for benefits expected for listed aquatic species.

Threatened and Endangered Species -- Implementation of the preferred alternative would provide for the interim operation of VARQ flood control plan at Hungry Horse Dam in compliance with the reasonable and prudent alternative, "action 22," of NMFS' December 2000 BiOp and with the revised FCRPS proposed action, item II.b.1, as documented in appended materials to the USFWS 2000 BiOp.

Hungry Horse Reservoir contains one of the healthiest populations of listed bull trout in the U.S. Higher reservoir elevations would likely result in slightly higher reservoir elevations in low and moderate water years, resulting in a potential improvement in primary production, zooplankton production, insect production, and ultimately bull trout production. Higher flows (averaging 2000 cfs higher) during May and June should help adult bull trout access smaller streams. The higher flows will eventually pass through Grand Coulee to the Mid and Lower Columbia River to the benefit of endangered salmonids by increasing the water available for spring flow augmentation for juvenile fish migration.

Cultural and Sacred Sites - Under Interim Operation of the VARQ Flood Control Plan, Hungry Horse Reservoir would be held higher on the average. This would offer added protection to some cultural or sacred sites in the reservoir shoreline vicinity. Even at highest projected levels (about 20 feet above current standard flood control levels), VARQ flood control would be within historic operational limits. The only difference would be the proportion of time that the wave zone would be at higher levels, which would affect no known sites in the Hungry Horse reservoir vicinity.

While operations at Lake Roosevelt may be slightly lower in a few years (about 2.2 feet), in most years there would be no difference. Overall operations would be within historic operational limits. It is extremely unlikely that any new cultural or sacred sites would be exposed. Any discoveries of new site components, or effects to already-impacted sites, will continue to be mitigated under the current cultural resources program. There would be no need for increased Archaeological Resources Protection Act (ARPA) patrols during key recreational seasons.

The potential cumulative effects of the proposed long-term VARQ operation on cultural resources in coordination with Hungry Horse, Grand Coulee, and Libby Dam operations will undergo full Section 106 consultation with concerned tribes and other parties as part of the EIS process.

Indian Trust Assets - Trust assets potentially influenced by the proposed interim action are resident and anadromous fish populations. As described earlier in this document, there may be some beneficial effects on Hungry Horse Reservoir fish populations and no expected change, on the interim, in fish populations inhabiting Lake Roosevelt. Anadromous fish downstream on the Middle and Lower Columbia River are expected to benefit from the proposed operation.

Socioeconomic Resources - Based on the foregoing, it is expected that there would be no significant change to visitation and recreational opportunities at Upper Columbia basin lakes and reservoirs. There would be no discernable effects on marinas, boat docks, or ferry operations. Power production would be largely unaffected, and there would be no increase in flooding potential resulting from the proposed interim VARQ operation. Irrigation deliveries and/or diversions, as applicable, would be unaffected.

Environmental Justice - There would be no expected, disproportional, adverse effects on tribal communities or other low income or minority populations resulting from the proposed interim operation.

Trans-boundary Effects - In correspondence with BC Hydro on the VARQ operations at Hungry Horse Dam, hydropower impacts were considered to be insignificant and acceptable (see attached Jan. 30, 2001, letter). Initially, BC Hydro did question whether VARQ at Hungry Horse may increase water temperature during the mid-April through June period, when white sturgeon are spawning downstream of the Waneta Dam project in Canada. However, upon further analysis, (see attached October 16, 2001 letter) BC Hydro has expressed that there should be no significant impact to sturgeon.

More detailed analysis on potential trans-boundary effects and coordination with Canadian entities will be conducted for the proposed long-term coordinated VARQ operation - results will be included in the EIS.

Consultation, Coordination, and Public Notification

The interim VARQ operation is proposed as a direct result of consulting with NMFS and USFWS under Section 7 of the ESA. Reclamation is coordinating the proposed action with the Corps, which ultimately has responsibility for flood control operations at Federal facilities within the FCRPS. BC Hydro is also being kept informed. While the proposed action is not deemed a major Federal action, nor a significant departure from the authorized purposes and historic operations of Hungry Horse or Grand Coulee dams, it is Reclamation's intent to notify all applicable Federal, State and local agencies; Native American tribes; and other interested parties of Reclamation's intent to implement the interim operation.

[Federal Register: October 1, 2001 (Volume 66, Number 190)]
[Notices]
[Page 49943-49944]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr01oc01-54]

DEPARTMENT OF DEFENSE

Department of the Army, Corps of Engineers

Intent To Prepare a Draft Environmental Impact Statement (DEIS) for Upper Columbia Basin Alternative Flood Control and Fish Operations at Libby Dam, Montana; Hungry Horse Dam, Montana; and Grand Coulee Dam, Washington

AGENCY: US Army Corps of Engineers (Corps), DoD and US Bureau of Reclamation (Bureau), Department of Interior.

ACTION: Notice of intent.

SUMMARY: Pursuant to section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended, the US Army Corps of Engineers (Corps), and the Bureau of Reclamation (Bureau) propose to prepare an Environmental Impact Statement (EIS) on operational alternatives for the conservation of threatened and endangered species of fish listed for protection under the Endangered Species Act. (The Corps has responsibility for publishing the notice in the Federal Register and for preparing and filing the EIS.) Specifically, this EIS will address those operational actions for Libby, Hungry Horse, and Grand Coulee Dams identified by the National Marine Fisheries Service (NMFS) and the US Fish and Wildlife Service (USFWS) as Reasonable and Prudent Alternatives in their Biological Opinions (BiOps) both dated December 21, 2000. Those BiOps call for the Corps of Engineers and Bureau of Reclamation to undertake various actions at their 14 main Federal Columbia River Power System (FCRPS) dams to assist in recovery of fish species listed under the Endangered Species Act in the Columbia River basin. Among those actions is implementation of an alternative flood control strategy, called variable discharge (variable Q, or VARQ), required at Libby and Hungry Horse Dams. This strategy has potential impacts in other parts of the Columbia system, and results in different operation at Grand Coulee Dam. All three reservoirs are storage reservoirs, and Libby and Hungry Horse are on headwater tributaries to the Columbia River, the Kootenai and South Fork Flathhead, respectively, while Grand Coulee is on the mainstream Columbia. Libby is a Corps project, and Hungry Horse and Grand Coulee are Bureau projects. VARQ is a flood control operation that reduces wintertime reservoir drawdown at Libby and Hungry Horse for floodwater storage compared to existing operation, and provides better assurance of reservoir refill in summer, to meet multiple water uses. The no-action alternative is called BASE-CRT63, and consists of the existing flood control operation.

In addition, the NMFS BiOp calls for summer flow augmentation from Grand Coulee Dam for juvenile salmon out-migration, as well as provision for fall flows for lower Columbia chum salmon spawning and incubation. The USFWS BiOp calls for reduction of adverse effects of flow fluctuations on bull trout below Hungry Horse and Libby dams, and for maintenance of minimum year-round flows for bull trout.

FOR FURTHER INFORMATION CONTACT: Questions regarding the scoping process or preparation of the DEIS may be directed to Dr. Stephen Martin, U.S. Army Corps of Engineers, Seattle District, Environmental Resources Section, PO Box 3755, Seattle, Washington 98124-3755; telephone (206) 764-3631; e-mail stephen.g.martin@usace.army. mil.

SUPPLEMENTARY INFORMATION:

1. Proposed Action

The Federal Columbia River Power System (FCRPS) comprises 14 major dams and a number of smaller ones. Libby, Hungry Horse and Grand Coulee dams are among the 14 large projects. The BiOps from the USFWS and NMFS were both issued on December 21, 2000, under Section 7 of the Endangered Species Act, as amended, in response to a Biological Assessment and supplementary information concerning effects of the FCRPS on listed stocks of white sturgeon, bull trout, salmon and steelhead in the Columbia and tributaries. Libby and Hungry Horse dams store water primarily for hydropower and flood control, as well as for other purposes such as fish and wildlife and recreation. Libby Dam is located at river mile (RM) 222 on the Kootenai River in northwestern Montana; when full, the reservoir (Lake Koocanusa) backs into southern British Columbia, Canada. Hungry Horse Dam is at RM 5 on the South Fork Flathead River, part of the Flathead/Clark Fork/Pend Oreille system, also in northwestern Montana. The two systems are adjacent to each other. Grand Coulee Dam is at RM 597 on the Columbia River in northeastern Washington State.

In general, flood control using reservoirs involves maintaining the reservoir low enough to impound inflow from high-runoff events such as rainstorms and sudden snowmelts. In multipurpose storage reservoirs, it means drawing down the reservoir beginning in early fall through March or April to a surface elevation appropriate for the runoff forecast for the coming spring and summer (generally based on snowpack readings). Then refill begins, and the reservoir is generally full by the end of July, where it is maintained through August. For Libby, Hungry Horse and Grand Coulee, water passed through the dam is used for power generation, and lowering the reservoir elevation serves to meet increased power needs of the region in fall and winter.

VARQ is an alternative flood control strategy intended to meet other needs by better assuring reservoir refill and higher spring flows, to come closer to natural snowmelt runoff conditions in the rivers. That runoff is impounded by Libby and Hungry Horse dams, which under normal operations released only minimum flows during that period. In the Kootenai River, starting in the 1990s, drawing down the reservoirs for power generation below the required flood control elevation has been curtailed in winter to allow water storage for flow augmentation in spring. In addition to benefiting sturgeon, it also benefits juvenile salmon outmigration in the lower Columbia River. Furthermore, August flow augmentation for Columbia salmon outmigration has also been provided from Libby in response to 1995 NMFS BiOp requirements.

VARQ is related to the Montana Department of Fish, Wildlife and Parks Integrated Rule Curves (IRCs) as an alternative flood control strategy. In lower and medium runoff-forecast years, compared to VARQ, IRCs allow deeper reservoir drawdown in winter, which benefits power.

As called for by USFWS and NMFS BiOps, the Corps and Bureau are to implement VARQ at Libby and Hungry Horse dams, as well as other actions for benefit of listed fish stocks in the Columbia basin. If remaining studies of system flood control prove VARQ feasible, and other impacts are either not significant or can be mitigated, then it would be implemented the next winter following completion of NEPA documentation.

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Other operations to provide water in summer and fall for salmon outmigration, spawning and incubation are also part of the proposed action, as are reduction of adverse effects of flow fluctuation below Libby and Hungry Horse dams, and provision of minimum flows for bull trout.

2. Alternatives

Alternatives to be evaluated will include existing operation (no-action), which includes current flood control operation with flow augmentation in spring for white sturgeon, bull trout, and salmon; VARQ with spring and summer flow augmentation for fish; increased summertime drawdown of Lake Roosevelt (Grand Coulee Dam) to meet summer flow objectives for salmon; and fall flow augmentation for salmon spawning and incubation in the lower Columbia. The scoping process will be used to derive the full range of reasonable alternatives.

3. Scoping and Public Involvement

Public involvement will be sought during the scoping and conduct of the study in accordance with NEPA procedures. Public meetings will be held in affected communities during scoping, and during public review of the DEIS. A public scoping process will be initiated to clarify issues of major concern, identify studies that might be needed in order to analyze and evaluate impacts, and obtain public input on the range and acceptability of alternatives. This notice of intent formally commences the joint scoping process under NEPA. As part of the scoping process, all affected Federal, State and local agencies, Native American Tribes, and other interested private organizations, including environmental interest groups, are invited to comment on the scope of the EIS. Comments are requested concerning project alternatives, mitigation measures, probable significant environmental impacts, and permits or other approvals that may be required.

To date, the following issues of concern have been identified to be analyzed in depth in the draft EIS: (1) Flood control impacts on a local and a system-wide basis; (2) fisheries and other aquatic ecosystem impacts and benefits in affected reservoirs and downstream in the Kootenai and Flathead systems and on the mainstem Columbia; (3) effects of potential increase in frequency of spill and impacts from dissolved gas on aquatic organisms; (4) groundwater seepage in lands from prolonged high spring flows along the Kootenai River in Idaho; (5) levee integrity concerns from prolonged high spring flows along the Kootenai River in Idaho and British Columbia; (6) potential for increased suspension of sediments due to drawdown of Lake Roosevelt (Grand Coulee); (7) potential aerial transport of contaminants (mainly heavy metals) from exposed Lake Roosevelt sediments; (8) exposure, looting and vandalism of prehistoric artifacts and human remains along Lake Roosevelt; (9) recreational impacts on affected reservoirs; (10) Columbia system power generation impacts; and (11) power generation impacts at Canadian projects downstream of Libby Dam, a treaty issue.

There are fish stocks listed under ESA that would be directly affected by the proposed action, including Kootenai River white sturgeon (endangered), bull trout (Salvelinus confluentus) (threatened); various stocks of chinook (Oncorhynchus tshawytscha), chum (O. keta) and sockeye (O. nerka) salmon, and steelhead (O. mykiss).

A notice of scoping meetings will be mailed to all involved agencies and individuals known to have an interest in this project. Scoping meetings are scheduled as follows:

(1) Grand Coulee, Grant Co., Washington, Oct. 29, 2001.
(2) Sandpoint, Bonner Co., Idaho, October 30, 2001.
(3) Bonners Ferry, Boundary Co., Idaho, November 1, 2001.
(4) Portland, Multnomah Co., Oregon, November 8, 2001.
(5) Libby, Lincoln Co., Montana, November 13, 2001.
(6) Eureka, Lincoln Co., Montana, November 14, 2001.

(7) Kalispell, Flathead Co., Montana, November 15, 2001.

These dates, or revised dates, as well as specific times and locations will be published in each town's newspaper approximately 30 days before each meeting. Specific dates and times can also be verified by visiting the Corps of Engineers' website at www.nws.usace.army.mil/index.cfm. There will also be up to six government-to-government meetings with Tribal council members in affected areas. Verbal or written comments will be accepted at the scoping meetings, or written comments may be sent by regular or electronic mail to Stephen Martin at the above addresses on or before November 2, 2001. Ongoing communication with agencies, Native American tribes, public interest groups, and interested citizens will take place throughout the EIS development through the use of public meetings, mailings, and the Internet.

4. Other Environmental Review, Coordination and Permit Requirements

The environmental review process will be comprehensive and will integrate and satisfy the requirements of NEPA, and other relevant Federal, State and local environmental laws. Other environmental review, coordination, and permit requirements may include preparation of a Clean Water Act, Section 404 evaluation by the Corps.

5. Schedule

The draft EIS is scheduled for release in Fall, 2003.

Ralph H. Graves,
Colonel, Corps of Engineers, District Engineer.
[FR Doc. **01-24481 Filed** 9-28-**01**; 8:45 am]
BILLING CODE 3710-ER-M

BC hydro

THE POWER IS YOURS

BUREAU OF RECLAMATION
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OCT 22 '01

TO	INIT	DATE
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1700	R	10/25
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CONTROL #:
FOLDER #:

October 16, 2001

Kenneth R. Pedde
Deputy Regional Director
Bureau of Reclamation
Pacific Northwest Region
1150 North Curtis Road, Suite 100
Boise Idaho 83706-1234

Dear Mr. Pedde:

Subject: Implementation of VARQ Flood Control Plan at Hungry Horse Dam, Montana

Further to my January 30, 2001 letter to you concerning the Bureau of Reclamation plan to implement the VARQ flood control plan at Hungry Horse in January 2001, and our concern with respect to the environmental impacts of that change in operation, I can provide the following update.

The consultant BC Hydro engaged to review the environmental impacts in BC, which are anticipated from the various alternatives proposed in the BiOp, has completed the review with respect to the Hungry Horse VARQ operation plan provided to us in December 2000. As you will recall, we had concerns regarding the possibility of increased water temperatures immediately downstream of the Waneta project as a result of the expected change in Hungry Horse operations during the mid-April through June period, when white sturgeon are normally spawning thereabouts. The consultant has further reviewed the proposed change in operation, and has determined that there should be no significant impact to sturgeon.

Therefore, from a power perspective and an environmental perspective, we now anticipate that the impacts we will realize from your implementation of the Hungry Horse VARQ flood control plan, or inclusion of this data in the PNCA studies will be insignificant, and acceptable. Similarly, the Hungry Horse VARQ operation plan implementation is acceptable. If there is any revision to the Hungry Horse VARQ operation plan provided to us in December 2000, then we may need to re-evaluate the impacts.

We would still appreciate receiving a copy of any NEPA documentation you have prepared in respect to the Hungry Horse VARQ operation plan.

...Page 2

We understand that you will again be submitting the Hungry Horse VARQ flood control plan as part of your February 1, 2002 data submittal to the Northwest Power Pool. This will be for use in their studies which are required to develop the Pacific Northwest Coordination Agreement (PNCA) 2002-03 Final Regulation plan, and implementation in 2002.

You may also wish to obtain the perspectives of other Canadian fisheries and operating agencies in respect to implementation of the Hungry Horse VARQ operation plan.

Yours truly,

Ralph D. Legge
Chair, Canadian Section
Columbia River Treaty Operating Committee

RDL/k

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C... NO. 1-994 PRJ-13.10

BC hydro

F... NO. 1774

THE POWER IS YOURS

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Mr. Kenneth R. Pedde
Deputy Regional Director
Bureau of Reclamation
Pacific Northwest Region
1150 North Curtis Road, Suite 100
Boise , Idaho 83706-1234

Dear Mr. Pedde:

Subject: Implementation of VARQ Flood Control Plan at Hungry Horse Dam, Montana

This is in reply to your letter of January 9, 2001, concerning the Bureau of Reclamation plan to implement the VARQ flood control plan at Hungry Horse in January 2001. We understand this action is pursuant to Action 22, in Chapter 9 of the National Marine Fisheries Service, US Department of Commerce, Biological Opinion on the Operation of the Federal Columbia River Hydropower System (BiOp) which was released December 21, 2000.

We also understand that you will be submitting the Hungry Horse VARQ flood control plan as part of your February 1, 2001 data submittal to the Northwest Power Pool for use in their studies which are required to develop the Pacific Northwest Coordination Agreement (PNCA) 2001-02 Final Regulation plan.

After our September 26, 2000, meeting with Patrick McGrane of your staff, we reviewed the data and studies that were subsequently provided by the U.S. Army Corps of Engineers, Portland Office. The studies were intended to reflect the possible power impacts of the expected change in Hungry Horse operations resulting from implementation of the VARQ flood control operation. Our review indicated that with respect to power generating projects in BC, the net impact of the expected change in operation is not significant, and therefore is acceptable.

With respect to environmental impacts, we have engaged a consultant to review the impacts in BC which are anticipated from the various alternatives proposed in the BiOp, including the Hungry Horse VARQ operation plan. Subsequent to our December 13, 2000, conversation with Mr. McGrane, our consultant, RL&L Environmental Services, has advised us that there is some concern regarding the possibility of increased water temperatures immediately downstream of the Waneta project as a result of the expected change in Hungry Horse operations. The possibility of increased water temperatures during the mid-April through June period, when white sturgeon which are red listed in Canada (similar to the ESA listing in the US) are normally spawning downstream of Waneta project, will require further review to determine whether this is significant to sturgeon. Therefore, in regard to our continuing environmental review, we would appreciate receiving a copy of any NEPA documentation you have prepared in respect to the Hungry Horse VARQ operation plan.

From a power perspective, the impacts we would anticipate from your implementation of the Hungry Horse VARQ flood control plan, or inclusion of this data in the PNCA studies appear to be insignificant, and acceptable. However, from an environmental perspective, we have some concerns and we will need to consult further with other Canadian agencies. You may also wish to obtain the perspectives of other Canadian fisheries and operating agencies in respect to implementation of the Hungry Horse VARQ operation plan.

Yours truly,

Ralph D. Legge, P.Eng.
Chair, Canadian Section
Columbia River Treaty Operating Committee

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Hydrologic Analysis
of the VARQ Flood Control Plan at Hungry Horse Dam

Prepared by
U.S. Bureau of Reclamation
Pacific Northwest Region
River and Reservoir Operations Group
1150 N. Curtis Road
Boise, ID 83706
(208)378-5118
3 January, 2002

Principal Investigators:

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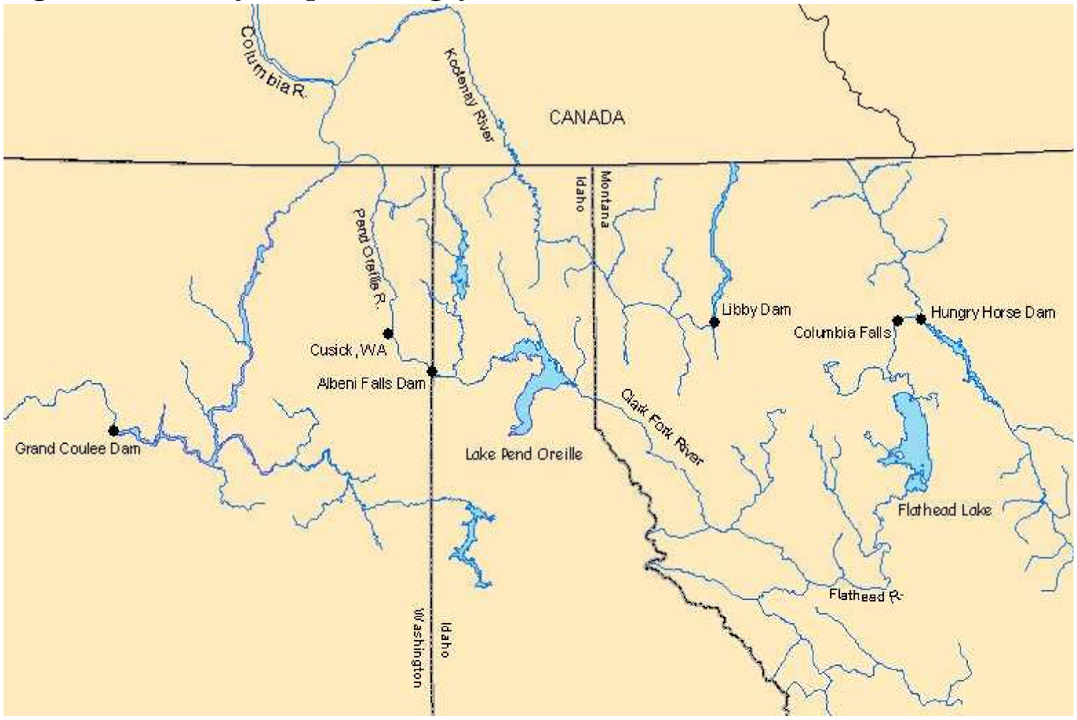
Mary Mellema

Figure 1. Vicinity Map of Hungry Horse and Grand Coulee Dams



Overview

The US Army Corps of Engineers developed the VARQ flood control plan in the late 1980's and has been refining it ever since. The logic behind VARQ is simple: More water is held in storage at Hungry Horse Reservoir during the winter months in those years when local downstream flooding is not anticipated. This results in higher reservoir elevations and discharges during the spring refill period with associated benefits to resident and anadromous fish. The VARQ flood control plan was identified in both the US Fish and Wildlife Service's and National Marine Fisheries Service's December 2000 Biological Opinions [1,2] as an action that should be taken for the benefit of bull trout in Hungry Horse Reservoir and anadromous fish downstream in the Columbia River.

This hydrologic analysis compares the VARQ and standard flood control operations (STDFC) for Hungry Horse Reservoir, and describes the associated hydrologic effects downstream. The effects include pool elevations, reservoir discharges, power production, water retention times, and downstream flooding. Projects include federal, non-federal, and Canadian projects on the Flathead, Clark Fork, Pend Oreille and

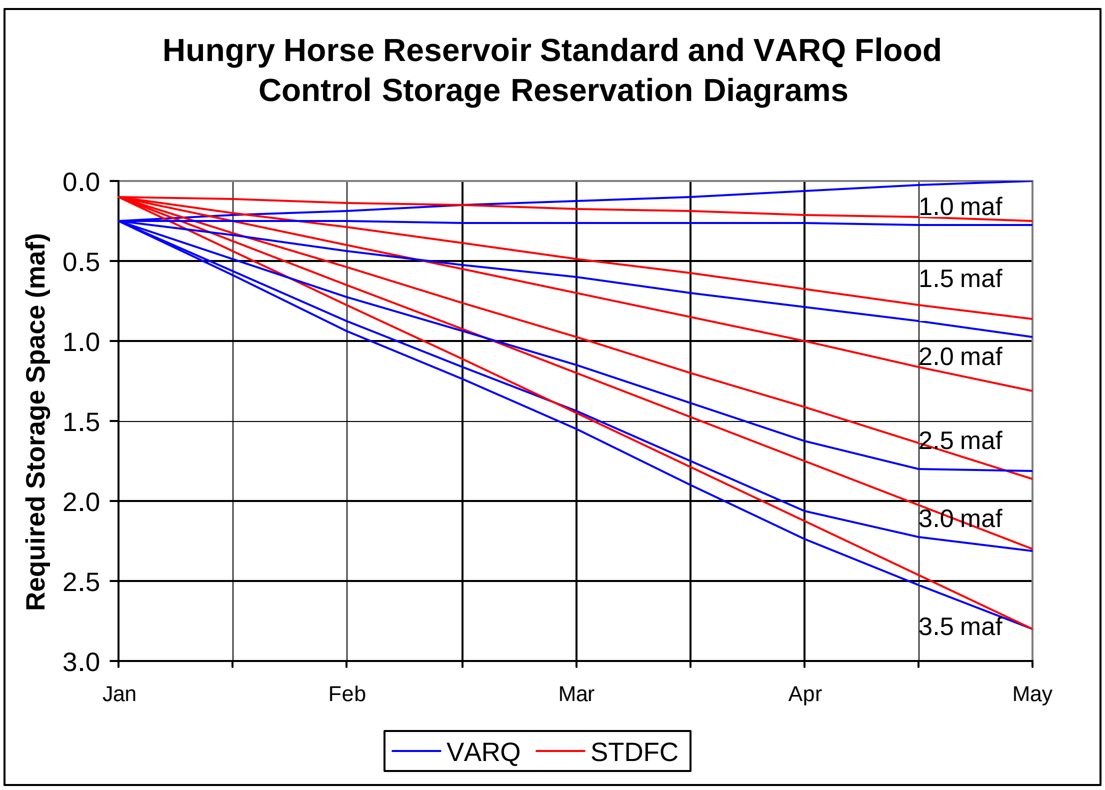
1 US Fish and Wildlife Service – Regions 1 and 6, "Biological Opinion – Effects to Listed Species from Operations of the Federal Columbia River Power System", December 20, 2000, p.84.
2 National Marine Fisheries Service – Northwest Region, "Endangered Species Act – Section 7 Consultation, Biological Opinion - Reinitiation of Consultation on Operation of the Federal Columbia River Power System Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin" December 21, 2000, pp. 9-63,9-64.

Columbia Rivers. A vicinity map is shown in Figure 1. This analysis compares recently completed computer modeling results from the Corps of Engineers, Bonneville Power Administration, and Reclamation. It also includes results from previous studies of VARQ operations.

Flood Control Storage Reservation Diagrams

Flood control storage reservation diagrams are graphs used to determine the amount of flood control space necessary to capture anticipated spring runoff. Figure 2 compares the Hungry Horse Dam storage reservation diagrams for the standard (STDFC) and VARQ flood control. On January 1 of every year, the flood control space requirement is slightly greater with VARQ at 250,000 acre-ft as compared to 100,000 acre-ft for STDFC. This winter space provides protection for winter rain events. During the winter drawdown period (January through April), in years when flooding is not anticipated, the VARQ flood control plan allows Hungry Horse Reservoir to be more full than STDFC. In years with high runoff conditions, VARQ will require drafting Hungry Horse to the same elevation by the end of April as was required by the STDFC. Because the reservoir is generally more full during the winter with VARQ flood control, there is less space to fill and higher reservoir releases during the spring refill period.

Figure 2. Hungry Horse Reservoir Standard and VARQ Flood Control Storage Reservation Diagram.



Hungry Horse Reservoir Elevations

Figure 3 shows an elevation/duration analysis that illustrates the percent of time Hungry Horse would be at (or above) a given elevation during the January-June period as modeled for the Biological Opinions[3]. This figure compares the elevations under VARQ and STDFC for the 50 years analyzed. The graph shows that Hungry Horse Reservoir water surface elevation will be higher more frequently with VARQ than under STDFC. Although the maximum elevation difference between VARQ and STDFC is about 20 feet, Hungry Horse reservoir maximum and minimum operating elevations will be the same for both VARQ and STDFC.

Figure 3. Modeled Elevation-Duration Analysis for Hungry Horse Reservoir (Jan-June).

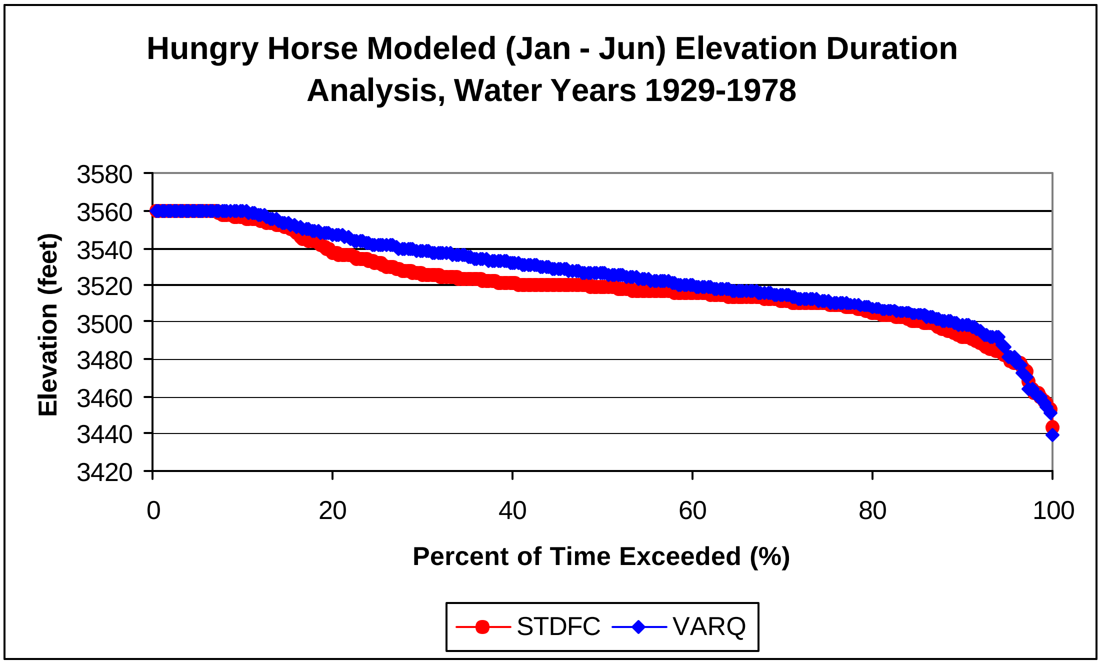


Figure 4 is a graph comparing modeled Hungry Horse elevations under VARQ and STDFC during three different conditions, a low water year (1977), a medium water year (1975), and a high water year (1974). While the storage reservation diagrams call for different amounts of reservoir draft, there will in practice be very little difference between the two flood control operations in dry or very wet years. This is because the differences between the two flood control operations are diminished by other operating constraints required for Hungry Horse Dam. During low water years the winter elevation of Hungry Horse Reservoir will often be lower than the flood control rule curves in order to provide minimum streamflows downstream at Columbia Falls, and/or to provide power

3 FRIII_000FSH33 (BiOp with VARQ) and FRIII_000FSH30 (BiOp without VARQ) monthly computer modeling done by Bonneville Power Administration in 2000.

production. During high water years, Hungry Horse Reservoir is drafted to the same elevation by the end of April with both VARQ and STDFC. VARQ will result in higher Hungry Horse reservoir elevations and flows primarily in years that are neither wet nor dry, but somewhere in the middle.

Figure 4. Modeled Hungry Horse Reservoir Elevations for Low (1977), Medium (1975) and High (1974) Water Years

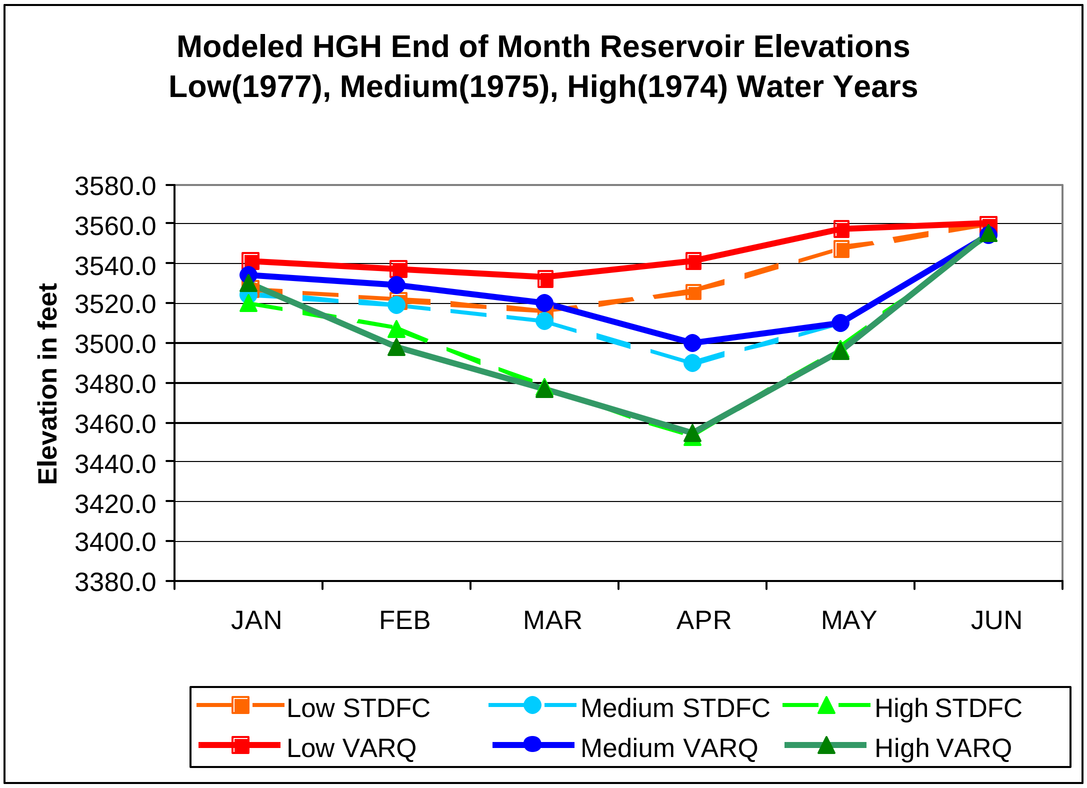


Figure 5 is a graph comparing the STDFC and VARQ rule curves and the actual historic elevation of Hungry Horse Reservoir from September 1, 2000 through May 1, 2001. Figure 6 shows the daily discharges from Hungry Horse Reservoir for the same time period. These figures illustrate that in the low water year of 2001 (64 % of average runoff) the reservoir elevation was well below the designated flood control elevations for both flood control rule curves. The low elevation was due to maintaining the minimum streamflow at Columbia Falls during the fall and winter and the need for increased power generation during cold snaps (See Figure 6).

Figure 5. Hungry Horse Reservoir Flood Control Rule Curves (Year 2000 – 2001) versus Actual Elevations

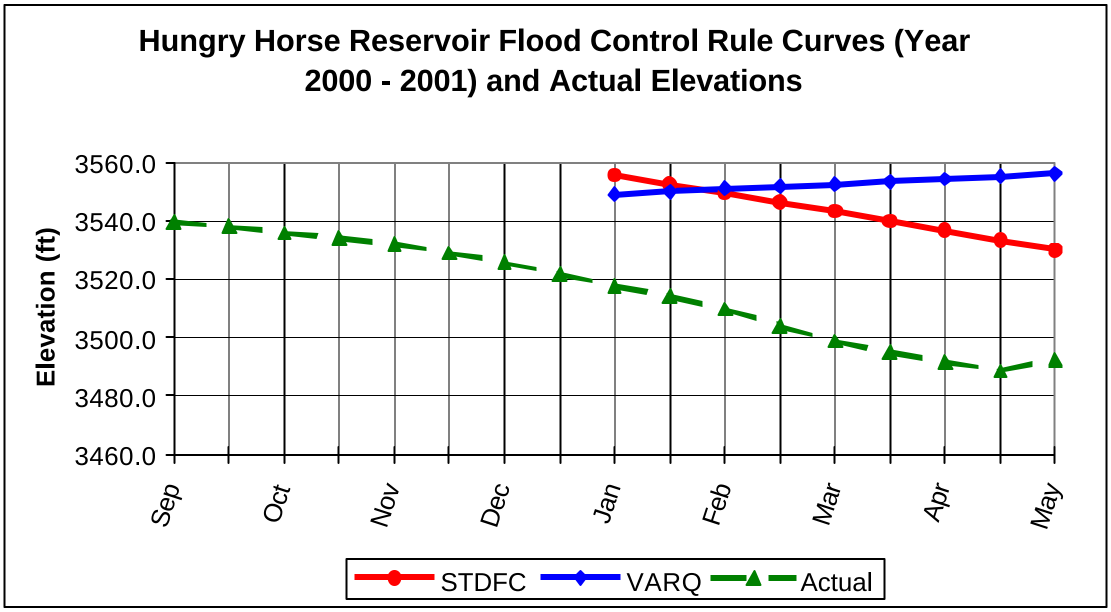
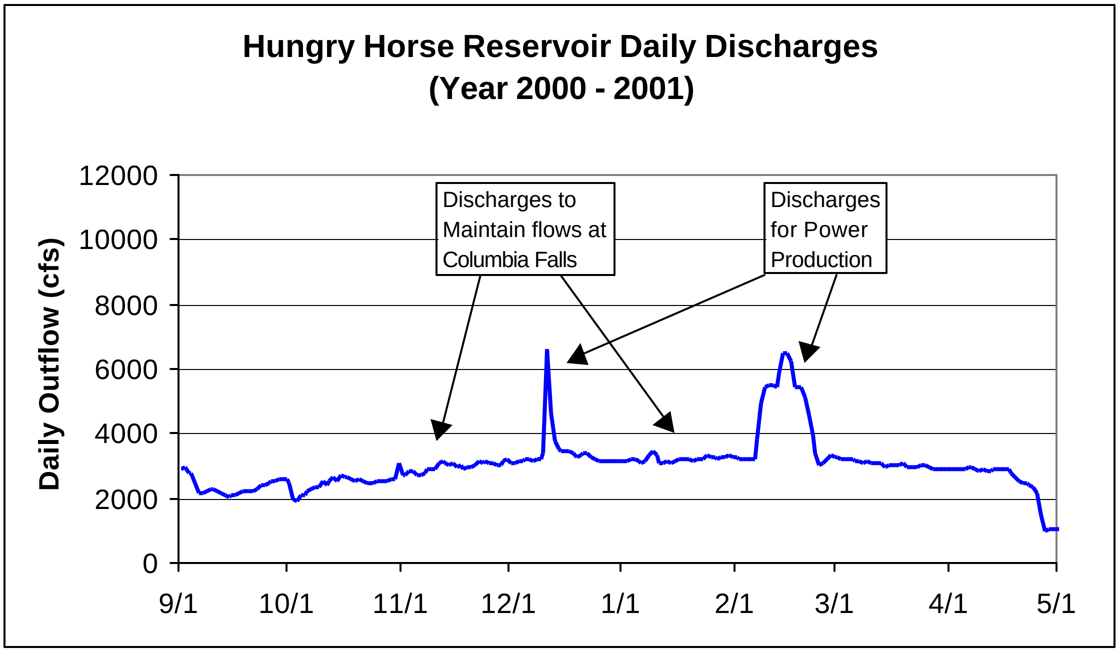


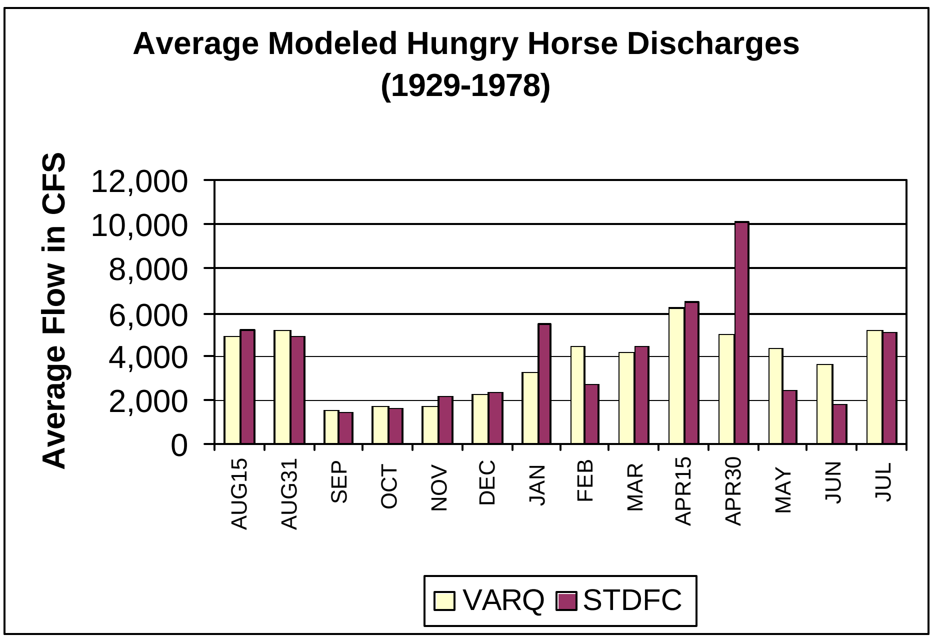
Figure 6. Hungry Horse Reservoir Daily Discharges (Year 2000 – 2001)



Hungry Horse Discharges

Hungry Horse discharges will generally be greater during February late May and June with VARQ flood control, and lower during January and April as illustrated in Figure 7. The rest of the year the discharges will be similar for both curves. The discharges under VARQ will follow a more normative hydrograph with less variability from one month to the next. VARQ will result in Hungry Horse being drafted to near its minimum elevation about one month earlier in the year than the STDFC. Under the VARQ operation there is less likelihood of having to spill water in April to reach the target end-of-month flood control elevation because most of the flood control draft will be completed by the end of March before the runoff season begins.[4] Erratic reservoir operations, such as decreasing the project discharge to minimum flows once the final flood control target elevation is met, will be minimized.

Figure 7. Comparison of modeled STDFC and VARQ Hungry Horse Monthly Discharges[5]



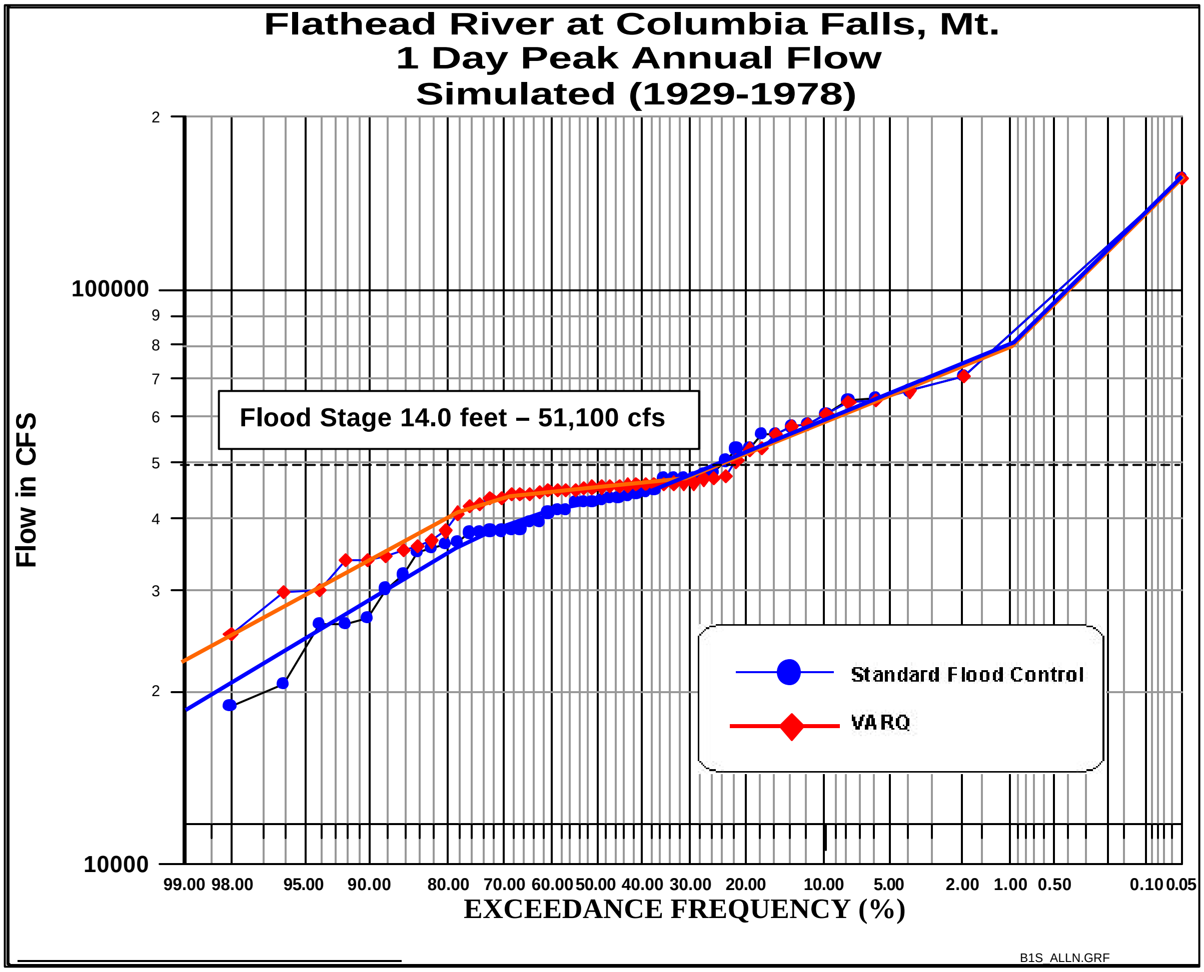
4 U.S. Army Corps of Engineers-Seattle District, "Local Effects of the Proposed VARQ Flood Control Plan at Hungry Horse Dam, Montana", July, 1998, pg.15.
5 FRIII_000FSH33 (BiOp with VARQ) and FRIII_000FSH30 (BiOp without VARQ) monthly computer modeling done by Bonneville Power Administration in 2000.

Local Flood Control Impacts below Hungry Horse

Flathead River at Columbia Falls

The VARQ flood control curves will allow higher flows downstream of Hungry Horse Dam in years when flooding is not anticipated, but will not increase flooding in years with high runoff. The Corps of Engineers has determined that the VARQ flood control plan will not impact the ability to control floods on the Flathead River at Columbia Falls, Montana. Figure 8 shows the modeled maximum one-day peak discharge frequency curves for the Flathead River at Columbia Falls (Jan-Dec). The flood stage at the Columbia Falls gage is plotted on the graph at 14.0 feet (2978.67 msl) which corresponds to a flow of 51,100 cfs. As indicated on the graph, VARQ results in slightly higher flows in the lowest 2/3 of years when flooding is not a problem. Years when runoff is high, and the Flathead River exceeds flood stage, VARQ results in the same peak flows as STDFC. The Corps determined that there was no increase in the likelihood of flows in excess of 47,000 cfs at Columbia Falls with VARQ flood control at Hungry Horse.

Figure 8. Frequency Curves for the Flathead River at Columbia Falls, 1-Day Maximum Flow (Jan-Dec).[6]



6 Ibid pg. 14.

Flathead Lake Summer Elevations and 4(e) flows

Results of the BPA models indicate that VARQ operations at Hungry Horse have the potential to improve refill at Flathead Lake particularly in dry years. The elevations at Flathead Lake were improved during July in six of the eight driest water years, due to VARQ flood control operations at Hungry Horse. Models also indicated that Flathead Lake water surface would drop below full pool in August in four of fifty years with STDFC or VARQ. Although Flathead Lake did not fill in August during these four years, VARQ does increase the water surface by an average of 1.5 feet.

Pend Oreille River below Albeni Falls Dam

The area below Albeni Falls Dam can be impacted by two types of flooding; 1. Agricultural flooding in March and April as a result of early spring runoff from Calispell and Trimble Creeks and 2. Flooding in June due to high flows in the Pend Oreille River from high elevation snowmelt.

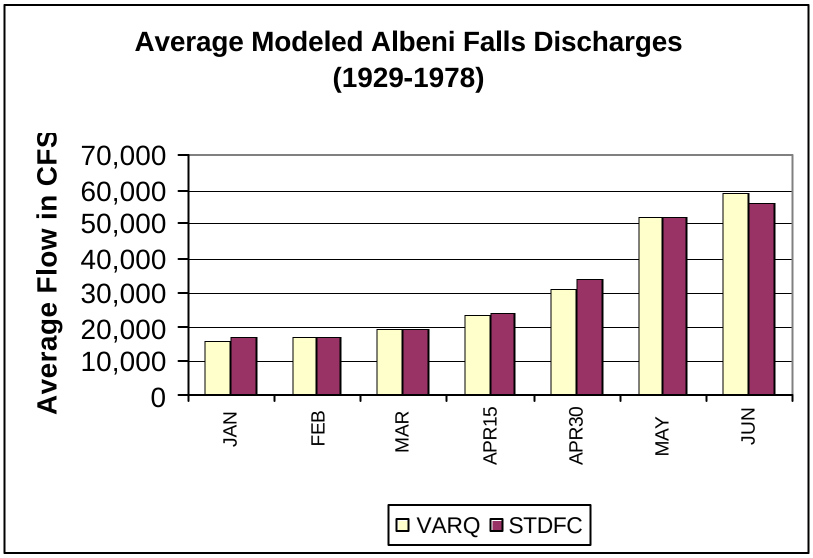
The agricultural flooding in the Cusick, Washington area is due to a combination of early spring runoff from Calispell and Trimble Creeks and high river levels due to the operation of Box Canyon and Albeni Falls Dams. Hungry Horse discharges in March and April can have an impact on water levels in the Pend Oreille River in the Cusick area.[7] Farmers near Cusick have problems draining their fields in late March and April when Calispell and Trimble Creeks are running high.

Discharges from Albeni Falls Dam, downstream of Hungry Horse were modeled by Bonneville Power Administration for the 1929 to 1978 period with VARQ and STDFC at Hungry Horse[8]. The monthly modeling showed that conditions in the Cusick area are slightly improved in late March and April with VARQ flood control at Hungry Horse. The discharges from Albeni Falls associated with VARQ were slightly lower in March for 30 of the 50 years and also lower in April in 41 of the 50 modeled years. Figure 9 shows the comparison of Albeni Falls average monthly discharges due to STDFC and VARQ operations.

7 U.S. Army Corps of Engineers, "Analysis of the Kokanee Experiment at Lake Pend Oreille on Water Levels in the Cusick, Washington Area" Seattle District, Hydrology and Hydraulics Section, September 7,1999.

8 FRIII_000FSH33 (BiOp with VARQ) and FRIII_000FSH30 (BiOp without VARQ) monthly computer modeling done by Bonneville Power Administration in 2000.

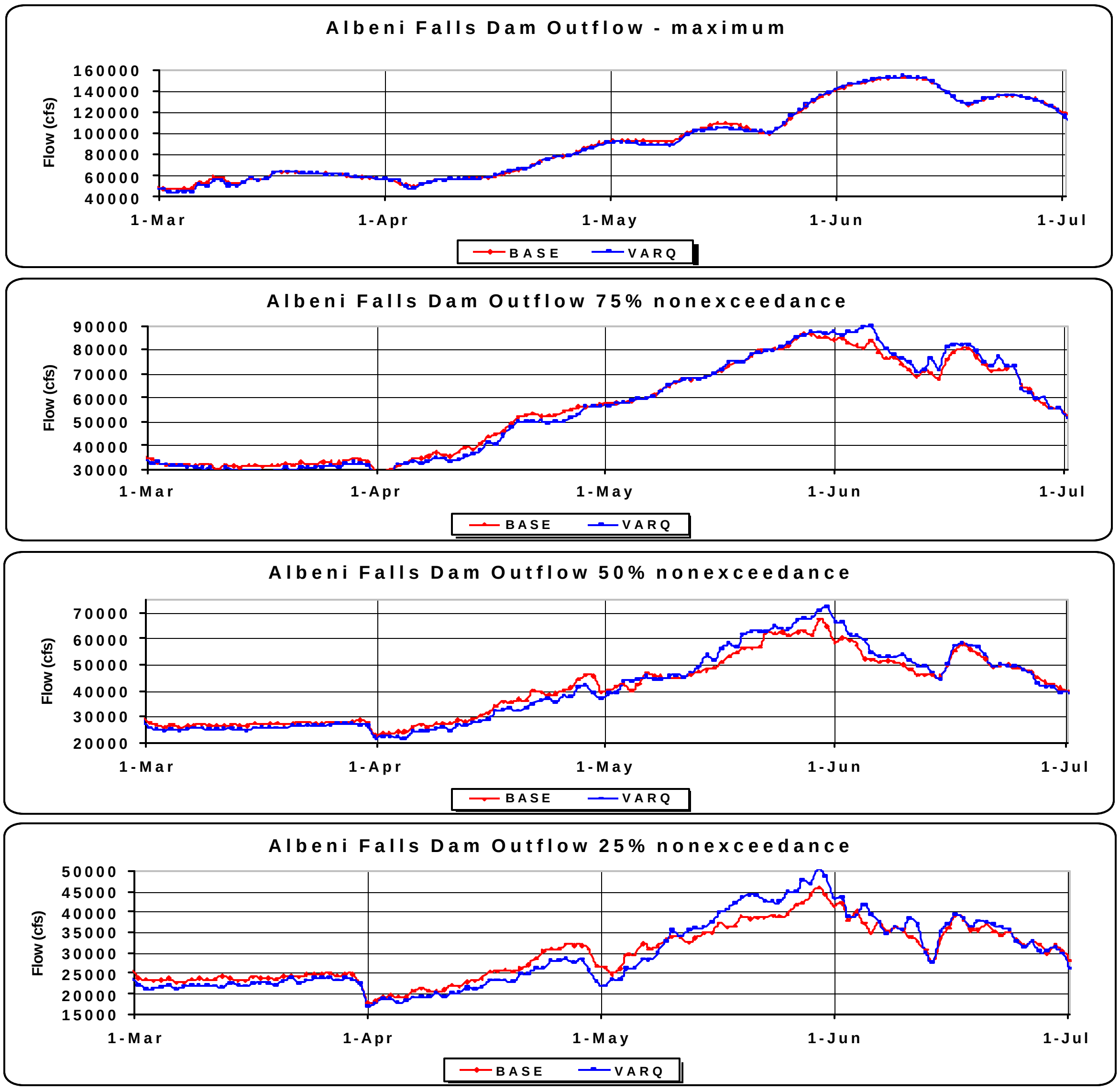
Figure 9. Comparison of VARQ and STDFC Operations at Hungry Horse on modeled Albeni Falls Monthly Average Discharges



A daily model study, done by the Corps of Engineers as part of ongoing studies associated with the Flathead Lake Drought Management Plan[9], also indicates that agricultural flooding in the Cusick area during March and April may be slightly decrease due to VARQ operations at Hungry Horse. Figure 10 contains summary hydrographs which reflect lower peak flows below Albeni Falls Dam before mid-May with VARQ, and higher flows in late May and June in years when agricultural flooding near Cusick is less of a problem.

9 U.S. Army Corps of Engineers, daily modeling for Flathead Lake Draft 2001 Flood Control Report done in conjunction with the ongoing Flathead Lake Drought Management Plan, Seattle District, Hydrology and Hydraulics Section, 2001.

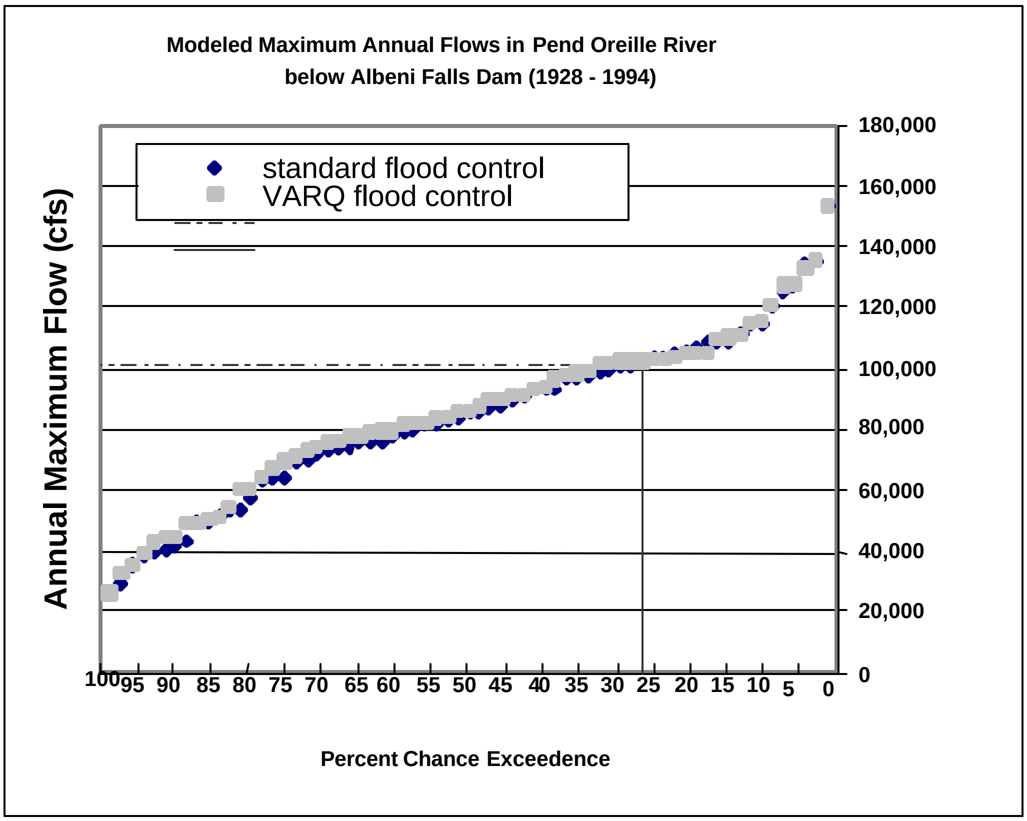
Figure 10. Summary hydrographs which reflect lower peak flows below Albeni Falls Dam before mid-May with VARQ, and higher flows in late May and June only in years when agricultural flooding is not a big problem



Flooding below Albeni Falls Dam in June, is due to spring snowmelt, and is a relatively common occurrence happening historically about one year in four. The National Weather Service issues flood warnings when the releases from Albeni Falls Dam are expected to exceed 100,000 cfs. Figure 11 is a frequency curve of the peak daily flow below Albeni Falls Dam.[10] It shows that the frequency of flooding events in excess of 102,000 cfs is the same for VARQ as STDFC. The peak flow below Albeni Falls Dam with VARQ at Hungry Horse is approximately 2,100 cfs higher than with STDFC when the river is at or below flood stage.

The 10-, 50-, 100-, and 500-year peak discharge from Albany Falls, as identified by the FEMA (Federal Emergency Management Agency) flood insurance study, are unaffected by VARQ.

Figure 11. Frequency curve for peak annual flow below Albeni Falls Dam.



10 U.S. Army Corps of Engineers, daily modeling for Flathead Lake Draft 2001 Flood Control Report done in conjunction with the ongoing Flathead Lake Drought Management Plan, Seattle District, Hydrology and Hydraulics Section, 2001.

Power Impacts

Effects on power production from VARQ appears to be relative to the amount and type of generating resources available to the various power producers downstream of Hungry Horse Dam. For example, Bonneville Power Administration can reshape releases from Hungry Horse Dam by catching that water behind Grand Coulee Dam and then making subsequent releases at a time when power is more valuable. Smaller run-of-river hydropower producers have little control of upstream runoff and therefore have little ability to do long term shaping.

Federal Columbia River Power System

In 1998 the Corps of Engineers modeled power impacts of VARQ at both Libby and Hungry Horse Dams. The energy analysis showed that, although there were some months in which generation decreases, there is an overall increase in the average monthly and total annual hydro system generation at the Federal Columbia River Power System (FCRPS) for all VARQ alternatives as compared to STDFC.[11] Other modeling studies, completed by the Corps in 2001, were reviewed by the Canadian Section of the Columbia River Treaty Operating Committee (BC Hydro) to evaluate the impacts on power production in British Columbia, Canada. The Canadian review stated "From a power perspective, the impacts we would anticipate from your implementation of the Hungry Horse VARQ flood control plan, or inclusion of this data in the PNCA (Pacific Northwest Coordination Agreement) studies appear to be insignificant, and acceptable."[12]

At a public meeting in Newport, Washington in November 2001, it was requested that Reclamation analyze power impacts at Box Canyon Dam and Boundary Dam associated with the implementation of VARQ flood control at Hungry Horse. There was some concern that changes in flow would have negative impacts on power generation at these run-of-river facilities. Simultaneously Power impacts were also analyzed at other non-federal power plants on the Clark Fork and Flathead Rivers. Those plants include Cabinet Gorge, Noxon, Thompson Falls, and Kerr.

Power Generation at Non-Federal Plants

Implementation of the VARQ flood control at Hungry Horse will effect power generation at Box Canyon, Boundary, Cabinet Gorge, Noxon, Thompson Falls, and Kerr Dams. Box Canyon Dam (operated by Pend Oreille Public Utility District) is effected because its turbines were designed to be most efficient at a relatively low flow of around 29,200 cfs. Flows in excess of 29,200 cfs at Box Canyon Dam, result in additional spill past the generating units which requires a larger gate opening thus a reduction in power

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11 U.S. Army Corps of Engineers, "The effects of VARQ at Libby and Hungry Horse on Columbia River System Hydropower", by Jim Barton and Joe Johnson, August, 1998, pg. 24.
12 Legge, Ralph D., Chair, Canadian Section Columbia River Treaty Operating Committee, British Columbia Hydro and Power Authority, in letter to Kenneth Pedde, U.S. Bureau of Reclamation, January 30, 2001.

generation (see power efficiency curve in the Appendix) due to a lower operating head. When flow in the Pend Oreille River exceeds 85,000 cfs (which happens slightly more often with VARQ), the water surface elevation at Box Canyon Dam is lowered to limit upstream flooding. At the lower operating head no power is produced.

Impacts at Boundary Dam (operated by Seattle City Light) are less than those at Box Canyon on a percentage basis (but more on a megawatt basis) due to its larger hydraulic capacity (~53,700 cfs). Cabinet Gorge and Noxon (operated by AVISTA Corp) and Thompson Falls and Kerr (operated by PPL Montana Pennsylvania Power and Light) also have larger operating hydraulic capacities the Box Canyon. Kerr is co-operated by the Salish-Kootenai Tribe and PPL.

Table 1 contains the impacts of VARQ based on 50-year simulations originally done by BPA for the 2000 FCRPS Biological Opinion [13]. Power generation based on STDFC was subtracted from power generation based on VARQ rule curves. A decrease in power generation as a result of VARQ is shown as negative. In addition the model based on STDFC used the old minimum flow of 145 cfs from Hungry Horse while the model based on VARQ used the new minimum flows which vary from 400 cfs to 900 cfs depending on the forecast. The project typically went to 145 cfs during refill in April, May and June. Impacts due to change in flood control were not separated from impacts due to change in minimum flows. Megawatt changes for individual months and years are available in the Appendix.

Table 1. The average change in power generation at Boundary and Box Canyon Dams as attributed to VARQ flood control at Hungry Horse.

Average Percentage change in power generation

	Aug_1	Aug_2	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr_1	Apr_2	May	Jun	Jul
Boundary	-1%	3%	1%	1%	-1%	0%	-6%	1%	1%	-1%	-5%	1%	2%	1%
Box Canyon	-1%	3%	1%	0%	-1%	0%	-6%	0%	0%	0%	1%	7%	-7%	2%
Cabinet Gorge	0%	3%	1%	2%	-2%	0%	-9%	1%	0%	-2%	-6%	1%	1%	3%
Noxon	-1%	3%	1%	3%	0%	1%	-8%	1%	1%	-2%	-14%	2%	2%	2%
Thompson Falls	-1%	3%	1%	2%	0%	0%	-5%	1%	0%	0%	-4%	-1%	-1%	2%
Kerr	-2%	5%	1%	4%	0%	-1%	-11%	1%	0%	-2%	-20%	0%	0%	4%

Average Megawatt/period change in power generation

	Aug_1	Aug_2	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr_1	Apr_2	May	Jun	Jul
Boundary	-4.4	6.3	2.0	4.4	-4.6	3.1	-22.3	4.9	3.2	-6.7	-38.7	5.8	12.1	2.7
Box Canyon	-0.4	0.8	0.3	0.2	-0.6	-0.1	-3.1	-0.2	0.0	0.2	1.3	0.6	-2.0	0.7
Cabinet Gorge	-0.8	1.6	0.5	0.9	-3.0	-0.3	-9.8	1.6	0.7	-2.6	-11.1	1.2	1.7	2.6
Noxon	-3.1	3.2	0.8	2.6	-2.0	1.9	-11.7	3.0	1.1	-5.9	-43.6	8.3	9.0	2.1
Thompson Falls	-0.8	1.0	0.3	0.9	-0.5	0.1	-3.4	0.5	0.2	0.1	-2.7	-0.8	-0.9	0.9
Kerr	-3.6	3.2	1.1	3.2	-3.5	-1.1	-17.8	-1.0	-0.6	-2.4	-29.0	0.3	0.4	3.9

13 FRIII_000FSH33 (BiOp with VARQ) and FRIII_000FSH30 (BiOp without VARQ) monthly computer modeling done by Bonneville Power Administration in 2000 and further manipulated by PN Region River and Reservoir Operations Group in Boise during December 2001.

Typically Power generation during summer and fall is slightly higher with VARQ and generation during winter and spring is slightly less. Table 2 shows the annual average change in power for all facilities both in percent and in megawatts.

Table 2. Average Annual Reduction in Power Generation at Non-Federal Facilities due to implementation of VARQ

	Percent change (%)	Megawatt change (MW)
Boundary	.32	.29
Box Canyon	.17	.86
Cabinet Gorge	.72	.87
Noxon	.37	.78
Thompson Falls	.77	.33
Kerr	3.21	2.56

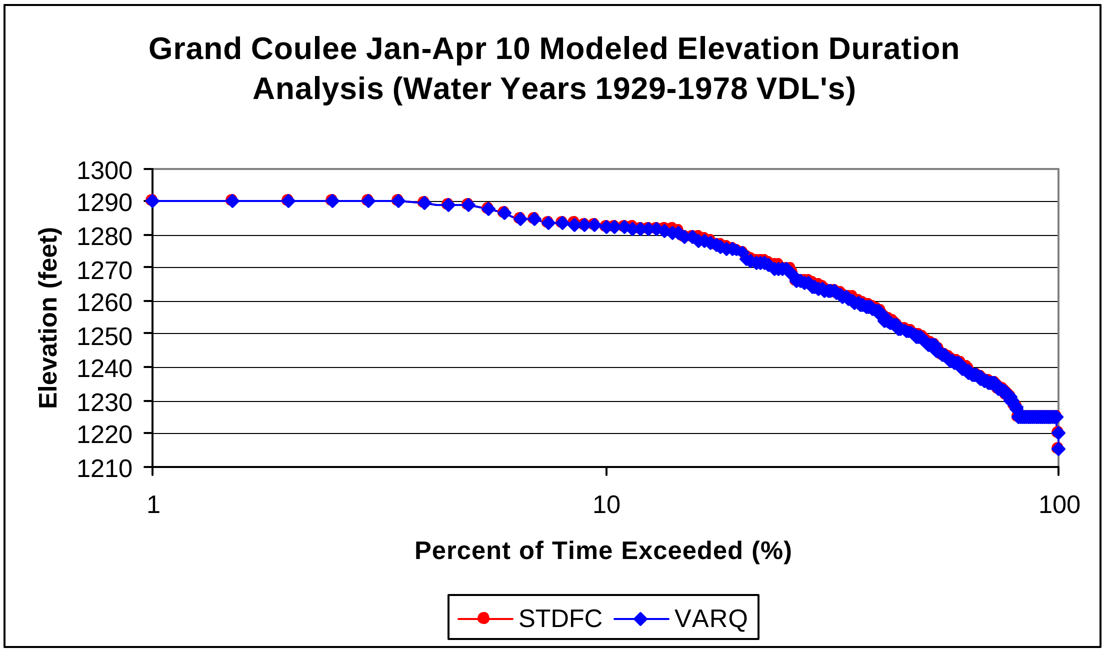
Spill

The difference in forced spill at all the projects, were compared for each modeled period. Figures showing period-by-period average difference in spills due to the VARQ flood control operation at Hungry Horse are located in the Appendix. Negative values indicate a decrease in spills with VARQ.

The Impacts of VARQ Flood Control at Hungry Horse on Grand Coulee

Grand Coulee Dam is approximately 550 miles downstream of Hungry Horse Dam. An indirect effect of VARQ at Hungry Horse is that slightly more flood control space is required by the storage reservation diagrams at Grand Coulee to partially offset the impacts to system flood control. Grand Coulee's flood control draft is based on the runoff forecast at The Dalles modified by the amount of upstream storage space that is availabe. If there is less storage space upstream at Hungry Horse, then Grand Coulee may have to draft slightly deeper in the spring. There is not a one-to-one relationship between the additional water in Hungry Horse and the additional draft at Coulee. In fact, the relationship is somewhat random with many years requiring no additional draft. An elevation/duration analysis for Grand Coulee Reservoir (Lake Roosevelt) for the January through April 10 period shows there is no discernible differences in reservoir elevations between the modeled 85 % confidence Variable Draft Limits (VDL) with VARQ and the VDL for the STDFC operations (See Figure 12).

Figure 12. Grand Coulee Modeled Elevation-Duration Analysis, Water Years 1929-1978



An individual year comparison of the VDL's for STDFC and VARQ elevations at Grand Coulee for the years 1929 through 1988 shows that in most years there is no difference between the two elevations for the January through April 10 periods. An average difference for these years is 0.30 feet on April 10 with a maximum of 2.2 feet. In most years there is no impact on reservation elevation at Grand Coulee (See Table 3).

Table 3. Grand Coulee Change in Elevations. (VDL STDFC Elevation - VDL VARQ Elevation) (1929-1978).

	January D Elevation (ft)	February D Elevation (ft)	March D Elevation (ft)	April 10 D Elevation (ft)
1929	0.00	0.00	0.00	0.00
1930	0.00	0.00	0.00	0.00
1931	0.00	0.00	0.00	0.00
1932	-0.05	-0.05	-0.05	-0.05
1933	0.00	0.00	0.00	0.00
1934	0.00	0.00	0.00	0.00
1935	0.00	2.19	2.21	2.08
1936	0.97	0.96	0.97	0.95
1937	0.00	0.00	0.00	0.00
1938	0.00	0.00	0.00	0.00
1939	1.41	1.42	1.41	1.45
1940	0.00	0.19	1.48	1.55
1941	0.00	0.00	0.00	0.00
1942	0.00	0.00	0.00	0.00
1943	0.00	0.00	0.00	0.00

1944	0.00	0.00	0.00	0.00
1945	1.50	1.64	1.60	1.55
1946	0.00	0.00	0.00	0.00
1947	0.00	0.00	0.00	0.00
1948	0.00	0.67	0.72	0.73
1949	0.63	0.67	0.62	0.69
1950	0.00	0.00	0.00	0.00
1951	0.00	0.00	0.00	0.00
1952	0.00	0.00	0.00	0.00
1953	0.00	0.00	1.34	1.31
1954	0.00	0.00	0.00	0.00
1955	1.46	1.16	1.15	1.17
1956	0.00	0.01	0.01	0.01
1957	0.00	0.34	0.34	0.36
1958	0.90	0.75	0.71	0.78
1959	0.00	0.00	0.00	0.00
1960	1.20	0.96	0.99	1.14
1961	0.00	0.53	0.52	0.54
1962	0.21	0.20	0.20	0.21
1963	0.19	0.16	0.16	0.17
1964	0.00	-0.04	-0.03	-0.04
1965	0.00	0.00	0.00	0.00
1966	0.00	1.57	1.51	1.64
1967	0.00	0.00	0.00	0.00
1968	0.00	1.37	1.24	1.27
1969	0.00	0.33	0.32	0.38
1970	-0.11	-0.12	-0.10	-0.10
1971	0.00	0.16	0.15	0.16
1972	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00
1974	0.00	0.00	-0.03	-0.04
1975	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00
Average	**0.17**	**0.30**	**0.35**	**0.36**
Maximum	**1.50**	**2.19**	**2.21**	**2.08**
Minimum	**-0.11**	**-0.12**	**-0.10**	**-0.10**

Grand Coulee is a multiple use project. Power needs and releases for endangered species can influence reservoir operations during the winter and spring as much, if not more, than flood control requirements. For example, in 2001 the end-of-April flood control requirement at Grand Coulee in both the VARQ and STDFC scenarios was elevation 1283 feet. Lake Roosevelt was drafted to elevation 1220 feet on 30 April (63 feet below flood control) for power generation and endangered species. The flood control needs at Grand Coulee were dwarfed by the needs for power and salmon. The flood control operation at Hungry Horse had no effect on Grand Coulee in 2001.

Water Retention Time

Water retention time is a measure of how quickly water moves through a reservoir. The water retention time in Lake Roosevelt during January through May is typically 30-40 days. Water retention time decreases, with VARQ by less than half a day per month in the January through May period. The combined effects on water retention time at Lake Roosevelt of VARQ at both Libby and Hungry Horse is addressed in the cumulative effects section of this report.

Cumulative Effects of VARQ rule curves at Libby and Hungry Horse on Grand Coulee

The cumulative effects on Grand Coulee of implementing VARQ at both Hungry Horse and Libby have been examined. The Corps of Engineers conducted a preliminary study on the cumulative effects of VARQ at Hungry Horse and Libby on Columbia River System flood control[14]. The Corps found that that during the months of February through June VARQ at both reservoirs required the drafting of less than one additional foot at Grand Coulee on average as compared to the standard flood control procedure. The end-of-May average elevation difference was 0.7 feet. The average end-of-April elevation was 1.2 feet lower in VARQ simulations and the maximum difference during the 50-year simulation was 7.7 feet. On the average, the VARQ operation at both reservoirs added two to four days to the annual flood control evacuation and refill cycle of the reservoir.

A second study conducted by the Northwest Power Planning Council had similar findings. This study found that under the VARQ scenario at Hungry Horse and Libby, Grand Coulee's elevation averaged around half a foot lower in February, 1.5 feet lower in March and about two feet lower in April. In the worst case, the elevation was 6 feet lower in March[15].

The Power Planning Council study also found that implementing the VARQ operation at both Hungry Horse and Libby lowered the average water retention time in June, July, and August by a little more than one day. In January, the average retention time increases by two days. Water retention times in other months are not affected as much[16].

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14 The Effects of VARQ at Libby and Hungry Horse on Columbia River System Flood Control, U.S. Army Corps of Engineers, North Pacific Region, Portland, OR, August, 1998, pg.13.
15 Fazio, John. Memorandum to Northwest Power Planning Council Members, "Impacts of the VARQ Flood Control". June 6, 2000, pg 4.
16 Ibid. pg 6.

The Corps is planning to do further studies of the cumulative effects of Hungry Horse and Libby VARQ.

Conclusions

The hydrologic impacts of VARQ flood control operation at Hungry Horse are small. VARQ allows Hungry Horse to be more full during the winter in years when flooding is not anticipated, but will require higher releases during the spring refill period. VARQ results in the Upper Rule Curves for Hungry Horse Reservoir up to 20 feet higher during the winter in some years. Columbia Falls minimum flows and system power demands will likely draw Hungry Horse down to elevations more comparable to Standard Flood Control. In high runoff years there will be no difference in end-of-April reservoir elevations at Hungry Horse. Hungry Horse Reservoir elevations and releases will continue to fluctuate within their normal operating range with VARQ flood control.

The discharges from Hungry Horse under the VARQ rule curves are generally higher in late May and June and have less variability from month to month. Under the VARQ operation there is less likelihood of having to spill water in April to reach the target flood control elevation. With VARQ there is less likelihood of decreasing the Hungry Horse discharges to minimums once the flood control draft is complete. There will be no increase in flooding on the Flathead River at Columbia Falls, MT and little effect in the Cusick area below Albeni Falls Dam as a result of VARQ. Enough flood control space will remain in Hungry Horse Reservoir to drop discharges to minimums during high runoff events when natural, uncontrolled flow are causing flooding downstream.

There appears to be little effect from VARQ on power generation at the Federal Columbia River Power System or at Canadian projects. Smaller non-federal projects will likely experience a small decrease in power generation. The average decrease in annual power generation at Boundary Dam is about 0.17% (.86 MW). The average decrease in annual power generation at Box Canyon is about 0.32% (.29 MW). The average decrease in annual power generation at Cabinet Gorge is about 0.72% (.87 MW). The average decrease in annual power generation at Noxon is about 0.37% (.78 MW).). The average decrease in annual power generation at Thompson Falls is about 0.77% (.33 MW). The average decrease in annual power generation at Kerr is about 3.21% (2.56 MW). Winter and spring months show negative effects on generation because less water is drafted from Hungry Horse. Power generation during summer and fall at these projects is slightly better with VARQ.

VARQ operations at Hungry Horse will have no significant impact on Grand Coulee. During most years there is no difference between the Grand Coulee reservoir elevations on 10 April as specified in the FCRPS Biological Opinion. When comparing the two flood control operations (STDFC and VARQ) the 50-year average difference in Grand Coulee elevations was 0.3 feet on April 10th and the maximum was 2.2 feet.

Preliminary studies on the cumulative effects of VARQ at both Hungry Horse and Libby on Grand Coulee indicate that the VARQ operation drafted from around a half a foot to two feet deeper in the months of February through June. The maximum differences in elevation ranged from 6 feet lower in March to 7.7 feet lower at the end of April.

The cumulative effects of VARQ at both Hungry Horse and Libby on Grand Coulee's water retention time is that it will lower the retention by a little more than one day in June, July , and August. In January the water retention time will increase by two days and in the other months the effects will not be as great.

Power and salmon operations can have as much (or more) influence on reservoir elevations at Lake Roosevelt during the winter and spring as flood control.

Appendix

Changes in Power Generation at Boundary in megawatts/period.

Water_Year	Aug_1	Aug_2	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr_1	Apr_2	May	Jun	Jul
1929	0	0	0	8	-26	-1	-1	-1	-1	-2	12	0	16	-11
1930	16	7	0	0	0	0	0	0	0	4	-60	-18	0	47
1931	0	0	1	0	5	-6	-4	0	-2	6	-35	-49	0	-2
1932	23	8	0	44	4	8	0	0	10	-10	-80	2	-2	-25
1933	59	85	2	-1	7	2	-82	-63	30	21	-29	46	-4	-11
1934	0	-130	0	54	27	93	35	71	69	-68	21	6	51	98
1935	63	0	0	0	-9	0	-79	-5	0	0	-38	3	24	-79
1936	61	98	2	-2	1	-1	-1	0	0	0	-93	4	57	79
1937	0	0	1	0	-1	-1	0	0	0	0	3	0	31	-52
1938	13	18	2	0	2	0	-23	0	0	-22	-95	1	-4	5
1939	1	-1	1	0	0	-1	-5	0	0	-28	-123	-7	53	83
1940	15	1	0	0	-2	3	0	-2	0	3	-32	-55	0	-6
1941	8	3	0	31	37	5	0	0	-3	2	4	6	6	0
1942	-17	-4	1	-1	0	0	-95	-49	-2	5	-16	23	60	25
1943	-51	0	0	0	0	0	-51	-5	1	-3	7	1	-7	0
1944	0	0	1	-1	0	0	-3	-5	-6	-5	5	3	0	0
1945	0	0	0	0	-1	0	9	-2	-2	-2	-2	0	9	29
1946	-59	-2	0	0	-30	0	-66	0	0	-1	-77	0	35	0
1947	0	0	0	0	-51	0	0	86	10	13	-43	1	-2	-37
1948	0	0	1	16	15	0	-74	-69	11	16	11	0	-8	24
1949	0	68	0	0	-48	0	0	-1	0	-4	-96	3	24	38
1950	0	0	0	0	-8	4	-86	73	15	41	-1	0	-1	1
1951	-49	8	0	15	14	30	10	18	-2	-56	-50	2	-2	20
1952	-8	0	16	11	-10	-12	-10	-62	11	18	-21	-1	37	-43
1953	0	0	1	-1	-1	-1	-4	0	0	0	-58	32	0	0
1954	0	0	0	0	0	0	0	0	-27	0	-9	1	-2	0
1955	0	0	0	0	0	0	-82	-4	-3	-22	-67	0	-6	0
1956	0	0	0	16	15	-18	34	15	-5	-7	3	6	0	22
1957	6	-6	0	0	-15	0	-35	0	0	-30	-56	2	-6	0
1958	0	0	1	-2	0	0	0	0	0	-6	-50	3	24	35
1959	0	0	1	2	8	-7	47	41	23	-39	-121	2	-2	-12
1960	0	0	16	0	27	74	37	-51	-65	-94	-54	-1	-3	2
1961	-67	47	0	-1	0	0	-19	-4	-27	-14	-29	-1	-3	0
1962	0	0	1	2	-25	-1	-43	0	7	9	-59	0	-2	15
1963	0	0	1	-1	4	3	-86	-22	-2	-1	-44	96	19	-70
1964	58	96	0	0	0	0	0	0	0	-15	-77	13	-3	-5
1965	0	0	5	15	-17	-3	42	17	11	-5	-51	-1	-2	-38
1966	-76	46	11	0	0	-9	-87	-56	-3	-15	-86	12	80	0
1967	0	0	1	0	0	0	-71	91	41	1	-26	-16	-1	-15
1968	-11	0	0	0	-16	0	-89	-2	7	8	-77	138	0	0
1969	-85	5	16	16	4	3	-4	30	7	-13	-32	3	26	50
1970	0	0	0	0	0	0	-2	0	0	-10	-7	8	-2	-53
1971	0	0	2	0	-2	0	-47	33	-6	12	10	-1	-1	0
1972	0	0	0	0	-23	0	-54	86	28	0	-16	2	-3	-23
1973	0	0	0	0	-82	11	-65	-1	-2	0	0	0	132	43
1974	-80	0	0	0	-15	0	29	54	26	-31	-51	2	-2	0
1975	-38	-31	0	0	-35	0	0	0	5	3	0	34	-4	1
1976	0	0	12	0	16	-7	-18	-46	8	13	-41	1	-3	2
1977	0	0	2	-1	-88	-20	-3	-5	-6	-5	2	4	2	0
1978	0	0	0	0	91	5	-67	86	6	-3	-113	-18	-5	0
Average Difference (mw)	-4.4	6.3	2.0	4.4	-4.6	3.1	-22.3	4.9	3.2	-6.7	-38.7	5.8	12.1	2.7
Average mw STDFC	347.3	306.6	277.9	555.6	372.3	390.8	371.7	374.1	418.9	532.8	701.4	858.4	858.5	646.2
Average mw VARQ	342.9	312.9	279.8	560.0	367.7	393.9	349.5	379.0	422.1	526.1	662.7	864.3	870.7	649.0

Changes in Power Generation at Box Canyon in megawatts/period.

Water_Year	Aug_1	Aug_2	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr_1	Apr_2	May	Jun	Jul
1929	0	0	0	0	-3	0	0	0	0	-1	1	0	0	-1
1930	2	1	0	0	-1	0	0	0	0	0	-1	-1	0	6
1931	0	0	1	0	1	0	-1	0	0	1	-5	-5	0	0
1932	3	1	0	5	0	1	0	0	1	0	3	2	-2	-1
1933	8	11	0	0	1	0	-11	-8	4	2	-2	-4	0	0
1934	0	-17	0	-2	2	-4	-3	-3	-2	11	39	12	2	13
1935	8	0	0	0	-1	0	-10	-1	0	0	-2	0	-5	-2
1936	7	13	0	0	0	0	0	0	0	0	3	4	-2	10
1937	0	0	1	0	0	0	0	0	0	0	1	0	2	-6
1938	2	3	0	0	0	0	-3	0	0	-2	3	0	-3	0
1939	0	0	0	0	1	0	-1	0	0	-3	-3	2	-1	8
1940	1	0	0	0	0	0	0	-1	0	1	-2	0	0	0
1941	1	1	0	3	5	1	0	0	-1	1	0	1	1	0
1942	-2	0	1	0	0	0	-12	-6	0	0	-1	-1	-6	-1
1943	-7	0	0	0	0	0	-6	0	0	1	6	2	-15	0
1944	0	0	0	0	0	0	0	-1	-1	0	1	1	0	0
1945	0	0	0	1	0	0	1	-1	0	0	0	0	0	1
1946	-7	0	0	0	-4	0	-9	0	0	0	2	-1	-5	0
1947	0	0	0	0	-5	0	0	8	0	-1	2	2	-2	-1
1948	0	0	0	0	1	0	-9	-9	1	2	0	0	0	-1
1949	0	7	0	0	-6	0	0	0	0	-1	3	6	-4	4
1950	0	0	0	0	-1	1	-11	8	1	-2	0	1	0	1
1951	-2	0	0	0	2	1	1	-1	0	2	4	4	-2	-1
1952	-1	0	2	0	-1	-1	-1	-8	2	0	2	-4	-3	-4
1953	0	0	0	0	0	0	-1	0	0	0	-4	-1	0	0
1954	0	0	0	0	0	0	0	0	-3	0	0	0	-5	0
1955	0	0	0	0	0	0	-11	0	0	-3	-7	0	-13	0
1956	0	0	0	0	2	-1	3	1	-1	1	2	0	-2	-1
1957	1	-1	0	0	-2	0	-4	0	0	-2	-3	2	-7	0
1958	0	0	0	0	0	0	0	0	0	0	-2	3	-2	3
1959	0	0	0	1	1	-1	4	2	2	1	4	1	0	1
1960	0	0	2	0	2	-1	4	-5	-5	4	5	1	-3	0
1961	-7	6	0	0	0	0	-2	0	-3	0	1	-1	-5	0
1962	0	0	0	0	-3	0	-6	0	0	1	3	1	-4	0
1963	0	0	0	0	0	0	-11	-2	0	0	-2	-3	-1	-3
1964	7	12	0	0	0	0	0	0	0	-1	-7	-1	0	1
1965	0	0	1	1	-3	-1	4	1	1	0	3	-1	-5	1
1966	-9	4	2	0	0	-1	-11	-8	0	0	3	-1	-5	0
1967	0	0	0	0	0	0	-8	10	4	0	-1	2	0	1
1968	-1	0	0	0	-2	0	-11	0	0	1	-5	-5	0	0
1969	-11	1	2	0	0	0	0	3	1	1	6	6	-3	-2
1970	0	0	0	0	0	0	0	0	0	-1	0	-1	-4	-1
1971	0	0	0	0	0	0	-5	0	0	1	0	0	0	0
1972	0	0	0	0	-3	0	-7	9	-1	-2	2	2	0	1
1973	0	0	0	0	-11	2	-9	0	-1	0	0	0	9	6
1974	-10	0	0	0	-1	0	-1	-2	1	1	5	1	0	1
1975	-4	-3	0	0	-5	0	0	0	0	0	0	-1	0	1
1976	0	0	1	0	2	-1	-1	-5	0	0	2	2	-3	-1
1977	0	0	0	0	-11	-2	0	-1	-1	-1	0	1	0	0
1978	0	0	0	0	11	0	-8	11	0	0	4	1	-4	0
Average Difference (mw)	-0.4	0.8	0.3	0.2	-0.6	-0.1	-3.1	-0.2	0.0	0.2	1.3	0.6	-2.0	0.7
Average mw STDFC	44.4	38.0	36.1	63.9	47.5	48.7	46.0	46.0	51.0	57.0	57.3	44.1	37.7	57.0
Average mw VARQ	44.0	38.8	36.3	64.1	46.8	48.6	42.8	45.8	51.0	57.2	58.6	44.7	35.6	57.6

Changes in Power Generation at Cabinet Gorge in megawatts/period.

Water_Year	Aug_1	Aug_2	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr_1	Apr_2	May	Jun	Jul
1929	-9	8	1	2	-11	-2	-1	-1	-1	-4	8	1	0	0
1930	3	-1	0	-1	-2	-2	-1	-1	-1	7	-24	6	2	14
1931	3	0	0	-1	1	-4	-3	0	-2	2	-13	-10	2	4
1932	3	2	0	15	0	2	-1	0	4	-1	-22	-1	1	-4
1933	24	33	1	-1	1	0	-36	-25	12	4	-15	5	0	2
1934	6	-53	1	19	11	10	3	24	8	5	10	0	10	42
1935	27	-2	0	-1	-5	-1	-34	-3	0	-6	-19	0	1	-19
1936	21	36	0	0	-1	-2	-1	-1	-1	-9	-11	0	5	33
1937	3	0	0	-1	-1	-2	-1	-1	-1	-7	9	3	12	-12
1938	4	-1	0	0	-1	-1	-9	0	-1	-15	-31	1	1	0
1939	-3	2	1	0	-1	-2	-2	0	-1	-8	-57	1	5	22
1940	6	-2	1	0	-2	0	-1	-1	0	5	-20	-7	1	0
1941	3	-1	0	11	13	6	1	0	-2	-1	4	1	1	0
1942	-4	-1	1	1	1	2	-39	-19	-1	-1	-8	4	1	5
1943	-21	1	1	0	-1	-1	-20	-1	0	3	2	1	-3	0
1944	1	-3	1	0	-1	-1	0	-2	-2	-4	4	1	0	0
1945	0	1	1	1	1	4	4	0	-1	-1	0	3	2	8
1946	-24	0	1	0	-13	-1	-28	1	6	-3	-12	1	3	0
1947	0	-2	0	-1	-17	0	-1	27	4	-1	-8	0	1	-10
1948	0	-3	1	3	6	-1	-28	-29	4	3	1	0	-2	0
1949	3	15	1	-1	-22	-1	1	-1	-1	-2	-32	0	4	10
1950	2	-3	0	0	-4	1	-34	29	7	9	-4	0	-1	0
1951	-13	0	0	6	4	11	-1	7	-4	-10	-7	0	0	2
1952	0	-3	7	3	-5	-5	-4	-25	4	8	-1	-3	3	-10
1953	14	12	1	0	0	0	-1	0	0	-5	-27	5	0	-1
1954	-1	-2	1	1	0	0	0	1	-11	3	-8	1	-1	0
1955	2	-2	0	0	0	1	-32	0	0	-8	-29	0	-3	0
1956	4	-4	1	7	7	-8	15	1	-2	-5	-1	0	0	7
1957	1	-4	2	0	-6	1	-10	1	0	-13	-32	0	1	0
1958	-2	0	2	1	1	0	0	-1	0	-11	-24	0	2	8
1959	-1	-1	1	1	3	-1	17	10	4	-51	10	0	0	0
1960	5	-4	7	1	11	19	3	-15	-22	-5	-12	1	0	6
1961	-15	18	3	0	1	-1	-9	5	-7	-2	-2	1	0	4
1962	0	2	-2	-2	-15	-3	-17	4	2	10	-1	0	1	7
1963	2	5	-4	-1	2	2	-34	-7	9	3	-23	13	3	-17
1964	17	36	-3	-2	-5	-2	1	1	0	-3	-26	0	0	1
1965	3	0	3	8	-6	3	18	4	7	-8	-1	-1	0	-2
1966	-18	15	7	3	1	0	-33	-20	3	2	-31	4	1	5
1967	0	-1	2	4	7	0	-26	39	14	5	-15	0	-1	1
1968	1	-2	3	0	-3	2	-33	6	8	5	-17	20	1	8
1969	-37	-1	6	4	1	-3	-5	3	-3	-3	-11	0	1	17
1970	2	1	2	0	-3	-4	-9	-7	-6	-8	-5	0	-1	-14
1971	-3	2	-3	-2	-5	-3	-21	20	-3	11	1	-1	-1	2
1972	-2	-4	-3	-5	-15	-4	-23	28	6	1	-9	-1	-2	0
1973	5	10	-4	-5	-39	-5	-28	2	2	2	0	5	35	11
1974	-33	-6	-7	-2	-8	-1	12	12	1	-14	-4	0	1	0
1975	-12	-9	-2	-4	-25	-6	-2	-3	1	-4	0	7	0	0
1976	-2	-5	1	-3	2	0	-2	-11	7	4	-8	-1	1	2
1977	0	4	-2	-7	-38	-13	-6	-6	-7	-8	-3	2	-1	-5
1978	-4	-3	-5	-4	29	2	-30	34	0	-1	-33	0	1	1
Average Difference (mw)	-0.8	1.6	0.5	0.9	-3.0	-0.3	-9.8	1.6	0.7	-2.6	-11.1	1.2	1.7	2.6
Average mw STDFC	101.9	87.8	55.3	80.4	100.5	105.7	99.3	96.5	104.0	133.0	167.7	199.5	198.9	162.3
Average mw VARQ	101.1	89.4	55.9	81.3	97.5	105.4	89.4	98.1	104.6	130.4	156.6	200.8	200.6	164.9

Changes in Power Generation at Noxon in megawatts/period.

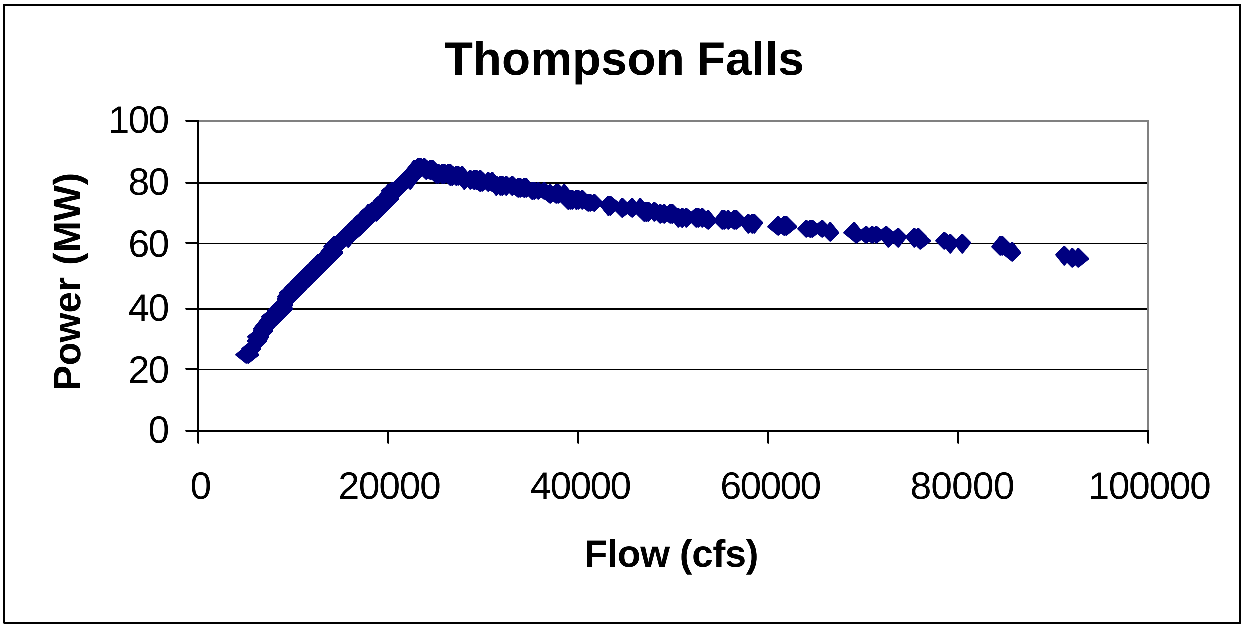
Water_Year	Aug_1	Aug_2	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr_1	Apr_2	May	Jun	Jul
1929	0	0	0	4	-14	-1	-1	-1	-1	-1	6	0	10	0
1930	0	0	0	0	0	0	0	0	0	2	-68	8	0	26
1931	0	0	0	0	3	-5	-2	0	-1	3	-18	-27	0	5
1932	4	0	0	25	4	6	0	0	5	-12	-74	0	0	-14
1933	33	47	0	0	4	1	-44	-35	15	11	-33	78	0	0
1934	0	-72	0	31	26	57	21	58	18	-42	-1	0	14	55
1935	35	0	0	0	-6	0	-43	-3	0	0	-47	30	16	-44
1936	34	56	0	0	0	0	-1	0	0	0	-99	0	25	44
1937	1	-1	0	0	1	0	0	0	0	0	2	0	20	-21
1938	2	0	0	0	0	0	-13	0	0	-12	-100	14	0	3
1939	0	0	0	0	0	0	-3	0	0	-16	-140	0	4	50
1940	7	0	0	0	-1	1	0	-1	0	2	-39	-19	0	0
1941	0	0	0	17	21	3	0	0	-1	1	2	3	3	0
1942	-10	-2	0	0	0	0	-52	-26	-1	3	-21	18	68	14
1943	-28	0	0	0	0	0	-28	-2	0	-3	3	0	0	0
1944	0	0	0	0	1	0	-2	-3	-3	-2	3	2	0	0
1945	0	0	0	0	0	0	4	-1	-1	-2	-1	0	5	16
1946	-34	0	0	0	-16	0	-36	0	0	-1	-81	0	48	0
1947	0	0	0	0	-29	0	-1	48	9	0	-47	0	0	-21
1948	0	0	0	9	9	0	-40	-37	6	12	4	0	0	0
1949	0	39	0	0	-26	0	0	-1	0	-6	-96	0	43	22
1950	0	0	0	0	-5	3	-46	40	14	24	-27	0	0	0
1951	-28	5	0	9	9	27	-5	16	-7	-59	-44	1	0	11
1952	-5	0	8	6	-6	-7	-5	-34	6	22	-71	-4	15	-25
1953	0	0	0	0	0	0	-2	0	0	0	-52	27	0	0
1954	0	0	0	0	0	0	0	0	-14	0	-9	0	0	0
1955	0	0	0	0	0	0	-45	-3	-1	-12	-36	0	0	0
1956	0	0	0	9	9	-16	32	1	-5	0	0	0	0	13
1957	3	-3	0	0	-9	0	-20	0	0	-16	-69	0	1	0
1958	0	0	0	0	0	0	0	0	0	-3	-60	1	24	19
1959	0	0	0	1	4	-4	35	20	8	-54	-70	0	0	0
1960	0	0	9	0	26	43	7	-29	-46	-54	-58	20	0	1
1961	-38	27	0	0	0	0	-10	-2	-14	-17	-13	0	0	0
1962	0	0	0	2	-14	0	-23	0	3	11	-74	-2	6	10
1963	0	0	0	0	3	2	-46	-19	6	-2	-53	68	9	-40
1964	31	55	0	0	0	0	0	0	0	-8	-44	23	0	0
1965	0	0	3	8	-10	-3	30	3	9	-20	-65	0	0	-21
1966	-42	26	6	0	0	-5	-46	-30	-2	-16	-75	45	54	0
1967	0	0	0	0	0	0	-39	52	20	2	-34	-6	0	-8
1968	-6	0	0	0	-9	0	-48	-1	6	-1	-43	74	0	0
1969	-48	3	9	9	4	0	-2	20	1	-13	-137	0	8	28
1970	0	0	0	0	0	0	-1	0	0	-5	-9	0	0	-29
1971	0	0	0	0	0	0	-25	29	-14	14	-6	0	0	0
1972	0	0	0	0	-13	0	-29	47	22	16	-55	0	0	-14
1973	0	0	0	0	-46	6	-36	0	-1	-1	0	0	74	24
1974	-45	0	0	0	-9	0	24	28	9	-41	-66	0	0	0
1975	-21	-18	0	0	-19	0	0	0	3	2	1	32	0	0
1976	0	0	6	0	9	-6	-7	-28	7	14	-58	0	0	2
1977	0	0	1	-1	-49	-11	-2	-2	-3	-2	1	2	1	0
1978	0	0	0	0	49	2	-36	47	5	-11	-111	29	0	0
Average Difference (mw)	-3.1	3.2	0.8	2.6	-2.0	1.9	-11.7	3.0	1.1	-5.9	-43.6	8.3	9.0	2.1
Average mw STDFC	151.8	130.4	80.2	119.0	148.2	153.4	142.9	141.1	147.2	209.0	301.8	436.2	449.4	288.7
Average mw VARQ	148.7	133.6	81.0	121.6	146.3	155.2	131.2	144.1	148.3	203.1	258.1	444.6	458.3	290.9

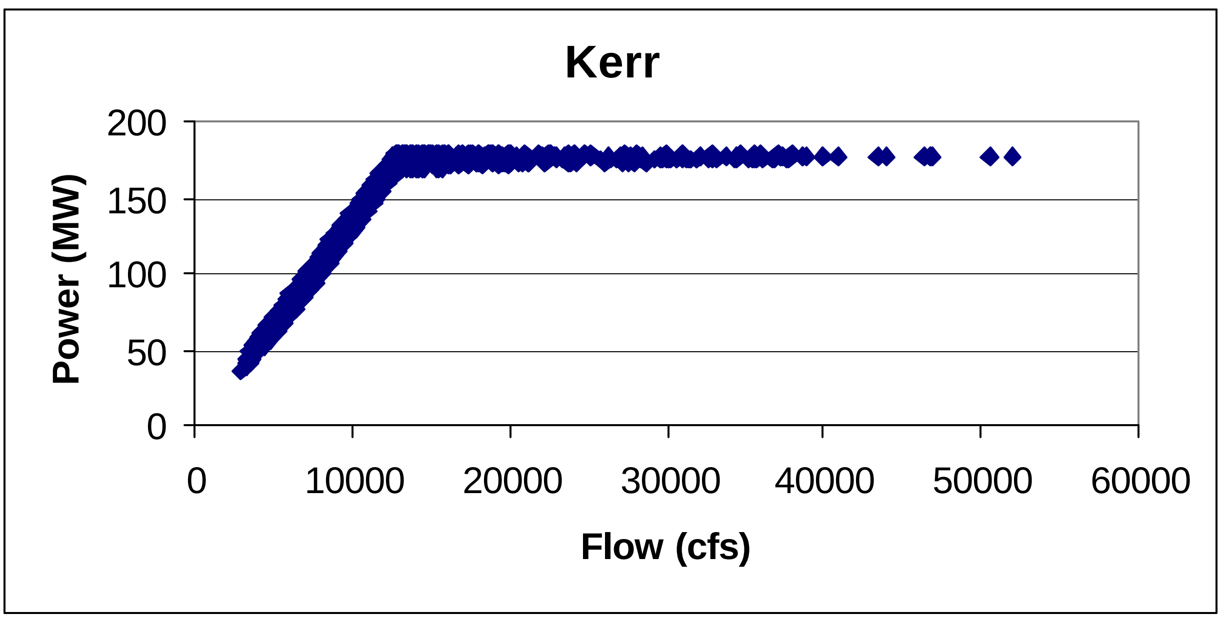
Changes in Power Generation at Thompson Falls in megawatts/period.

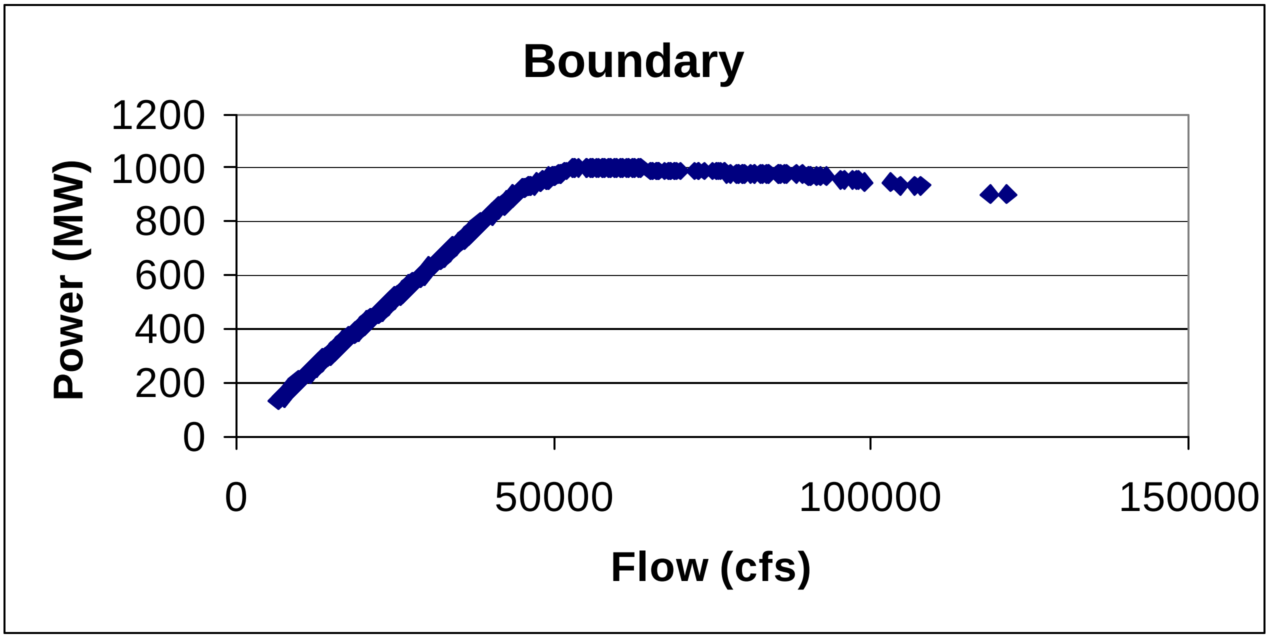
Water_Year	Aug_1	Aug_2	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr_1	Apr_2	May	Jun	Jul
1929	0	0	0	1	-4	0	-1	0	0	0	2	0	-1	0
1930	0	0	0	0	0	0	0	0	0	1	4	-1	0	7
1931	0	0	0	0	0	0	-1	0	0	1	-6	0	0	2
1932	1	0	0	9	2	0	0	0	2	-3	5	-1	-1	-3
1933	9	13	0	0	1	0	-12	-11	4	3	-9	-4	1	0
1934	0	-19	0	8	6	-3	-1	1	-1	10	5	0	-1	14
1935	10	0	0	0	-1	0	-11	0	0	0	-13	-1	-2	-3
1936	9	17	0	0	0	0	0	0	0	0	5	0	-1	12
1937	0	0	0	0	0	0	0	0	0	0	0	0	-2	-5
1938	0	0	0	0	0	0	-4	0	0	-4	-7	-2	-1	0
1939	0	0	0	0	0	0	-1	0	0	-5	-18	-1	0	14
1940	0	0	0	0	0	0	0	-1	0	1	-11	1	0	0
1941	0	0	0	7	7	0	0	0	0	0	1	1	1	0
1942	-4	0	0	0	0	0	-14	-9	0	1	-6	-1	-3	-1
1943	-7	0	0	0	0	0	-8	-1	0	0	4	-2	-2	0
1944	0	0	0	0	0	0	0	-1	-1	-1	1	1	0	0
1945	0	0	0	0	0	0	2	0	0	-1	0	0	0	-2
1946	-9	0	0	0	-4	0	-9	0	1	-1	4	-1	-2	0
1947	0	0	0	0	-7	0	0	13	2	0	2	0	0	-1
1948	0	0	1	3	2	0	-11	-10	2	4	0	0	-1	0
1949	0	10	0	0	-8	0	0	0	0	-1	-5	0	-3	5
1950	0	0	0	0	-1	0	-13	11	3	1	1	-1	-1	0
1951	-6	2	0	2	2	7	-1	4	-1	3	2	0	-1	-1
1952	-1	0	2	2	-1	-1	-1	-9	2	6	3	-3	-1	-6
1953	0	0	0	0	0	0	0	0	0	0	-14	-1	0	0
1954	0	0	0	0	0	0	0	0	-4	0	1	0	-1	0
1955	0	0	0	0	0	0	-12	-1	-1	-4	-10	0	-2	0
1956	0	0	0	3	3	-4	8	1	-1	0	2	0	-1	-1
1957	1	-1	0	0	-2	0	-5	0	0	-4	-19	-1	-3	0
1958	0	0	0	0	0	0	0	0	0	-1	-16	0	-2	5
1959	0	0	0	1	1	-1	9	6	2	3	3	-1	1	0
1960	0	0	3	1	5	8	2	-7	-12	3	3	-1	-1	1
1961	-10	7	0	0	0	0	-3	-1	-4	-4	-4	-1	-1	0
1962	0	0	0	1	-4	0	-6	0	1	3	3	0	-2	-1
1963	0	0	0	0	0	1	-13	-4	2	0	-14	-3	0	3
1964	8	16	0	0	0	0	0	0	0	-2	-12	-1	-1	0
1965	0	0	1	3	-3	-1	8	1	2	-4	3	-2	0	1
1966	-10	7	2	0	0	-1	-13	-9	0	-4	-15	-2	-3	0
1967	0	0	0	0	0	0	-11	15	6	1	-9	0	0	0
1968	-1	0	0	0	-3	0	-13	-1	2	0	-12	-4	0	0
1969	-12	1	3	2	1	0	-1	6	0	0	6	-1	-1	-2
1970	0	0	0	0	0	0	0	0	0	-1	-2	-1	-1	2
1971	0	0	0	0	0	0	-7	4	-3	4	0	0	0	0
1972	0	0	0	0	-3	0	-8	13	-1	-2	3	0	-1	0
1973	0	0	0	0	-12	2	-9	0	-1	0	0	0	-4	7
1974	-14	0	0	0	-2	1	2	8	2	2	3	0	0	0
1975	-5	-4	0	0	-5	0	0	0	1	1	0	-2	-1	0
1976	0	0	1	0	2	-1	-2	-8	3	-1	3	-1	-1	0
1977	0	0	0	0	-13	-2	0	0	-1	-1	1	1	1	0
1978	0	0	0	0	16	0	-10	13	2	1	-2	-2	-1	0
Average Difference (mw)	-0.8	1.0	0.3	0.9	-0.5	0.1	-3.4	0.5	0.2	0.1	-2.7	-0.8	-0.9	0.9
Average mw STDFC	56.8	49.0	37.8	50.2	56.7	55.5	59.6	50.7	55.7	61.4	70.1	72.0	70.9	73.3
Average mw VARQ	56.0	50.0	38.1	51.0	56.2	55.6	56.2	51.2	55.9	61.5	67.5	71.2	70.0	74.3

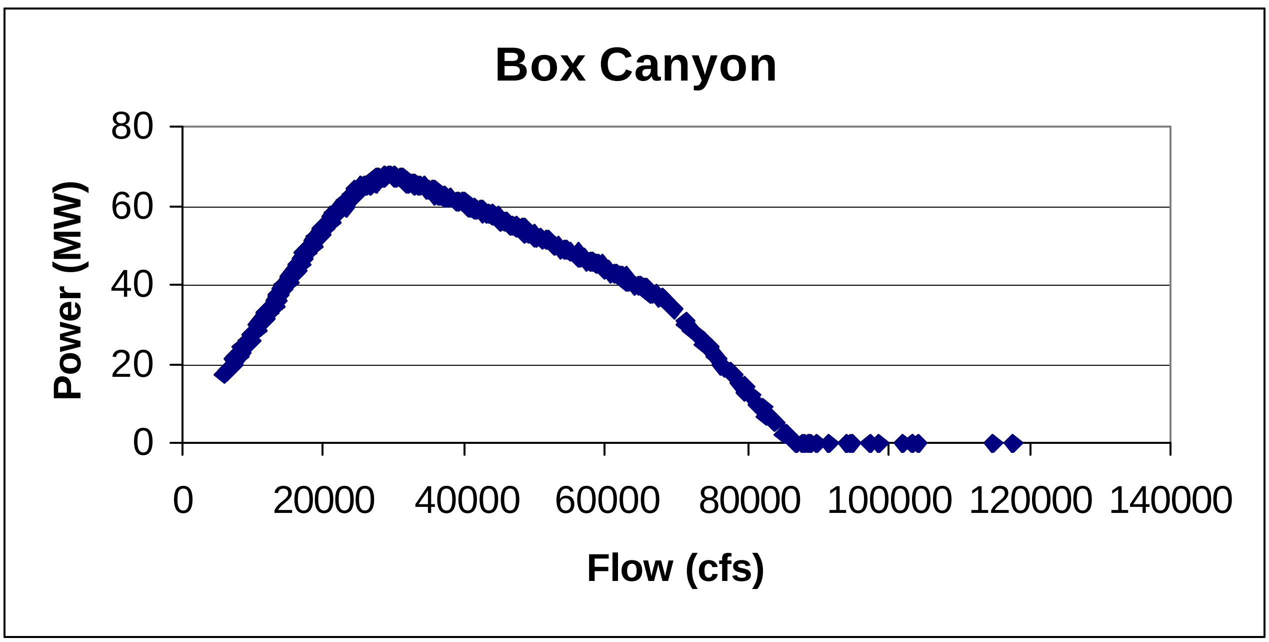
Changes in Power Generation at Kerr in megawatts/period.

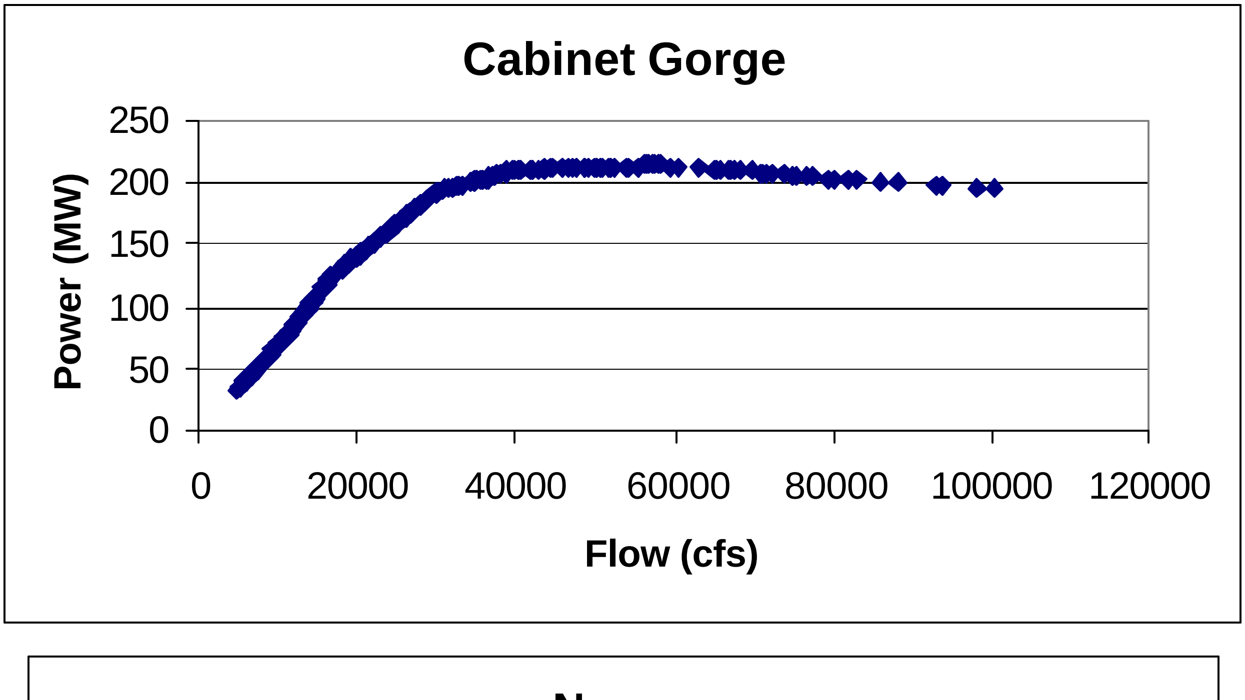
Water_Year	Aug_1	Aug_2	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr_1	Apr_2	May	Jun	Jul
1929	0	0	0	5	-17	-1	0	-1	-1	-1	7	0	0	0
1930	0	0	0	0	0	0	0	0	0	2	-84	9	1	31
1931	0	0	0	0	0	0	-2	0	-1	3	-20	-27	0	8
1932	6	1	1	32	7	0	0	0	7	-15	-1	0	0	0
1933	34	57	0	0	5	2	-52	-42	19	14	-41	0	0	0
1934	0	-81	0	37	-1	-2	-4	-5	-9	-7	-3	-1	1	67
1935	43	0	0	0	-6	0	-50	-4	0	0	-57	0	0	0
1936	26	67	0	0	0	0	-1	0	0	0	-115	0	1	54
1937	0	0	0	0	0	0	0	0	0	0	2	1	1	-26
1938	0	0	0	0	0	0	-15	0	0	-13	-115	0	0	0
1939	0	0	0	0	0	0	-4	0	0	-20	-117	0	2	31
1940	0	0	0	0	0	0	0	-1	0	3	-45	-21	0	1
1941	1	1	1	22	28	0	0	-1	-2	1	2	4	4	0
1942	-9	-2	0	1	1	0	-61	-32	-1	3	-24	0	0	0
1943	-35	0	0	0	0	0	-32	-3	1	-4	-1	-1	0	0
1944	0	0	0	0	0	0	-2	-3	-4	-3	3	2	1	1
1945	0	0	0	0	1	0	6	-1	-2	-1	-1	0	0	0
1946	-41	0	0	0	-19	0	-42	0	0	-2	-8	0	0	0
1947	0	0	0	0	-34	0	0	57	11	1	0	0	0	-3
1948	0	0	0	10	11	0	-49	-45	7	17	0	0	0	0
1949	0	25	0	0	-32	0	0	-1	0	-7	-116	-1	1	27
1950	0	0	0	0	-6	3	-54	46	17	1	1	0	0	0
1951	-26	0	0	10	10	-1	-10	-5	-13	-3	-1	0	0	0
1952	-5	0	11	8	-7	-8	-9	-43	7	29	0	0	0	-30
1953	0	0	0	0	0	0	-3	0	0	0	-61	0	0	0
1954	0	0	0	0	0	0	0	0	-16	-1	-12	0	0	0
1955	0	0	0	0	0	0	-52	-3	-2	-14	-43	0	0	0
1956	0	0	0	10	11	-20	-3	0	-7	0	-3	0	0	8
1957	0	-4	0	0	-10	0	-23	0	0	-19	-85	0	0	0
1958	0	0	0	0	0	0	0	0	0	-3	-73	0	0	24
1959	0	0	0	2	5	-5	-2	-3	-3	-3	-6	0	0	0
1960	0	0	10	-1	-1	-3	-6	-41	-62	-2	0	0	0	0
1961	-3	30	0	0	0	0	-12	-3	-17	-22	-1	1	0	0
1962	0	0	0	2	-16	0	-28	0	4	14	0	0	0	0
1963	0	0	0	0	3	2	-55	-26	7	-2	-65	12	0	0
1964	23	65	0	0	0	0	0	0	0	-9	-52	0	0	0
1965	0	0	4	11	-11	-4	-3	-2	-1	-7	-14	0	0	0
1966	-52	0	8	0	0	-6	-55	-36	-2	-21	-76	0	0	0
1967	0	0	0	0	0	0	-45	64	26	0	-25	0	0	0
1968	-8	0	0	0	-11	0	-57	-2	9	-1	-52	24	0	0
1969	-53	0	11	11	4	0	-4	-1	1	-15	-64	0	0	0
1970	0	0	0	0	0	0	-1	0	0	-7	-10	0	0	-16
1971	0	0	0	0	0	0	-29	20	-16	5	1	0	1	0
1972	0	0	0	0	-16	0	-34	55	1	1	0	0	0	0
1973	0	0	0	0	-54	7	-41	0	-1	0	0	1	1	18
1974	-55	0	0	0	-11	1	-2	-3	-2	-2	0	0	0	0
1975	-26	0	0	0	-23	0	0	0	3	2	2	7	0	0
1976	0	0	7	0	10	-9	-11	-36	10	4	0	1	0	0
1977	0	0	2	-1	-58	-12	-2	-3	-4	-2	1	3	4	2
1978	1	1	1	1	62	3	-42	54	7	-15	-79	0	0	0
Average Difference (mw)	-3.6	3.2	1.1	3.2	-3.5	-1.1	-17.8	-1.0	-0.6	-2.4	-29.0	0.3	0.4	3.9
Average mw STDFC	127.0	106.7	62.8	104.4	128.5	122.3	143.3	100.0	107.5	110.1	142.7	167.6	176.7	163.7
Average mw VARQ	123.5	109.9	64.0	107.6	125.0	121.2	125.5	99.0	106.9	107.6	113.7	167.9	177.1	167.6

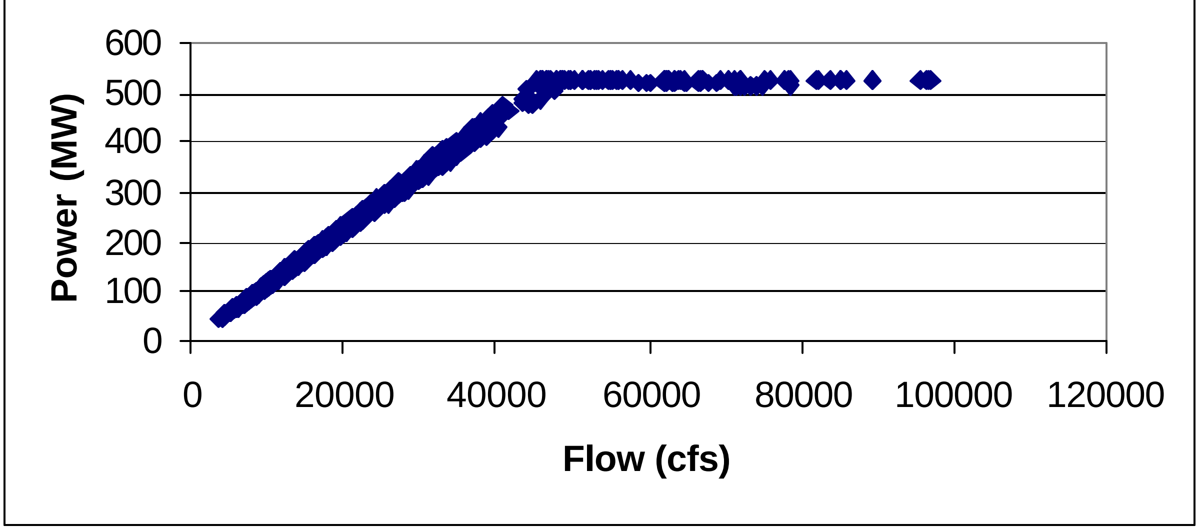

Thompson Falls
Power (MW)
100
80
60
40
20
0
0
20000
40000
60000
80000
100000
Flow (cfs)

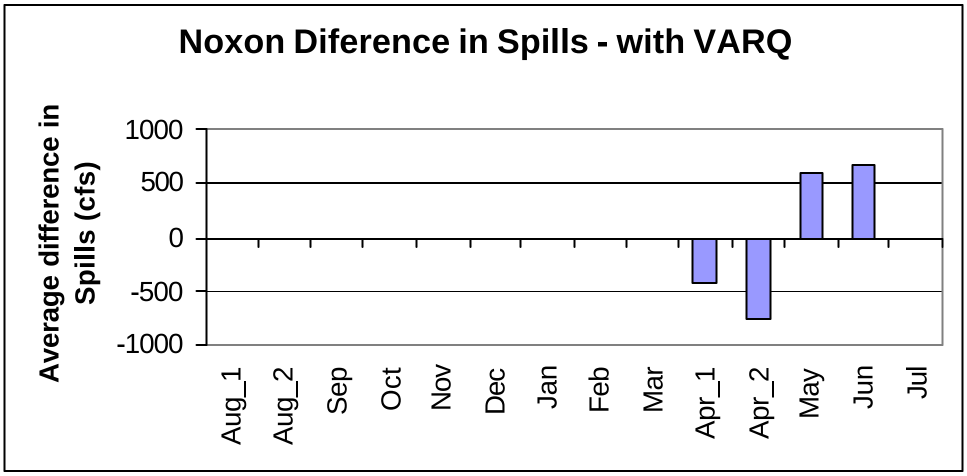

Kerr
Power (MW)
200
150
100
50
0
0
10000
20000
30000
40000
50000
60000
Flow (cfs)

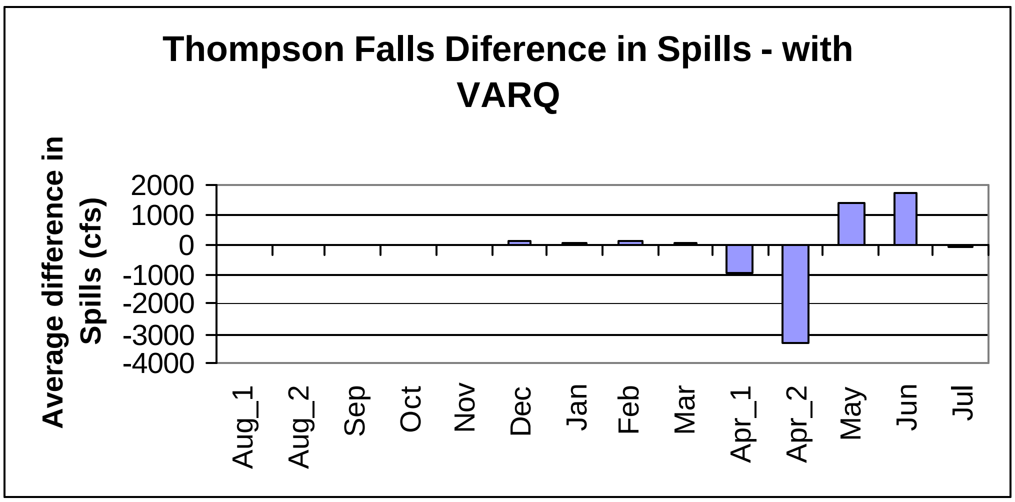

Boundary
Power (MW)
1200
1000
800
600
400
200
0
0
50000
100000
150000
Flow (cfs)

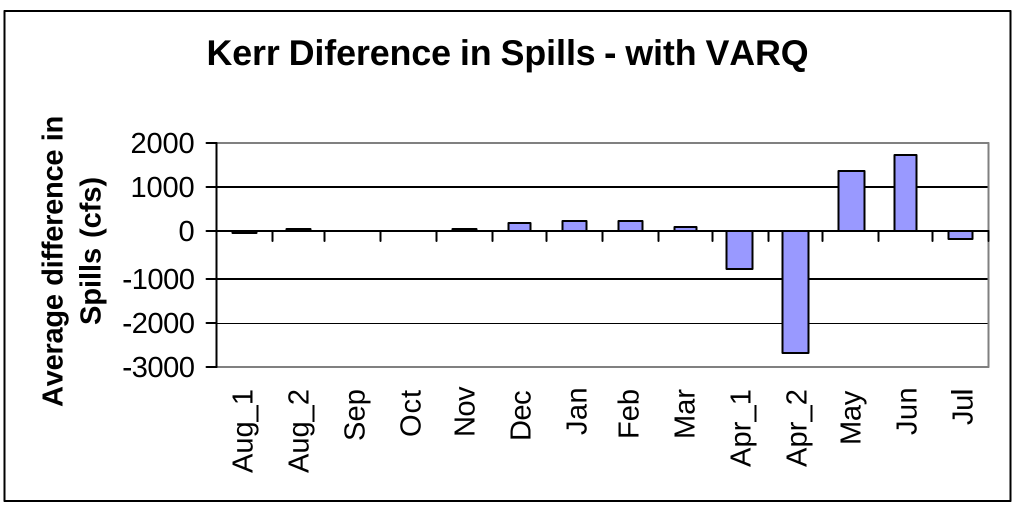

Box Canyon
Power (MW)
80
60
40
20
0
0
20000
40000
60000
80000
100000
120000
140000
Flow (cfs)

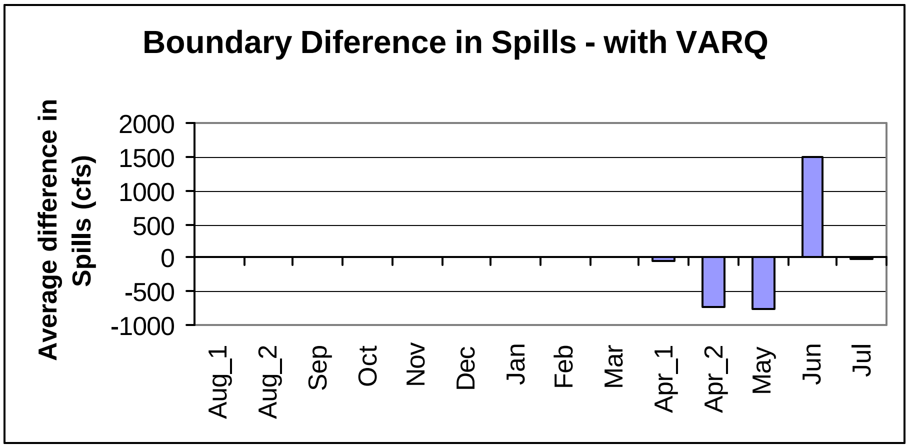

Cabinet Gorge
Power (MW)
250
200
150
100
50
0
0
20000
40000
60000
80000
100000
120000
Flow (cfs)


Noxon
Power (MW)
600
500
400
300
200
100
0
0
20000
40000
60000
80000
100000
120000
Flow (cfs)

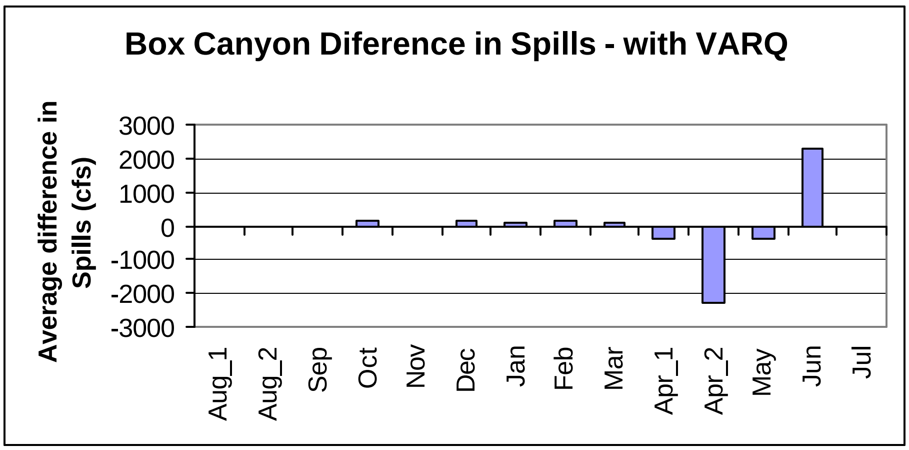

Noxon Diference in Spills - with VARQ
Average difference in Spills (cfs)
1000
500
0
-500
-1000
Aug_1
Aug_2
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr_1
Apr_2
May
Jun
Jul


Thompson Falls Diference in Spills - with VARQ
Average difference in Spills (cfs)
2000
1000
0
-1000
-2000
-3000
-4000
Aug_1
Aug_2
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr_1
Apr_2
May
Jun
Jul

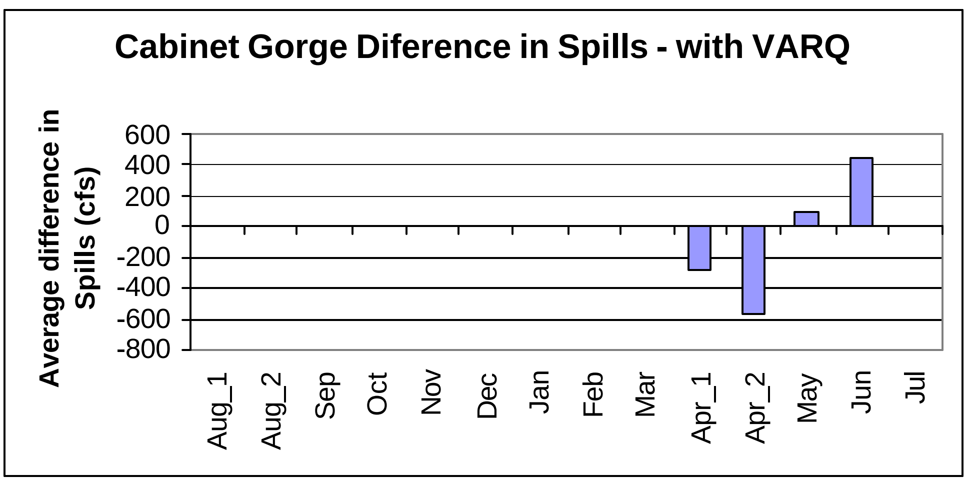

Kerr Diference in Spills - with VARQ
Average difference in Spills (cfs)
2000
1000
0
-1000
-2000
-3000
Aug_1
Aug_2
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr_1
Apr_2
May
Jun
Jul



Boundary Diference in Spills - with VARQ
Average difference in Spills (cfs)
2000
1500
1000
500
0
-500
-1000
Aug_1
Aug_2
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr_1
Apr_2
May
Jun
Jul



Box Canyon Diference in Spills - with VARQ
Average difference in Spills (cfs)
3000
2000
1000
0
-1000
-2000
-3000
Aug_1
Aug_2
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr_1
Apr_2
May
Jun
Jul



Cabinet Gorge Diference in Spills - with VARQ
Average difference in Spills (cfs)
600
400
200
0
-200
-400
-600
-800
Aug_1
Aug_2
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr_1
Apr_2
May
Jun
Jul