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US Army Corps
of Engineers®
Portland District

Appendix 1-I to Willamette Master Water Control Manual

Water Control Manual Green Peter Lake

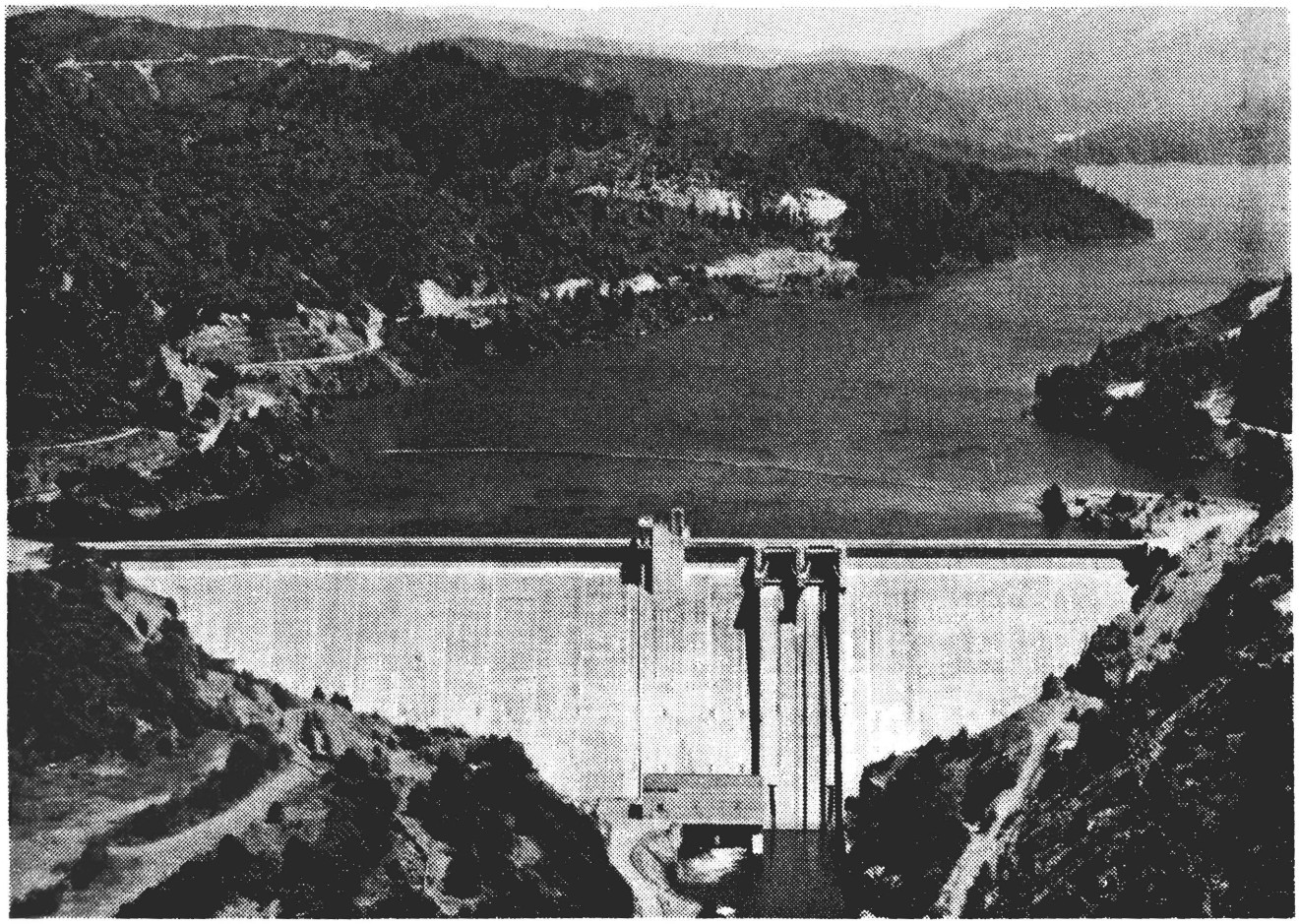
Oregon

September 1967
Revision 5, July 28, 2017

US Army Corps
of Engineers
Portland District

Water Control Manual for Green Peter Lake

Oregon



NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be published in loose-leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep this manual current. Changes to individual pages must carry the date of revision, which is the Division's approval date.

Change No.	Page / Paragraph / Section	Statement of Review or Change	Approval Date
Rev. 0		Interim Green Peter Dam Water Control Manual	Sept 1967
Rev. 1		Revision to Interim Manual	Jan 1968
Rev. 2	Chart 5	Issued and Revised Chart 5	Aug 1970
*Rev. 3	Exhibit 1 added Insert page 36a	1. An Interim Water Control Plan is added after the Plates as Exhibit 1, and includes Interim Risk Reduction Measures memorandums. 2. Add paragraph 6-00 to Section VI for discussion of Interim Water Control Plan.	Sept 3, 2013
**Rev. 4	Remove Exhibit 1 Remove page 36a	1. Remove Exhibit 1, Interim Water Control Plan. 2. Remove paragraph 6-00 to Section VI for discussion of Interim Water Control Plan.	Sept 6, 2016
Rev. 5	Exhibit A Replaced	Comprehensive Update of Exhibit A, Drought Contingency Plan	July 28, 2017

*Rev. 3 is an Interim Water Control Plan describing modified spillway gate and flood operations as a result of Interim Risk Reduction Measures (IRRM). This interim plan is to be used until the spillway gates are repaired. IRRMs are in place because an analysis has shown that the spillway tainter gates are overstressed and need to be strengthened to be compliant with EM 1110-2-2702. For simplicity, Exhibit 1 and page 36a will be revised as needed or removed when the IRRM is rescinded. No changes to the table of contents are made for this revision.

**Rev. 4 - As of 07 March 2016, rehabilitation work on both Tainter gates was completed, including replacement of end frame struts and bracing, replacement of downstream flanges on the girders, trunnion hubs and bushings and the lifting cable anchors. In addition, mechanical and electrical components were replaced. As a result, the gate operating restriction IRRM is lifted.

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during duty hours, contact between Willamette Valley Project staff and Reservoir Regulation and Water Quality staff (CENWP-EC-HR) can be made by calling the CENWP-EC-HR phone line at (503) 808-4896. If CENWP-EC-HR is unstaffed, further assistance can be achieved by contacting (in the order listed) one of the following persons assigned to be on call during non-duty hours:

1. Willamette Basin Regulator
   Work (503) 808-4960
   Cell (503) 819-9823

2. Backup Regulator
   Work (503) 808-4869
   Cell (503) 927-4642

3. Backup Regulator
   Work (503) 808-4891
   Cell (503) 475-2492

4. Backup Regulator
   Work (503) 808-4967
   Cell (503) 318-3524

5. Chief, Reservoir Regulation
   Work (503) 808-4887
   Cell (503) 819-4189

6. Willamette Basin Project
   (541) 937-2131

In addition, the list of staff on call during non-duty hours is updated about once a week, and is provided in the after-hours call list provided through the Columbia Basin Telecommunications link at:

http://nwp-wmlocal2.nwp.usace.army.mil/nwp/schedules/www/Portland_District_Weekend_Duty_List

CENWD Approval July 28, 2017

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND OR 97208-2870

REPLY TO
ATTENTION OF

July 28, 2017

CENWD-PDW

MEMORANDUM FOR: Lance Helwig, Chief, CENWP-EC

SUBJECT: Approval of Willamette Drought Contingency Plan

Thank you for responding to our comments on your submission of the Willamette Drought Contingency Plan. You have done an excellent job addressing our concerns, and the plan is approved. Please contact Ron Malmgren (503) 808-3975, if you have any further questions regarding this subject.

STEVEN B. BARTON, P.E.
Chief, Columbia Basin Water
Management Division

CF:
CENWD-PDW-R (Ammann)
CENWD-PDW-H (Proctor, Malmgren)
CENWP-EC-H (Hart)

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND OR 97208-2870

CENWD-PDW

6 Sep 2016

MEMORANDUM FOR: Lance Helwig, Chief, Engineering and Construction Division (CENWP-EC)

SUBJECT: Removal of Interim Water Control Plans from the Water Control Manuals

We are pleased to hear that Portland District has completed spillway gate strengthening at Green Peter and Lookout Point projects and that their Interim Water Control Plans are no longer needed. We applaud the efforts Portland District has undertaken since 2010 when the Interim Risk Reduction Measures were put in place. I support and approve your request to remove the Interim Water Control Plans from the Green Peter and Lookout Point Water Control Manuals through your proposed updates to the "NOTICE TO USERS OF THIS MANUAL" pages.

Please continue to update our office on progress as more spillway gates are strengthened at the other projects. Please contact William Proctor at (503) 808-3829 if you have any further questions regarding this subject.

STEVEN B. BARTON, P.E.
Chief, Columbia Basin Water Management Division

CF:
CENWD-PDW-R (Ammann)
CENWD-PDW-H (Proctor)
CENWP-OD-V (Petersen)
CENWP-EC-HC (Craig)
CENWP-EC-HR (Hart)
CENWP-DE (COL Aguilar)
CENWP-PA (Rabe)
CENWD-RBT (Berre)

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WATER CONTROL MANUAL STATUS SHEET

PROJECT: GREEN PETER LAKE

CHAPTER	STATUS	PLANNED ACTION
I. INTRODUCTION	*** 2 ***	Update and revise RRMAN Section I, Introduction; add additional material
II. DESCRIPTION	*** 2 ***	Update and revise RRMAN Section II, Basin Description, and Section III, Project Description; add addl. material
III. HISTORY	*** 4 ***	Compile a new chapter using existing records and additional information
IV. WATERSHED CHARACTERISTICS	*** 2 ***	Update and revise RRMAN Section II, Basin Description
V. DATA COLLECTION	*** 4 ***	Update and revise RRMAN Section IV, Climatology; Section V, Hydrology; and Section IX, Hydrometeorological Facilities; Add additional material
VI. HYDROLOGIC FORECASTS	*** 2 ***	Update and revise RRMAN Section V, Hydology; add additional material
VII. WATER CONTROL PLAN	*** 2 ***	Update and revise RRMAN Section VI, Flood Control Regulation, and Section VII, Storing For Conservation; add additional material
VIII. EFFECT OF WATER CONTROL PLAN	*** 4 ***	Update and revise RRMAN Section VIII, Utilization Of Stored Water; add additional material
IX. WATER CONTROL MANAGEMENT	*** 4 ***	Update and Revise RRMAN Section X, Responsibilities And Emergency Instructions Add additional materials
SUPPPORTING INFORMATION (photo, pertinent data, tables, graphs, etc)	*** 2 ***	Selected tables, charts, and graphs req- revision and update

STATUS CODES:
1 - approved, up to date
2 - approved, needs revision
3 - preliminary draft
4 - incomplete and/or outdated

NOTE: RRMAN=Reservoir Regulation Manual

NPDEN-WC (1 Dec 66) 7th Ind
SUBJECT: Green Peter Reservoir Regulation Manual

DA, North Pacific Division, Corps of Engineers, 210 Custom House, Portland, Oregon 97209 10 April 1968

TO: District Engineer, Portland

for G. H. F.

ENGCW-EY(1 Dec 66) 6th Ind
SUBJECT: Green Peter Reservoir Regulation Manual

DA, CofEngrs, Washington, D. C. 20315 3 April 1968

TO: Division Engineer, North Pacific

Revisions incorporated in the subject manual satisfy comments in previous indorsements and are approved.

FOR THE CHIEF OF ENGINEERS:

wd incl

WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

ENGCW-EY

NPDEN-WC (1 Dec 66) 5th Ind
SUBJECT: Green Peter Reservoir Regulation Manual

North Pacific Division, Portland, Ore., 20 February 1968

TO: Chief of Engineers

1. Recommend approval of the revised manual.

2. Following are additional comments on minor items in the manual.

a. Paragraph 6-10. The 4,000 cfs mentioned in the first sentence should be changed to 4,600 cfs.

b. Paragraph 7-04. This portion of the manual would be more complete if the following sentence was inserted after the first sentence: "After approximately 1972, when several large reservoir storage projects will be completed, the end of the critical period for power will be near the end of February."

c. Paragraph 7-09. It appears that the 90 percent confidence forecast, mentioned in the last sentence, should be changed to 95 percent, considering that the intended meaning is to indicate the safety factor in the interest of filling.

d. Paragraph 7-10. The standard deviations for runoff forecasts which are cited in the next to last sentence appear to be computed on the basis of observed precipitation. In actual practice it is necessary to adopt some method of estimating the future precipitation, such as using a mean, median, or precipitation based on a long-range weather forecast. In any event the standard deviations will be larger than those which assume perfect hindsight precipitation forecasts. It would be more realistic to cite the approximate standard deviations estimated on the basis of imperfect precipitation forecasts. Alternatively, if the indicated standard deviations are retained in the text, the basis upon which they are computed should be stated. Similar comments apply to charts 23-25.

3. The inclosed manual replaces the preliminary copy transmitted with our 1st Indorsement, dated 3 July 1967, and withdrawn by your office.

FOR THE DIVISION ENGINEER:

C. A. Carroll

1 Incl
wd 3 cys

C. A. CARROLL
Colonel, Corps of Engineers
Deputy Division Engineer

NPPEN-PL-6 (1 Dec 66) 4th Ind
SUBJECT: Green Peter Reservoir Regulation Manual

Portland District, Portland, Oregon 17 JAN 1968

TO: Division Engineer, North Pacific Division

1. Comments on the preliminary draft of the Green Peter Reservoir Regulations Manual by the North Pacific Division office and the Office, Chief of Engineers, have been reviewed and requested revisions have been incorporated in the final draft which is submitted to higher authority for their use and general information.

2. The following are our comments on the revisions incorporated into the manual and questions raised by both the North Pacific Division and Office, Chief of Engineers. The comments are in the order the questions and revisions were presented in the 1st and 2nd Indorsements.

3. Flood control regulation at Green Peter Reservoir is closely related to the flood control regulations at Foster and Detroit reservoirs which have been taken into consideration in developing the parameter curves shown on chart 17 and discussed in paragraph 6-04 of the manual. Portland District is of the opinion those curves provide a regulation schedule with the flexibility needed to effectively regulate the storage projects in Santiam River Basin. Experience has shown that a cutback in releases from Detroit and Green Peter Reservoirs will be required whenever the rainfall on a saturated basin exceeds 0.5 inches in 12 hours. When the ground is not saturated, rainfall intensities are less critical. It takes three to five inches of precipitation to condition the soil for maximum runoff. Those hydrologic elements are monitored almost hourly during critical flood periods and regulation can be effected promptly when the rule curves call for upstream regulation. Evacuation of flood waters from Green Peter and Detroit Reservoirs are contingent on the streams below the projects receding to within-bankfull stages. The key downstream stations are Jefferson on Santiam River and Salem on Willamette River. Travel times to those key stations, in conjunction with recession forecasts, provide the basic information for scheduling flood evacuation at Green Peter, Foster and Detroit Reservoirs.

4. The suggestion to revise the procedure for scheduling the evacuation of the 70,000 acre-feet of secondary flood control storage between 15 November and 1 February has been studied and incorporated into the Green Peter manual. The basic concept is to discharge as much of the secondary flood control storage through the turbines as possible so long as flood control is not adversely affected by the operation. Paragraph 6-08 in the manual discusses the revised operation and the safeguards to insure flood control will be adequately provided. The revision also incorporates a change in the rate of evacuation of flood waters stored in the secondary flood control space following a flood. The revisions proposed for evacuating secondary flood control storage at Green Peter, if approved, would be incorporated into the

Lookout Point and Detroit reservoir regulations manuals.

5. Evacuation of secondary flood control storage at Hills Creek and Cougar, both power projects, would require a slightly different treatment as the turbine capacities at those two projects are too restrictive in most instances to rely upon the turbines to evacuate secondary flood control storage.

6. Reference is made to comments on paragraph 7-03 of the manual in regard to departures from the normal filling schedule. Runoff forecast after 1 February will be the normal basis for those departures. A normal delayed filling for power generation would only be effected when there remained a 95-percent probability of filling. Undoubtedly many special filling situations will develop over the years that will require unusual departures requiring special clearances from higher authority. At the present time, forecasting runoff into Green Peter Reservoir is subject to a large standard deviation. For this reason, there will be times when a normal guideline may have to be reconsidered in the light of experience, an unusual climatic situation, or outside pressures for affecting a departure from the normal filling schedule.

7. A revised procedure has been developed for forecasting runoff into Green Peter Reservoir on the basis of the water content of the snowpack above the reservoir. The revised method is a more direct approach rather than a correlation with the Detroit runoff forecast which was proposed originally. There is a slight improvement in the forecasts using the revised procedure, but much remains to be desired. The relatively low elevations of the basin and the significance of the late-season precipitation accounts for the large standard deviations and the potential error in a specific forecast. Charts 23, 24, 25, and 26 in the revised reports are pertinent to the revised forecasting procedure.

8. Inactive and dead storage have been clarified in the text of the manual and on those charts and plates where the terms are pertinent. Dead storage refers to the space below the invert elevation of the lowest facility that can discharge water from the reservoir. Inactive storage is that storage which can be discharged from the reservoir but would not be discharged in the normal operation of the project.

9. Reference is made to the comment from the Office, Chief of Engineers, in regard to the filling of Green Peter Reservoir at a faster rate in February than later in the filling season. The accelerated filling results from filling all of the secondary flood control space plus a proportional part of the flood control space. This is to enhance the conservation filling. Green Peter Reservoir is a multi-purpose project with water conservation a major function.

10. Studies show that floods in the Willamette River Basin start to decrease in intensity and frequency after 1 February and that filling of the space reserved for floods can be undertaken without jeopardizing the flood control effectiveness of the project. Secondary flood control storage space is only needed to regulate the very infrequent flood. Other than the February 1890 flood which occurred on the fourth of the month, there has been no large-volume flood after 1 February. Storage space after 1 February is adequate to regulate all past floods. If an abnormal snowpack should exist above Green Peter, filling of the reservoir would be delayed in the interest of flood regulation. This special regulation is presented in the manual.

11. In addition to the revisions, photographs have been added to the manual to complement the text. Among the photographs is an aerial view of the project which shows in the background the rugged nature of the area tributary to the reservoir. Several pertinent project features are illustrated with photographs, including the powerhouse, spillway, control center and upstream gaging station.

Robert L Bangert

1 Incl (quad)
Reservoir Regulations Manual;
Green Peter.

ROBERT L BANGERT
Colonel, Corps of Engineers
District Engineer

NPDEN-WC(1 Dec 66) 3rd Ind
SUBJECT: Green Peter Reservoir Regulation Manual

North Pacific Division, Portland, Oregon, 11 September 1967

TO: District Engineer, Portland District

For your information and necessary action. Discussion of items in the manual or indorsements can, if you desire, be arranged informally by our technical staffs.

FOR THE DIVISION ENGINEER:

for C. A. CARROLL
Colonel, Corps of Engineers
Deputy Division Engineer

ACTION COPY

ENGCW-EY(1 Dec 66) 2nd Ind
SUBJECT: Green Peter Reservoir Regulation Manual

DA, CofEngrs, Washington, D. C. 20315 5 September 1967

TO: Division Engineer, North Pacific

The subject regulation manual for Green Peter Reservoir is approved subject to comments contained in the 1st Indorsement by the Division Engineer and the following:

a. Paragraph 5-14 and chart 12 should be revised to conform with actions taken on the suggestions contained in paragraph 2b of the 1st Indorsement regarding release of water stored in space reserved for secondary flood control.

b. It is not clear why the proposed rate of filling, shown on chart 12, is most rapid in February when the probability of a rare flood occurrence is relatively great in comparison with the latter part of the filling period.

FOR THE CHIEF OF ENGINEERS:

Homer B. Willis

wd incl

WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

NPDEN-WC (1 Dec 66) 1st Ind
SUBJECT: Green Peter Reservoir Regulation Manual

North Pacific Division, Portland, Ore., 3 July 1967

TO: Chief of Engineers

1. The inclosed reservoir regulation manual for Green Peter Reservoir is similar in scope and format to approved manuals for other Corps of Engineers dam and reservoir projects in the Willamette River basin. Indorsements to Portland District letter dated 8 September 1965, subject, Fall Creek Reservoir Regulation Manual, contain rather extensive discussions of specific items in the Fall Creek Reservoir Regulation Manual, nearly all of which are applicable to the manual for Green Peter Reservoir. Most of the recommendations of your office have been incorporated into the inclosed draft manual. In a few cases where it has not been practicable to adopt a recommendation the explanation is presented in Portland District 4th Indorsement dated 2 September 1966 to the above-cited letter.

2. Following are additional comments on the inclosed manual:

a. Paragraph 6-04 refers to Chart 17 as the normal flood control regulation schedule for Green Peter Reservoir although it indicates only the combined allowable release from Detroit and Foster Reservoirs. Approximate releases from Green Peter Reservoir during a flood or incipient flood can be computed, within a rather wide range, by applying the broad guidelines in paragraph 6-04 to Chart 17. A completely rigid schedule is not necessary or practical but a more specific flood regulation aid is believed desirable to provide guidance to personnel responsible for prompt reservoir regulation decisions. Such a regulation aid would be most useful during relatively small floods and during the early storing and evacuation stages of larger floods because only minimum releases normally are made during the major storing periods of moderate or larger floods. Development of coordinated flood regulation aids for the three existing flood control reservoirs in the Santiam River basin may entail revision or replacement of the flood control schedule for Detroit Reservoir, figure 2 of plate 20 of the Detroit Reservoir Regulation Manual.

b. Paragraph 6-08 states that should a Columbia River forecast indicate that the system power will be critical, 70,000 cfs (natural) or less at The Dalles during the winter months, the 70,000 acre-feet of secondary flood control storage in Green Peter Reservoir will be scheduled for power use between 15 November and 1 February. Somewhat similar provisions are in the Detroit, Lookout Point, Hills Creek and Cougar Reservoir Regulation Manuals. This criterion is no longer a meaningful measure of the need to conserve stored water for electrical energy in the Willamette River basin or elsewhere in the Pacific Northwest because of the increasing degree of control of Columbia River afforded by upstream reservoirs. Since power demands can

be met from storage for progressively longer periods of time as additional storage projects are constructed, meaningful flow forecasts must likewise be for progressively longer periods. With the completion of the under-construction reservoir projects in the Columbia River basin, both United States and Canada, the length of the critical period for power will be increased to about three years. In addition, the increasing market resulting from inter-regional transmission of power and from replacement of the growing thermal installation in the Northwest will provide a ready market for most of the secondary power that can be produced. For these reasons it is proposed that the procedure for use of water stored in the secondary flood control reservation be reviewed in connection with the current studies for the comprehensive Willamette River Basin Review Report. The following procedure for Green Peter Reservoir is suggested:

> Starting 15 November, water stored in the secondary flood control storage reservation (elevations 922 to 952) will be released at a rate equal to the hydraulic capacity of the power plant at the applicable head. If for any reason all or any portion of that discharge is not passed through the turbines, the deficiency will be released through the outlets. The same procedure will apply to post-flood evacuation of water stored for flood control. Should flood water not be stored above elevation 952 the release rate will be the powerplant capacity. Water stored above elevation 952 will be released through both turbines and outlets as rapidly as downstream conditions permit.

The foregoing procedure appears to be satisfactory for Green Peter, Detroit, and Lookout Point Dams, provided it is clearly stated that the controlling powerplant capacity is that of the major dam, not the re-regulating dam. The procedure is not satisfactory for Hills Creek and Cougar dams because of the low hydraulic capacity of the powerplants. A higher stipulated release or other criterion will be required at these projects.

c. Paragraph 7-03 provides for seasonal storing for conservation at a lesser rate than indicated by Table 10 and Chart 12 when the forecasted inflow volume indicates nearly assured filling to maximum conservation pool. Likewise, paragraph 7-08 provides for limited storing above the scheduled elevations under certain conditions during seasonal filling. We concur with both types of departures from the filling schedule but believe that more specific guidelines could be provided. It would appear that a quantitative regulation aid for either type of departure may be based primarily on the forecasted inflow volume although other factors may be considered at times. Specific guidelines to control and limit the degree of flexibility in seasonal filling, although desirable, are not

essential at this time. It is therefore suggested that the current studies for the Willamette River Review Report also include development of such guidelines for all Willamette River basin dam and reservoir projects which have power facilities.

d. With respect to delayed refilling of Green Peter Reservoir as contemplated in a critical power situation set forth in section 7-04, it is pointed out the reservoir regulation studies in progress for the Willamette River Review Report will define specific rules for such regulation.

e. Paragraph 7-09 states that forecasts of seasonal runoff during the filling season are determined from Chart 22, which is a correlation between runoff volumes from the areas tributary to Green Peter and Detroit Dams. The volumetric runoff forecasts for Middle Santiam River at Green Peter Dam have a large standard error of estimate compared to other Willamette River basin projects for which such forecasts are prepared. This is caused largely by the lower elevation of the drainage basin compared to those of the other reservoirs. A smaller percentage of the total runoff results from the accumulated winter snowpack and hence seasonal runoff is less amenable to forecasts. However, the present method of correlation with Detroit forecasted runoff does not take into account the changing relationship between the runoff of these two drainage areas as the filling season progresses. The Portland District is currently revising the forecasting procedure to provide for this variable relationship and to make other improvements in the forecast.

f. The 97,000 acre-feet of storage between elevations 700 and 887 is designated "dead storage" in some references in the manual and "inactive storage" in other references. Examples of the former are in Charts 12 and 13, Plate 20, and paragraph 7-04; examples of the latter are in Item 4 of Pertinent Data and paragraphs 3-10 and 5-14. It is recommended that the storage between minimum power pool and the outlet invert elevation be designated "inactive storage" and that below the outlets as "dead storage". This terminology has been adopted by the Water Management Subcommittee of the Columbia Basin Inter-Agency Committee and is illustrated in Sheet 3 of Exhibit 2 to Engineer Technical Letter 1110-2-8, Computation of Freeboard Allowances for Waves in Reservoirs, 1 August 1966. It differs, however, from the definition given in paragraph 11c of Inclosure 2 to Engineer Circular 1110-2-27, Policies and Procedures Pertaining to Determination of Spillway Capacities and Freeboard Allowances for Dams, 1 August 1966.

NPDEN-WC (1 Dec 66)
SUBJECT: Green Peter Reservoir Regulation Manual

3. Initial seasonal storing of conservation water in Green Peter Reservoir started on 13 March 1967. Because of the late start, which was necessitated by construction work, the reservoir will not fill to maximum conservation pool this season. However, it has filled sufficiently to permit normal testing and operation of the power units. The project is fully operative for flood control.

FOR THE DIVISION ENGINEER:

C. A. Carroll

1 Incl
3 cy wd

C. A. CARROLL
Colonel, Corps of Engineers
Deputy Division Engineer

DEPARTMENT OF THE ARMY
PORTLAND DISTRICT, CORPS OF ENGINEERS
628 PITTOCK BLOCK
PORTLAND, OREGON 97205

1 DEC 1966

NPPEN-PL-6

SUBJECT: Green Peter Reservoir Regulation Manual

TO: Division Engineer
North Pacific Division

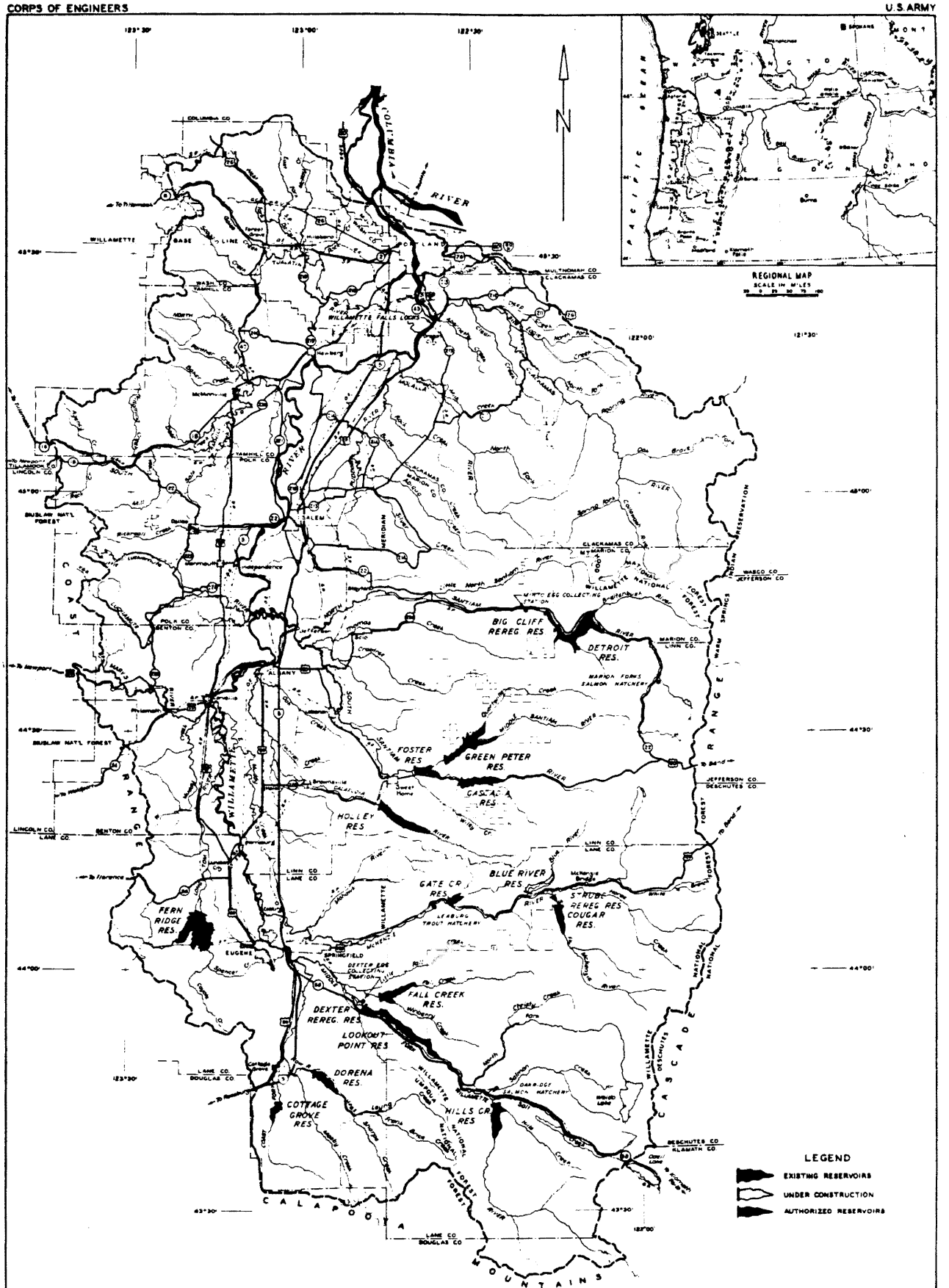
1. Four copies of the Green Peter Reservoir Regulation Manual are submitted for review and comment by Office, Chief of Engineers. The diversion tunnel closure was made in October 1966 but the project will not become fully operative for flood control until the spillway gates are installed which is scheduled for January 1967. In the interim, the project will serve as a detention reservoir with the outlet gates wide open.

2. The final manual will be documented with a number of pertinent photographs that will enhance the descriptive material. We are waiting for completion of the dam so that a photograph of the completed project with the reservoir full can be included as well as several other items we wish to document with photographs.

3. Until the final manual is prepared the preliminary draft will be used by the Engineering personnel in scheduling the operation of the project.

WILLIAM J. TALBOTT
Colonel, Corps of Engineers
District Engineer

1 Incl (quad)
Reservoir Reg. Manual
Green Peter



WILLAMETTE RIVER BASIN
RESERVOIR SYSTEM
CORPS OF ENGINEER PROJECTS

MILES

U S ARMY ENGINEER DISTRICT, PORTLAND

DECEMBER 196

WR-1-97

REVISION SHEET

Approved by the Chief of Engineers 5 September 1967

Date	Nature of revision	Approved By	Date
Jan 1968	Revisions to interim manual	B. E. Wilcox	Jan 1968
Aug 1970	Issued & Revised Chart 5	C. Pedersen	Aug 1970

GREEN PETER RESERVOIR

PRIOR DESIGN MEMORANDUMS

No.	Subject	Date
1.	Site Selection Report	15 February 1957
2.	Hydrology and Meteorology	1 June 1957
3.	General Design Memorandum	25 May 1959
4.	Relocations (Supplements 1 through 5, 1961-1964)	June 1960
5.	Real Estate (Supplements 1 through 3, 1960-1964)	29 June 1959
6.	Hydropower Capacity	3 April 1961
7.	Reservoir Management and Public Use Development	23 December 1958
7B.	Master Plan, in Part	April 1966
8.	Clearing	31 August 1960
9.	Geology and Foundations	August 1961
10.	Concrete Dam	August 1961
	Supplement A	October 1961
11.	Preliminary Design Report, Powerhouse and Switchyard	June 1962
11.1	Structural and Architectural Design	October 1962
11.2	Mechanical Design	December 1962
11.3	(a) thru (f) Generator and Accessory Electrical Gear (February 1963-April 1964)	October 1962
12.	Reservoir Regulation	June 1961
13.	Fish Facilities	March 1962
14.	Concrete Aggregate	November 1962
15.	Foundation Grouting and Drainage	December 1965
16.	Foundation Instrumentation	June 1966

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NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be published in looseleaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep this manual current.

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during non-duty hours, contact can be made by telephone to the Reservoir Control Center, North Western Division (A.C. 503 808-3945). If Reservoir Control Center is unmanned, assistance can be achieved by contacting, in the order listed, one of the persons assigned on the Columbia Basin Teletype (CBTT) to be on call during non-duty hours, or one of the following persons:

1. Chief of Reservoir Control Center
   (Phone: 503-808-3945)

2. Reservoir Regulation Unit
   (Phone: 503-808-3942)

3. Chief, Reservoir Regulation and Water Quality Section, Portland District
   (Phone: 503-808-4886Pager: 299-0512)

November 1966

GREEN PETER DAM AND RESERVOIR

PERTINENT DATA

1. Project location:

Public land survey	SE 1/4 Sec. 10, T. 13 S., R. 2 E., W.M.
Stream:	Middle Santiam River
Above mouth	5.5 river miles
Distance from Sweet Home, Oregon	9 airline miles
Distance from Salem, Oregon	40 airline miles
Distance from Portland, Oregon	75 airline miles

2. Project basin, description, and hydrology:

Drainage area	277 square miles
Mean elevation	2,920 feet, m.s.l.
Highest elevation	5,820 feet, m.s.l.
Elevation at damsite (low water)	700 feet, m.s.l.
Normal annual basin precipitation	91 inches
Average annual runoff (1926-1964)	1,145,800 acre-feet
Average annual discharge (1926-1964)	1,581 c.f.s.
Maximum observed flood peak (Dec 1964)	66,000 c.f.s.
100-year flood	61,000 c.f.s.
Spillway design flood (reservoir inflow)	132,800 c.f.s.
Standard project design flood	87,000 c.f.s.
Minimum mean monthly flow (1926-1964)	70 c.f.s.
Maximum mean monthly flow (1926-1964)	7,150 c.f.s.

GREEN PETER DAM AND RESERVOIR

PERTINENT DATA (cont'd)

3. Reservoir data:

Feature	Elevation (feet m.s.l.)	Water surface area (acres)	Storage (1,000 acre-feet)
Low point in reservoir	700	0	0
Minimum flood control pool	922	2,070	160.0
Spillway crest	968.7	2,910	276.8
Maximum conservation pool	1,010	3,610	410.0
Full and maximum pool	1,015	3,720	430.0
Top of dam	1,020	4,500	450.0

4. Storage allocation:

Below maximum and full pool (1,015)	430,000 acre-feet
Usable flood control (922-1,015)	270,000 acre-feet
Conservation storage (922-1,010)	250,000 acre-feet
Power storage (887-922)	63,000 acre-feet
Inactive storage (745-887)	95,875 acre-feet
Dead storage (700-745)	1,125 acre-feet

5. Spillway:

Type	Concrete gravity, gated, ogee section
Crest length, gross	100 feet
Crest length, effective	90 feet
Crest elevation	968.7 feet, m.s.l.
Gate sill elevation	967.7 feet, m.s.l.

GREEN PETER DAM AND RESERVOIR

PERTINENT DATA (cont'd)

5. Spillway: (cont'd)	
Design discharge	110,000 c.f.s.
Number of gates	2
Type of gates	Radial (Tainter)
Gate width	45 feet
Elevation, top of gates	1,015 feet, m.s.l.
Gate height (sill to top)	48 feet
6. Planned reservoir releases:	
Minimum releases (average daily)[1/]	
February-April	500 c.f.s.
May	450 c.f.s.
June-November	300 c.f.s.
Flood periods	
Without power	100 c.f.s.
With power	2,100 c.f.s.
Maximum releases	
Pre-flood and flood evacuation	13,000 c.f.s.
7. Outlets:	
Type of gates	Hydraulic pressure slide
Size of gates	5'-5" by 10'-0"

1/ During peaking, minimum release may be as low as 50 c.f.s.

GREEN PETER DAM AND RESERVOIR

PERTINENT DATA (cont'd)

7. Outlets: (cont'd)	
Number of regulating gates	2
Number of emergency gates	2
Gate operation	Hydraulic
Conduits	2 - rectangular concrete lined
Invert elevation at intake	745 feet, m.s.l.
Capacity of outlets at minimum flood control pool, elevation 922	10,500 c.f.s.
Capacity of outlets at maximum pool, elevation 1,015	13,000 c.f.s.
8. Dam:	
Type	Concrete gravity
Elevation, top of dam	1,020 feet, m.s.l.
Height (streambed to roadway deck)	327 feet
Freeboard above full pool	5 feet
Length	1,380 feet
9. Penstocks:	
Number	2
Diameter	14'-0"
Emergency closure	Bulkhead gate

GREEN PETER DAM AND RESERVOIR

PERTINENT DATA (cont'd)

10. Power plant:	
Powerhouse	Indoor
Power units	2
Type turbine	Francis
Capacity of units (each)	40,000 KW
Installed capacity	80,000 KW
Maximum head (gross)	323 feet
Minimum head (gross)	187 feet
Average tailwater elevation	700 feet, m.s.l.
Schedule for initial operations	
1st unit	March 1967
2nd unit	March 1967
11. Power data:	
Normal operating load factor	40%
Prime power (43 months)	21,200 KW
Firm power (40% load factor)	53,000 KW
Total energy, average annual	237,396,000 kw.-hr.

GREEN PETER RESERVOIR REGULATION MANUAL

SECTION I - INTRODUCTION

1-01. Authority. - Authority for preparing this manual is contained in paragraph 5 of ER 1110-2-240, dated 25 March 1963. Its preparation has been in accordance with instructions presented in EM 1110-2-3600, dated 25 May 1959.

1-02. Purpose and scope. - The function of this manual is to document the plan of reservoir regulation and to provide a reference source for higher authority and for personnel who will be responsible for the regulation and coordination of Green Peter Reservoir with other Willamette Valley reservoirs for flood control and conservation uses.

1-03. The manual contains a description of the river basin, project, coordinated plan of basin development, information necessary for understanding the objectives of the project, and instructions for regulating the reservoir. Full coverage is given to method of regulation, operating rules and schedules, hydrologic network, forecasting procedures, organization for reservoir regulation, communication facilities, and emergency flood regulation instructions.

1-04. Revisions to manual. - Changes and revisions to the manual will be made by the Engineering Division of the Portland District as techniques of regulation and forecasting are developed which will improve the effectiveness of the project. Any change in the manual which affects the authorized functions of the reservoir or involves a significant deviation from the approved plan will be submitted through the North Pacific

Division Office to the Office, Chief of Engineers for prior approval. All revisions will be dated and a master file will be kept by the Portland District.

SECTION II - BASIN DESCRIPTION

2-01. Location and topography. - The Middle Santiam River Basin is located in western Oregon on the west slope of the Cascade Range, approximately 75 miles southeast of Portland, Oregon. Plate 1 and the frontispiece show the location of the basin with respect to other major geographical features in western Oregon, including existing storage projects, storage projects under construction, and authorized storage projects in the Willamette River Basin. The Middle Santiam River drains a half-moon shaped mountainous area of 287 square miles with about 50 percent of the basin lying within the Willamette National Forest. The terrain is rugged and, in general, is heavily forested. Ninety-six percent of the Middle Santiam Basin, 277 square miles, is tributary to Green Peter Dam. The mean elevation of the basin above Green Peter Dam is 2,920 feet, varying from 700 feet at the dam to 5,820 feet along the eastern boundary of the watershed. Chart 1 shows an area elevation curve for the area above the dam.

2-02. Streams. - Plate 1 shows the stream system of the Santiam River Basin. The Middle Santiam River, a principal tributary, flows generally in a westerly direction. Quartzville Creek, a major tributary of Middle Santiam River, joins Middle Santiam River about 5 miles upstream from the dam, and within the Green Peter pool area. There are numerous smaller tributaries, nearly all of which flow in deep canyons and have steep gradients.

2-03. Stream gradients vary from several hundred feet per mile in the headwater reaches to 38 feet per mile through the reservoir.

Low-water profiles for Middle Santiam and South Santiam Rivers are shown on plate 2.

2-04. Forest cover. - Most of the lower basin above Green Peter Dam and a considerable portion of the upper basin have been logged off. Vegetation in the recently logged off areas varies from brush and small coniferous trees to good stands of second growth coniferous trees. Near the project comparatively little old growth timber remains; the existing stand of Douglas fir ranges from 30 to 50 years old. The high elevation areas in the eastern sector, comprising about 50 percent of the drainage basin, are in the Willamette National Forest. Forty percent of the remaining area, generally lower in elevation and located in the western part of the drainage basin, is administered by the Bureau of Land Management and 60 percent is held in private ownership.

2-05. Population. - The 1965 census shows the population within a 50-mile radius of the Green Peter Reservoir to be about 380,000, of which 240,000 is urban. In this 50-mile zone, nine cities have populations exceeding 3,000. The largest is Salem with a 1965 population of 62,860.

2-06. There is no residential development above the reservoir. Below the reservoir in the South Santiam River Basin, the principal towns are Sweet Home and Lebanon. Lebanon, the largest, had a 1965 population of 5,200 and Sweet Home, 4,050. Both towns have had significant population growths in the past 25 years as a result of increased activity in construction, logging, and expansion of the lumber, plywood, and pulp and paper industries.

2-07. Industry and resources. - Above Sweet Home, in the South Santiam Basin, the greater portion of lands are forested. Processing of timber products is the major industry in the populated sectors of the South Santiam Basin. More than 60 forest products manufacturing firms operate in or near the towns of Lebanon and Sweet Home, which are downstream from Green Peter 25 and 12 miles, respectively.

2-08. Valley lands in the South Santiam and Santiam Basins downstream from Sweet Home are used principally for agriculture. The soil is fertile and very productive. Crops that are grown include string beans, hops, sweet corn, squash, mint, fruit, nuts, fall and spring grains, and alfalfa. String beans return the largest dollar income per acre. A large number of farmers sprinkle irrigate with water pumped from wells or nearby streams. The demand for irrigation water has steadily increased and in the not too distant future stored water will be required to supplement the present sources.

2-09. Power transmission. - The Central Willamette Basin has been deficient in locally produced electric power. Bonneville Power Administration's 230-kilovolt transmission line, McNary-Detroit-Goshen, and the Detroit hydroelectric plant provide supplementary electric service to the region. The Green Peter hydroelectric plant, located near the load end of this long,heavily loaded transmission line, will be most valuable in furnishing peak power to the mid-Willamette area and will increase the reliability of the service.

2-10. Transportation. - Green Peter Reservoir is served by county, Federal, and private roads. U. S. Highway 20 extends from Interstate 5

near Albany along the left bank of the South Santiam River and connects with U. S. Highway 97 at Bend, Oregon. At Foster, a county road connects with Highway 20 and runs along the right bank of the Middle Santiam River, thence along the right shore of Green Peter Reservoir to the headwaters of Quartzville Creek. The left side of Green Peter Reservoir is served by a private road owned by Weyerhaeuser Timber Company which terminates at approximately the Willamette National Forest boundary, 6 miles above the head of Green Peter Reservoir. There are no roads presently serving the peninsula area between Quartzville Creek and Middle Santiam River but the Bureau of Land Management has tentative plans for a road down the left bank of Quartzville Creek from the head of the reservoir. This road probably would be extended later up the north bank of the Middle Fork to connect with existing roads at the head of the pool. Railroad service extends to the Willamette National Mill at Foster.

2-11. Flood damages. - South Santiam River was unregulated in December 1964, at which time a major flood of unusual magnitude inundated over 27,000 acres in South Santiam Basin and contributed to the inundation of over 69,000 acres in the flood plain of Santiam River and Willamette River below the mouth of the Santiam. Average annual damages in the flood plain below Green Peter Reservoir at 1965 price levels and existing channel conditions with no upstream flood regulation would be approximately $12,513,000. Green Peter Reservoir would reduce these average annual damages by about $2,680,000. Based on data obtained from the December 1964 flood damage survey, the distribution of damages to the various categories of properties in the flood plain, below the Green Peter Reservoir, would be as follows:

Reach	Percent of damages				
	Agricultural	Residential	Commercial	Industrial	Other 1/
South Santiam and Santiam R.	41	8	4	3	44
Willamette R. below mouth of Santiam R.	21	11	19	30	19

1/ Includes damages to utilities, public facilities, transportation, channel improvements and control structures, and emergency relief.

At 1965 prices and development, flood damages that would result from the recurrence of the larger of the more recent floods with no storage regulation, are shown below:

Flood	South Santiam River	Santiam River	Willamette R. below mouth of Santiam R.
December 1964	$3,950,000	$2,280,000	$446,700,000
February 1961	1,850,000	1,510,000	16,550,000
December 1955	1,420,000	1,020,000	19,110,000
December 1945	2,230,000	1,160,000	10,040,000
Dec 1942/Jan 1943	1,300,000	740,000	18,400,000

Existing, under construction, authorized, and recommended storage projects, 14 in total, will reduce the above damages 85 percent in the South Santiam Basin, 81 percent in the Santiam Basin, and 86 percent in the Willamette Basin. Green Peter's contribution to those reductions will be approximately 62 percent, 40 percent, and 17 percent for the respective reaches.

2-12. Average annual benefits of $9,700,000 are creditable to Green Peter for reduction of flood damages in the flood plain below Green Peter Reservoir, based on a 100-year project life and 1966 prices.

SECTION III - PROJECT DESCRIPTION

3-01. General. - A need for flood control was recognized early in the history of the Willamette Valley, but control by reservoirs was not considered economically feasible until about 1936. As late as 1932 the Corps of Engineers reported that no extensive flood control project was economically justified. After that date, population growth and industrial development was rapid. With the accelerated growth of the region, demands for flood protection became increasingly urgent, leading to the development of a general comprehensive plan for the control of floods and utilization of the water resources in Willamette River Basin.

3-02. Project authority. - The Flood Control Act of 1938 (PL 761, 75th Congress, Chapter 795, 3d session) authorized a flood control reservoir in the South Santiam Basin. The original plan of improvement was for a dam at the Sweet Home site below the town of Sweet Home on the South Santiam River. Subsequent to authorization, industrial and residential development in the reservoir area made the construction of a dam at that site infeasible. This led to consideration of an alternative plan of three reservoirs. The alternative plan consisting of Green Peter, Cascadia, and Wiley Creek is described in House Document 531, 81st Congress, 2d session.

3-03. In considering the recommendation in House Document 531, the Bureau of the Budget indicated that authorization of two of the three alternative dams would not be in accord with the program of the President. Subsequently, House-Senate conferences concluded that Green Peter should be considered authorized as an alternative to the previously authorized

Sweet Home Dam. As no other action was taken by Congress at that time, Green Peter Dam and Reservoir was authorized for all functions proposed in House Document 531, except that only minimum facilities would be provided for future generation of power.

3-04. Specific authorization for the construction of power-generating facilities at the Green Peter site was provided in the Flood Control Act of 3 September 1954 (PL 780, 83rd Congress, Chapter 1264, 2d session).

3-05. Project purpose. - Green Peter project is a major unit in the reservoir system proposed for the comprehensive development of the water resources in Willamette River Basin. One of the principal functions of the project is flood control. Storage at Green Peter will contribute effectively to reducing flood stages along South Santiam and Santiam Rivers as well as along Willamette River below the mouth of Santiam River. Green Peter Reservoir will control 27 percent of the total drainage area above the mouth of the South Santiam River. After Cascadia and Foster Reservoirs are constructed the controlled area will be increased to 48 percent.

3-06. In addition to flood regulation, Green Peter will supply stored water for navigation, power generation, and irrigation. The reservoir will be used for recreation, and increased downstream flows will be beneficial to fish life and water quality.

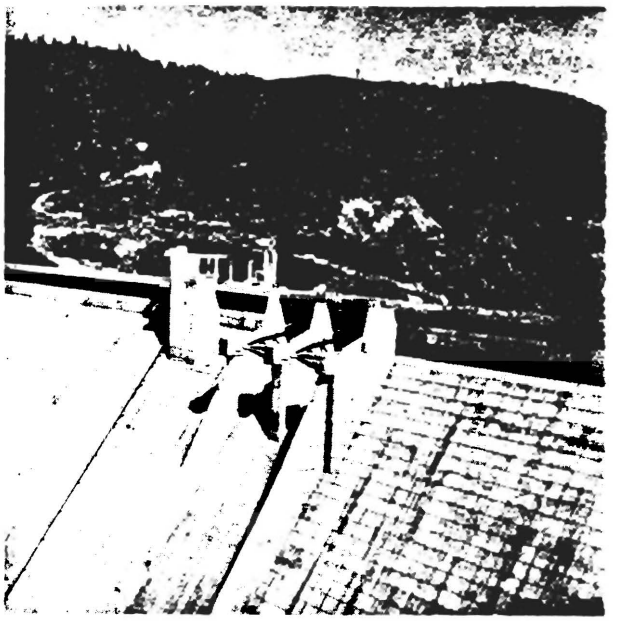
3-07. Location of project. - Green Peter Dam and Reservoir is located 5.5 miles above the mouth of the Middle Santiam River, which flows into South Santiam River near Foster, Oregon, approximately 58 miles

upstream from the junction of Santiam River with Willamette River. The frontispiece shows the geographical location of the project.

3-08. Guide taking line. - The general criterion for establishing the taking line in Green Peter Reservoir was 300 feet horizontally from maximum conservation pool, elevation 1,010 feet, but not to exceed elevation 1,030 feet. There were many exceptions; land requirements for public use, roads, slides, operation and maintenance, and permanent structures dictated the procurement of additional lands. Finally, where government lands were involved, a block-type perimeter was used as the most practical for acquiring reservoir lands. Plate 3 shows the boundary of the lands acquired by the Government for the operation of Green Peter Dam and Reservoir.

3-09. Green Peter Dam. - Green Peter Dam is a concrete gravity structure with a gated spillway. The concrete gravity section of the dam is 1,380 feet long and 327 feet high, from streambed to roadway deck. The gated ogee-type spillway has a net length of 90 feet and is located near the central section of the dam. It has a discharge capacity of 110,000 c.f.s. at maximum pool, elevation 1,015, with the gates fully open. The powerhouse is located directly downstream and to the right of the spillway. The installed generator capacity is 80,000 kilowatts. Power penstocks and outlet tunnels are through the main dam. Plate 4 shows the general plan, typical sections, and other principal features of the project. Discharge rating curves for the spillway and outlets are shown on charts 2,3, and 4.

3-10. Green Peter Reservoir. - At full pool, elevation 1,015, Green Peter Reservoir is about 11 miles long, 0.9 mile wide at maximum width, and has a surface area of 3,720 acres. Gross capacity of the reservoir is



SPILLWAY AND FISH STRUCTURES



DAM AND RESERVOIR

430,000 acre-feet, which includes a usable storage space of 333,000 acre-feet. Backwater studies indicate that the reservoir will be practically level except during flood periods and the only significant backwater effect in the pool will be confined to the upper end where the reservoir pool intersects the streams flowing into the reservoir. No backwater problem is anticipated as the upper end of the reservoir is in relatively steep canyons.

3-11. Regulating outlets. - Two rectangular outlet conduits are located under the spillway adjacent to the powerhouse, and discharge into the stilling basin. The outlets are controlled by 5'-5" by 10'-0" slide gates at the upstream end. Each outlet has two slide gates, one for normal operation and the other for emergency operation. The outlets can discharge 10,500 c.f.s. when the pool is at minimum flood control pool, elevation 922, and 13,000 c.f.s. at full pool level, elevation 1,015. Discharge rating curves for the regulating outlets are shown on charts 2 and 3 and in tabular form in table 9.

3-12. Power generating facilities. - The powerhouse is located on the right side of the spillway stilling basin and houses two Francis-type hydraulic turbines, each rated 55,000 horsepower at a net head of 265 feet. Each unit is equipped with a 14-foot diameter steel penstock about 230 feet in length. Penstock intakes are located in the face of the dam, and are provided with trashracks, bulkhead, and emergency slide gates. Each generator develops 40,000 kilowatts at 0.95 power factor and is capable of continuous operation at an overload of 15 percent. The power plant normally will be operated at a daily load factor of not less than 40 percent. Prime power is 21,200 kilowatts and dependable capacity is 53,000

kilowatts. The gross heads will vary from a minimum of 187 feet between normal tailwater and minimum power pool, and a maximum of 322 feet between minimum tailwater and maximum pool. Turbine discharges per unit will vary from a minimum of 700 c.f.s. to a maximum of about 2,800 c.f.s. Reregulation of the flows from Green Peter power plant will be made at Foster Dam, located about 7 miles downstream. Power generation curves are shown on chart 5.

3-13.

3-14. The powerhouse also houses a small Francis-type hydraulic turbine to provide attraction water to the fish ladder adjacent to the powerhouse. The turbine will deliver 60 c.f.s. at minimum head of 161 feet and 80 c.f.s. at maximum head of 290 feet, and will draw its water supply through 24-inch diameter pipes from either penstock. The generator is rated at 1,425 kilowatts at 0.95 power factor.

3-15. Principal changes in the authorized project. - The plan finally adopted for construction of Green Peter Dam was decided after making several major changes in the project document plan as authorized in House Document 531. Major changes are as follows:

a. The dam was relocated at a site approximately 1-1/2 miles upstream from the project document location and changed from an earth-and-rockfill dam to a concrete gravity dam with a gated spillway. Total gross storage capacity was increased from 360,000 to 430,000 acre-feet.

The power plant was changed from two 45,000-kilowatt units to two 40,000-kilowatt units.

b. The project document plan presented in House Document 531 authorized the construction of White Bridge Regulating Dam for regulating releases from Green Peter Reservoir. Foster Dam and Reservoir, a multiple-purpose project, was substituted in lieu of the authorized White Bridge Reregulating Reservoir and the recommended Wiley Creek Reservoir.

3-16. The General Design Memorandum dated May 1959 outlined the studies and justification for the changes made to the original project document plan. The changes were approved by the Office, Chief of Engineers, with certain comments and recommendations that were incorporated into other design memorandums. Page i shows a complete list of prior design memorandums and the dates they were prepared.

3-17. Resume of construction activities. - Construction of Green Peter project began 7 June 1961 with relocation of a county road. During the next 76 months major contracts were awarded including the main dam, bridges, powerhouse, clearing, road construction, and drilling and grouting. Only one major contract, recreational facilities, remained to be let, as of October 1967. Construction at the main dam was started in April 1963 and partial flood control retention was initiated 5 October 1966. Construction of the powerhouse was started in August 1965 and power-on-the line was established 28 June 1967. As of October 1967 the main dam was 99.9 percent complete. All work on the powerhouse was completed 18 August. Shop drawing submittals were pending as of November 1967.

3-18. Construction contracts and projects costs. - The following tabulation lists (1) major contractors, (2) dates that contracts were

awarded, and (3) total bid costs.

Contract item	Principal contractor	Contract	
		Award date	Bid costs
Relocated county road, lower end to Thistle Creek	MacGregor Triangle Co.	06/07/61	$2,035,496
Damsite excavation and County Road No. 912	Durbin Bros. and S. W. Grossbeck	06/09/61	487,520
Whitcomb Creek bridge	C. H. Strong Engineering Construction Co.	05/14/62	472,200
Relocated county road Thistle Creek to M&M Road	S. E. Grossbeck and W. R. Durbin	01/11/63	548,080
Green Peter Dam and Powerhouse substruct.	Paul Hardeman, Inc.	04/12/63	28,880,896
Furnish two turbines	Allis-Chalmers Mfg.Co.	04/16/63	1,108,894
Furnish and install two generators	Westinghouse Electric Co.	01/28/64	1,025,085
175-ton bridge crane	Ederer Corporation	04/10/64	153,700
Right bank road upper section (BLM)	Grossbeck-Durbin,Inc.	08/24/64	1,777,592
Transformers	General Electric Co.	09/17/64	167,395
Procure 15 KV busses and switchgear	Golden Gate Switchboard Co.	02/03/65	141,253
Peninsula road	Barnhardt & Platt,Inc.	04/26/65	441,992
Completion of Green Peter powerhouse	A.S. Schulman	08/27/65	1,108,900
Remote control equipment	United Power & Control Systems, Inc.	02/19/66	288,105
Drilling and grouting	Boyles Bros.Drilling Co.	04/15/66	891,600
Grading and surf. 1/4 mile powerhouse access road	Harbert Bros.	07/14/67	134,472

As of 1 September 1967, the estimated total cost of Green Peter project was $56,957,700.

3-19. Public use facilities. - Section 4 of the Flood Control Act of 1944, as amended, authorizes the development and management of recreation facilities by the Corps of Engineers, other agencies, groups, or individuals and authorizes the Corps of Engineers to administer all agreements. Various other Federal statutes, including PL 85-624, the Fish and Wildlife Coordination Act, PL 86-717, the Conservation Act, and PL 89-72, the Federal Water Project Recreation Act, provide for the development and management of Federal reservoirs for various conservation purposes including recreation.

3-20. Initial public use development at Green Peter Reservoir will be provided by the Corps of Engineers at Whitcomb Creek Park and Thistle Creek access. Linn County has informally expressed a willingness to operate and maintain the initial developed areas. The Master Plan for Reservoir Management and Public Use Development for Green Peter Reservoir will include plans for future development of public use facilities.

3-21. While recreation is not an authorized function of the project, the land and water areas afford considerable recreation potential for picnicking, camping, and water-associated activities such as boating and fishing. The recreation potential of the project is moderate, and will be given as much consideration as possible as long as this can be done without adversely affecting higher priority interests. The basic policy will be to provide optimum beneficial use of the stored water consistent with the project document plan, and Federal and Oregon State water laws.

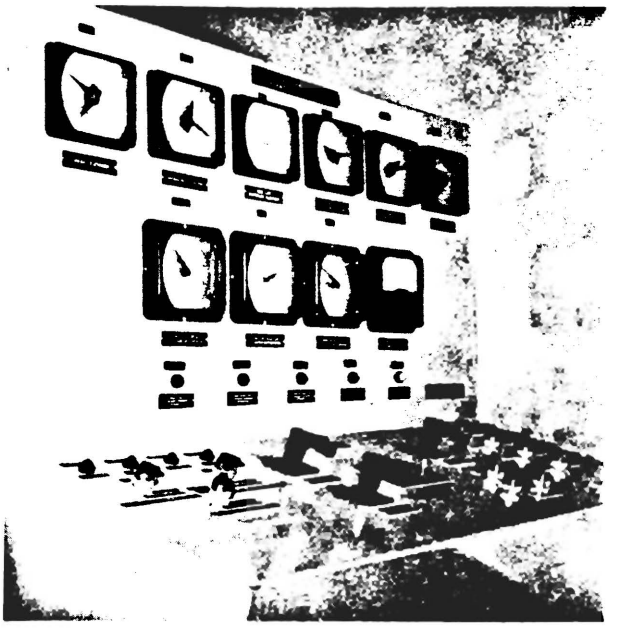
3-22. Debris control. - The watershed above Green Peter Reservoir is extensively timbered and logging operations in the area will be a

constant source of debris, which will accumulate on the pool. A floating log boom, which will fluctuate with the pool level, has been provided to keep floating debris away from the spillway, fish facility, outlet works, and power intake. The debris will be collected, beached, and burned whenever the accumulation becomes a hazard to the operation of the project.

3-23. Fish facilities. - Fish facilities are provided at Green Peter project for the upstream and downstream passage of chinook salmon and steelhead migrants. These facilities are described in detail in Green Peter Design Memorandum No. 13, Fish Facilities.

a. Upstream migrant facilities. - The upstream passage facilities are conventional in design and consist of a fishladder on the right side of the powerhouse tailrace which leads to a collection point inside the dam where dual hoppers are employed in tandem to lift adult fish to the top of the dam, carry them across the deck, and lower and release them into the reservoir. A pictorial sketch of the facilities is shown on chart 6. The water supply to operate the ladder is taken from the main unit penstocks through a fish water turbine and varies in amount from 50 to 70 c.f.s. depending upon forebay head conditions. A curve indicating the amount of water used by the fish water turbine is shown on chart 7. The ladder uses about 37 c.f.s. of the turbine water and the balance is diverted for attraction purposes. Pumps are provided at the ladder entrance to supplement the attraction water.

b. A gated hole is provided through the guide wall between the stilling basin and the powerhouse for the passage of fish during low-flow periods when it is necessary to attract adult migrants from the



FISH CONTROL PANEL



FISH PASSAGE FACILITIES

stilling basin area into the powerhouse tailrace and then into the fishway entrance.

c. Pipes also are installed to provide standby fishladder water directly from the forebay when the fish water turbine-generator unit is out of service. A special dissipator has been built into this system to reduce the energy in the water for ladder use.

d. The dual collection hoppers were designed so that ultimately they could be automated. They will not be automated, however, until after they have been in service for a sufficient time to assure fishery interests such automation is practical. The tramway across the top of the dam is also integrated into the system in such a manner that hoppers can be stopped to load fish tank trucks on the deck of the dam. See chart 6.

e. The 70 c.f.s. of water which will be discharged through the fishway turbines at high pool during the summer season serves a dual purpose by providing sufficient water to keep the stream "alive" and provide a suitable transportation medium for upstream and downstream migrant fish during periods when no water is being discharged through the turbines or outlets, a normal situation during peaking operations at Green Peter.

f. Downstream migrant facilities. - The downstream passage facility for juvenile migrants is unique in design. It consists of a large well constructed on the upstream face of the dam equipped with collection and passage components. Chart 8 illustrates these facilities. The well is located in the block adjacent to that in which the penstock

intakes are located. The penstock intakes, which contributes fish attraction water, will be submerged a minimum of 100 feet at minimum flood control pool, too deep for downstream migrants to sound. Therefore a surface collector provides an egress route near the surface of the reservoir to handle downstream migrants. The collector intake, which is 20 feet high and adjustable, will be operated with a centerline submergence from 15 to 30 feet, thus providing fishing capability from 5 to 40 feet of submergence at all pool levels throughout a 93-foot range of pool fluctuations.

g. An attraction flow of 200 c.f.s. is designed to enter the collector intake and carry the migrating fish across a skimmer-type separator into a trough from which they will be carried in 6 to 10 c.f.s. of transportation water to a release site downstream from the project. The remaining 190 to 194 c.f.s. is reclaimed at the separator screen and returned to the reservoir via pumps at the bottom of the concrete well on the face of the dam. This conserves the excess water for power generation. The velocity to the fish passage collector increases to 10 feet per second at the throat of the collector intake which is maintained at this or higher velocities throughout the remainder of the system. Open channel flow conditions prevail in a steep pipeline which transfers the fish from the downstream face of the dam to the release point. Velocities reach 50 to 60 feet per second as this transfer pipe levels off at the bottom of the dam, but friction will slow this water to about 10 feet per second at the end of the pipeline without a hydraulic jump. Current plans call for an evaluation facility at the end of the pipeline.

After passing the evaluator the fish will be returned to the stream via a flume. The water in the flume will reach a velocity of 30 feet per second before it discharges into a deep water pool in the natural river as a submerged jet.

h. Evaluation facilities. - The evaluation facilities which will be operated near the downstream end of the fingerling transfer pipe will be used during the early years of project life to determine the effectiveness of both the upstream and downstream passage facilities in maintaining the salmon and steelhead runs in the stream. These facilities will be operated by biologists from one of the interested State fishery agencies in close cooperation with project personnel who will be responsible for the operation of passage facilities.

SECTION IV - CLIMATOLOGY

4-01. Climate. - The climate of the area above Green Peter Dam is characterized by mild, wet winters and warm, dry summers. With the exception of an occasional short period of continental air mass control, maritime air masses dominate the area throughout the year. Principal climatic controls are topography, proximity to the Pacific Ocean, and location near the center of the prevailing westerly winds. The area is subject to frequent winter storms of varied intensities. Winter temperatures are generally below freezing at the higher levels, resulting in snow accumulating to great depths. Summer rainstorms occur occasionally and are generally of the convective type, characterized by short duration and small areal coverage.

4-02. Climatological records. - Past climatological records applicable to the watershed tributary to Green Peter damsite are available at two stations. One is a recording precipitation gage formerly located about 12 miles southwest of Quartzville in Middle Santiam River Basin at a location now covered by Green Peter Reservoir. Data at this station are confined to precipitation records from 1939 through 1961. The second station is located at Cascadia in South Santiam River Basin and about 5 miles southeast of Green Peter Dam. Both temperature and precipitation records have been observed at the Cascadia station since 1908. Because of Cascadia's close proximity and similarity in elevations to Green Peter, its records are considered most representative of conditions at the damsite. Other climatological stations in the general vicinity of Green Peter Dam are Waterloo, Lacomb, and Detroit. Plate 1 shows the

location and length of record of climatological stations in the Santiam River watershed and surrounding area.

4-03. Precipitation. - Normal annual precipitation over the 277 square mile watershed above Green Peter Dam is estimated to be 91 inches. The normal annual precipitation varies from about 68 inches near the damsite to over 108 inches near Quartzville. Normally, 70 percent of the annual precipitation falls in the 5-month period, November through March. July and August are usually the driest months of the year; less than 2 percent of the annual precipitation occurs in those 2 months. Rainless periods of over 30 days are not uncommon during the summer season. Monthly minimum, average, and maximum precipitation of record for selected stations in and near the basin are shown on plate 5.

4-04. The areal distribution of normal annual precipitation over the drainage area tributary to Green Peter damsite is shown on plate 6 which was developed as part of a comprehensive report for the Willamette River Basin. Available precipitation data, streamflow, snow course data, and topography were taken into consideration in preparing the annual isohyetal map for the basin.

4-05. At Cascadia, where the weather and climatic conditions are considered to be representative of conditions at Green Peter damsite, the greatest recorded 1-day precipitation was 4.69 inches on 20 November 1921. The wettest month of record was November 1942, with 20.91 inches of precipitation and the wettest year was 1950, with 82.02 inches of precipitation. On the average, 156 days per year experience 0.01 inch or more of precipitation. Tables 1, 2, and 3 summarize climatological

data by months for Quartzville, Cascadia, and Salem, respectively. Table 4 compares climatological data for Quartzville and Cascadia with those of three other stations in the general area.

4-06. Snow - Less than 5 percent of the precipitation at the lowest elevation in the basin above Green Peter damsite occurs as snow, compared with 60 percent at the highest elevation. Snow cover below 2,000 feet is generally transient and may accumulate and melt several times during a winter season. Above 4,000 feet snow generally accumulates until about mid-April.

4-07. No snow courses exist within the watershed above the damsite, but snow courses in the adjacent North Santiam River Basin are considered representative at comparable elevations. April 1 snow surveys at elevations above 4,000 feet generally indicate maximum water equivalent depth for the season. Table 5 shows that April 1 average values range from 43.7 inches at Hogg Pass, elevation 4,755 feet, to 13.2 inches at Marion Forks, elevation 2,730 feet. Maximum seasonal depth at Breitenbush, elevation 2,325 feet, are generally recorded on 1 March, the average depth on that date being 4.8 inches. Plate 5 graphically illustrates the variations in depth and water equivalent of the snowpack by months for the period of record at Hogg Pass, Santiam Junction, and Marion Forks snow courses.

4-08. Temperature. - Because of the moderating effects of maritime air from the Pacific Ocean, seasonal variations of temperature are relatively small. Average monthly temperature at Cascadia, as shown on table 2, ranges from 37.1 degrees F. in January to 65.1 degrees F. in July.

Average daily maximums and minimums are 44.6 and 29.8 degrees F., respectively, in January, and 81.9 and 48.1 degrees F., respectively, in July. The absolute maximum temperature recorded at Cascadia was 106 degrees F. in July 1946, and the absolute minimum temperature was 1 degree F. in December 1932 and January 1950. These temperatures are approximately representative of conditions at Green Peter damsite. Temperatures decrease with increase in elevation at the rate of about 3 degrees F. per thousand feet. Temperature data for selected stations are shown in tables 2, 3, and 4 and on plate 5.

4-09. Storms. - Flood-producing storms occur chiefly during the winter season but are not uncommon in late fall and early spring. The seasonal storm pattern is largely a result of the southward displacement of the Aleutian Low during the winter season. With increased pressure gradient between the Aleutian Low and the Pacific High, a strong westerly to southwesterly flow of moist maritime air develops over the area. Lifting of the air over topographic barriers, augmented by convergence and frontal lifting results in precipitation of varied intensities, often of flood-producing proportions. Frontal activity generally consists of a series of north-south oriented occluded fronts moving eastward over the area. Frequently, however, a quasi-stationary front will develop over the area in an east-west direction. The strong westerly flow of moist air and minor waves associated with such fronts results in continuous precipitation, generally of high intensity, in the frontal area.

4-10. The sequence of meteorological events in December 1964 produced one of the greatest floods of record in the Willamette Basin.

The synoptic situation prior to the storm consisted of a high pressure area dominating the Pacific Northwest and subnormal low temperatures froze the exposed ground which later contributed to a fast runoff and small surface losses. Beginning on the 18th, a weakening of the high pressure system and the passage of several fronts resulted in light to moderate precipitation that fell mostly as snow through the 20th. Freezing was generally experienced below 3,000 feet, prior to the 21st. Warming that started on the 19th reached a maximum on the 22nd when the freezing level extended to elevation 10,000 feet. A strong westerly flow of moist air accompanied by several storm fronts resulted in intense rains on the 21st and 22nd, with moderate amounts occurring through the 30th. A sharp drop in temperature and diminished precipitation on the 31st marked the end of a 13-day storm period.

4-11. On the basis of reports from adjacent stations it is estimated that 21 inches of precipitation fell over the Green Peter Basin during the 13-day storm period, 0700 18 December to 0700 31 December. Maximum 24-hour and 96-hour basin precipitation depths are estimated to be 4.5 inches and 12 inches, respectively.

4-12. Winds. - No data are available on wind speed in the Middle Santiam River basin. For study purposes, wind data observed at Eugene, Oregon, from 1941 to 1964 were used. On the average, the wind at Eugene is 3 miles per hour or less about 37 percent of the time. Sixty-one percent of the time the wind speed is between 4 and 15 miles per hour, and most of the remaining 2 percent of the time the wind speed is between 15 and 31 miles per hour. Occasionally, sustained wind speeds reach 45 miles

per hour with gusts in excess of 80 miles per hour. The highest wind of record at Eugene occurred on 12 October 1962 with a maximum 1-minute velocity of 63 miles per hour and a maximum gust of 86 miles per hour. Velocities ranging from 45 to 55 miles per hour were sustained for about 2 hours during that storm. The stronger winds have a westerly component and blow upstream, which would be less critical as they would generate waves away from Green Peter Dam.

4-13. Evaporation. - No evaporation records are available in the vicinity of Green Peter Reservoir. Records at Fern Ridge Reservoir, located about 40 miles southwest of Green Peter, show an annual land pan evaporation of 38.1 inches, and 40 percent of this amount occurs during July and August. Evaporation is negligible during the winter months, increases progressively during the spring months, and decreases during the autumn months, with the maximum occurring during July and August. Table 6 shows estimated average monthly evaporation amounts for Green Peter Reservoir. These values are based on data observed at Fern Ridge Reservoir which have been adjusted in accordance with the findings in the publication: Water Loss Investigations. Lake Hefner Studies, U. S. G. S., Professional Paper No. 269. Using 0.71 as the yearly conversion factor, it is estimated that in the average year approximately 7,650 acre-feet will evaporate from Green Peter Reservoir.

4-14. As indicated in table 6, the monthly evaporation varies largely in accordance with the mean monthly air temperature which is primarily a function of solar and terrestrial radiation. Although wind is an important factor in the appraisal of daily evaporation amounts, it

is not a significant factor when evaluating mean monthly values. Records for the Willamette Basin show that the average wind speed for each month of the year is nearly constant, 2-3 miles per hour.

SECTION V - HYDROLOGY

5-01. Discharge records. - Discharge records for Middle and South Santiam Rivers in the vicinity of Green Peter damsite date back to 1910, but none of the records are continuous for the period 1910 to date. The longest continuous record, 1923 to date, is for South Santiam River at Waterloo, drainage area 640 square miles. Discharge records for Middle Santiam River near Foster are available since 1931 and for South Santiam below Cascadia since 1935. Two new gaging stations were established in August 1963 at the head of Green Peter Reservoir, one on Middle Santiam River, and one on Quartzville Creek. Plate 1 shows the location, period of record, and other pertinent data for all stream gaging stations in the Santiam River Basin.

5-02. The Waterloo station will be one of the primary downstream control points for flood regulation at Green Peter Reservoir. Other significant control points are Santiam River at Jefferson and Willamette River at Salem.

5-03. Streamflow characteristics. - The streamflow regimen of Santiam River and tributaries is similar to the seasonal precipitation pattern. Low flows normally prevail from June through September, the season of low precipitation. Higher flows, which may fluctuate widely, prevail during the remainder of the year, the season of highest precipitation. Snowmelt at the high elevations sustains a moderate base flow until early summer. From July through September the streams recede to their minimum flows. Daily discharge hydrographs shown on plates 7 through 16 illustrate the streamflow pattern, the frequency of high and

low water periods, and the flashy character of the floods in the Middle Santiam and South Santiam Basins. Nearly 90 percent of the annual runoff occurs during the 8-month period, November through June.

5-04. Runoff. - A runoff summary of minimum, maximum, and mean monthly flows at Green Peter Dam, including a flow duration curve, are shown on chart 9. These data show that the inflow to Green Peter Reservoir, based on past records, will equal or exceed 1,250 c.f.s., 50 percent of the time and will equal or exceed 150 c.f.s., 90 percent of the time. Annual runoffs at Green Peter Dam, for the period 1926-1964, are shown in table 7 and are graphically illustrated on chart 9. The mean annual runoff at Green Peter Dam is 1,145,800 acre-feet, with extremes of 1,747,500 acre-feet in 1956, and 651,600 acre-feet in 1931.

5-05. Flood characteristics. - Floods on Santiam River and tributaries are usually produced by intense precipitation of 2 to 4 days duration, augmented to varying degrees by snowmelt runoff. The snowmelt contribution is largely from areas of low and intermediate elevations and generally increases the volume with relatively little effect on the flood peak. A notable exception was the December 1964 flood when a frozen ground and excessive snowmelt not only contributed to the flood volume but likewise to the peak. The bulk of the high-level snowpack usually melts and runs off without damaging effects after the first of March. When periods of intense rainfall, which occur frequently during the rainy season, are preceded by an extended period of moderate precipitation that saturates the ground, a flood develops. Double-crested floods are not uncommon and may at times create reservoir regulation problems because of the excessive volume.

5-06. The area above Green Peter damsite is heavily timbered and normally little damage occurs in the upstream reaches of the basin. An exception was the December 1964 flood when trees were swept from the hillsides into the channel. The duration of the average flood in the upper reaches is usually from 2 to 4 days, but a series of storms have, at times, extended the period of downstream flooding to a week or more. The maximum high water in any year can occur in any month from October through April.

5-07. Flood frequencies. - Recorded and computed maximum annual discharges through 1965 at the Green Peter damsite were used in the derivation of the maximum annual flood frequency curve shown on chart 10. The following tabulation shows computed peak discharges for Green Peter damsite for selected recurrence intervals.

Average recurrence interval in years	Maximum discharge in c.f.s.
5	33,500
10	40,000
25	48,000
50	54,500
100	61,000

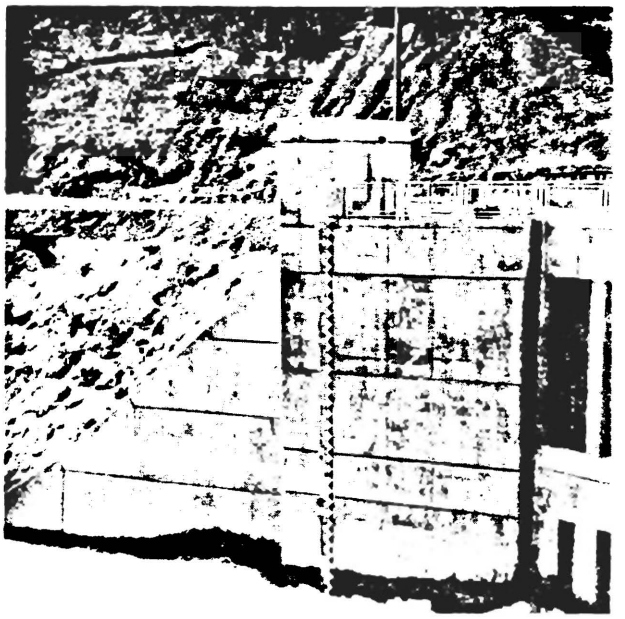
5-08. Past floods. - The maximum flood peak observed since the establishment of the gage on Middle Santiam River at the mouth near Foster, was 66,000 c.f.s. in December 1964. This peak discharge was not only higher than any other of record, but was also greater than the estimated peak of 52,000 c.f.s. for the historical flood of December 1861. Table 8 lists annual peak discharges at selected stations in the basin. The 6-day volume of 327,000 acre-feet for the December 1964 flood was greater than any of the other past floods of record. The historical

flood of December 1861 was estimated to have had a 6-day volume of about 329,000 acre-feet. Flood volume frequencies for several recurrence intervals are shown on chart 11. The 6-day volume of the December 1964 flood has a recurrence frequency of approximately once in a 100-year period.

5-09. Channel velocities. - During normal peaking operation at Green Peter Dam, releases may fluctuate from 50 c.f.s. to 2,800 c.f.s. in less than a half hour and the velocity and stage of the river in the 2- to 3-mile reach between Green Peter Dam and the head of Foster pool will fluctuate significantly, a definite hazard to public safety. A fence has been constructed to keep the public from this hazardous reach of the river. Following floods, the normal maximum release from Green Peter will be 13,000 c.f.s. and this will only occur after the flows downstream have receded to within banks and the pool at Foster has the capability to pass this flow safely. The following table shows average stream velocities that may be expected in the 2- to 3-mile reach below Green Peter Dam for sustained flows. Maximum velocity may be as much as 50 percent greater than the average velocity.

Discharge in c.f.s.	Average velocity in feet per second
300	3
3,200	5
8,400	7
18,200	9
36,500	11

Velocities resulting from sudden releases at Green Peter would exceed those for a sustained flow as the flow would react as a wave moving through this short confined reach.



TAILWATER STAFF GAGE



TAILWATER GAGING EQUIPMENT

5-10. Channel capacities. - Between Foster damsite and Lebanon, South Santiam River has a fairly adequate channel capacity and a narrow flood plain. The flood problem in this reach is not critical. Below Lebanon the South Santiam River Valley widens and the river banks are lower resulting in serious overbank flooding even at moderate flood discharges. Serious flooding also occurs along the entire length of the Santiam River below the junction of North and South Santiam Rivers where the river banks are relatively low and the flood plain is wide.

5-11. Flood regulation at Green Peter Reservoir will first consider protecting lands along South Santiam River, using the stage at the gaging station near Waterloo as an index. Existing bankfull capacity in this reach of the river is approximately 18,000 c.f.s., which can be expected to be exceeded quite frequently, until Cascadia Reservoir is built. Bankfull capacities at downstream locations pertinent to the operation of Green Peter Reservoir are shown in the following tabulation.

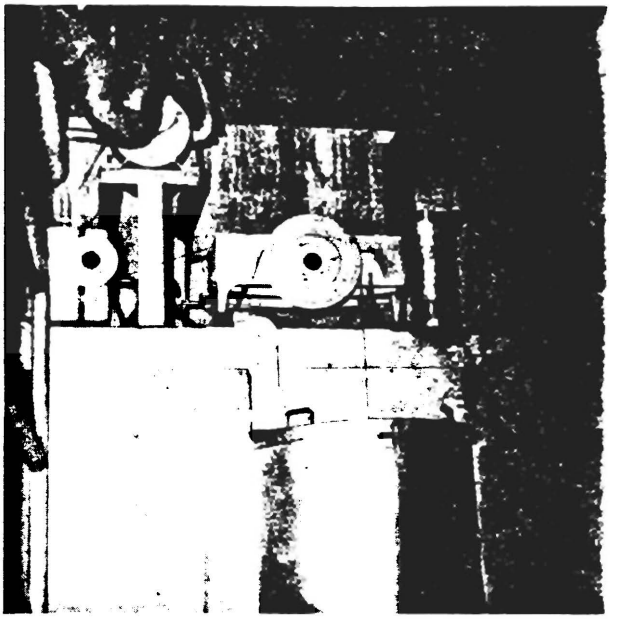
Station	Stream	Drainage area in square miles	Bankfull data	
			C.f.s.	Stage
Waterloo	South Santiam	640	18,000	9.9
Jefferson	Santiam	1,790	35,000	13.2
Salem	Willamette	7,280	120,000	23.3

5-12. Outlet capacity. - The outlet works for Green Peter Reservoir are designed to discharge 10,500 c.f.s. at minimum flood control pool, elevation 922. Maximum discharge at maximum pool, elevation 1,015, is 13,000 c.f.s. The outlets will seldom be utilized at maximum capacity. A full reservoir can be evacuated in approximately 2 weeks with existing

outlets and full power generation. Discharge rating of the Green Peter Reservoir outlets is given in table 9 and on charts 2 and 3. During a spillway design flood, the reservoir outlets could complement the spillway. The spillway has the capacity to discharge the regulated spillway design flood when the pool is at or less than the spillway crest at the start of the flood. The probability of the outlets being required to complement the spillway is quite remote.

5-13. Reservoir capacity. - The principal criterion, in determining the flood control storage requirement for Green Peter Reservoir, was that the reservoir should be capable of effectively regulating a flood the magnitude of the 1861 flood and the December 1964 flood until such time that the controlled spill would not result in a secondary flood crest at Waterloo in excess of that caused by the peak runoff from the uncontrolled area between the damsite and Waterloo. A reservoir capacity of 270,000 acre-feet complies with this criterion. All floods of record, with the exception of the December 1964 flood, can be completely controlled by Green Peter Reservoir at the damsite with the adopted flood control storage, which is equivalent to 18.3 inches of runoff tributary to the reservoir.

5-14. Total capacity of Green Peter Reservoir at full pool, elevation 1,015, is 430,000 acre-feet. Between elevation 1,015 and elevation 922, minimum flood control pool, there are 270,000 acre-feet of storage space reserved for flood regulation and multiple-purpose use. Between elevation 922 and elevation 887, 63,000 acre-feet are reserved exclusively for power. Below elevation 887, there are 97,000 acre-feet of storage space, 95,875 acre-feet are inactive storage and 1,125 acre-feet



FOREBAY GAGING EQUIPMENT



CONTROL PANEL

are dead storage. See chart 12 for the annual flood control storage schedule. After the flood season has passed, 250,000 acre-feet of the flood control storage space will be filled for multiple-purpose use. The remaining storage space, 20,000 acre-feet between elevation 1,010-1,015, will be reserved for summer flood regulation. Reservoir storage and area curves are shown on chart 13.

5-15. Powerhouse tailwater. - Powerhouse tailwater rating curve is shown on chart 14. Tailwater elevations at the powerhouse will fluctuate about 7 feet for turbine discharges varying from 1,400 c.f.s. to 5,600 c.f.s. From a minimum release of 50 c.f.s. to a maximum turbine discharge of 5,600 c.f.s., the fluctuation is about 13 feet. The powerhouse tailwater gage should be used only to determine gross head differential between pool and tailrace. The flow of the river will be determined by adding the simultaneous discharges from the powerhouse, regulating outlets, spillway, and fish facilities.

5-16. Sedimentation. - The channel of Middle Santiam River in the vicinity of Green Peter Reservoir is typical of the tributaries which originate high in the Cascade Range. The riverbed is composed largely of bedrock and the side slopes are well covered with vegetation. Only during intense storms is there any appreciable erosion of the river banks and surface area. No significant bedload movement is anticipated because of the nature of the streambed.

5-17. Sedimentation studies made in the Willamette River Basin from 1949 to 1951 showed that suspended sediment concentrations in mountainous streams were not significant except during flood periods. In addition to

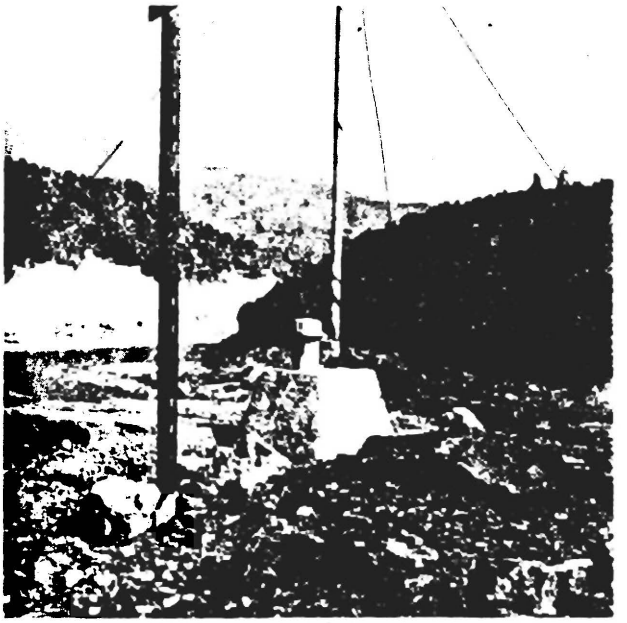
the 1949-1951 suspended sediment studies, reservoir surveys have been made at Cottage Grove, Fern Ridge, and Dorena Reservoirs which show that siltation has not appreciably affected the capacities of the existing reservoirs.

5-18. No suspended sediment observations have been made in the vicinity of Green Peter Reservoir. Between 1949 and 1951, 321 samples of suspended sediment were taken at the gaging station on the South Santiam River at Waterloo. Analysis of these samples showed that during low flows, only a trace of sediment was evident. A maximum concentration of 370 parts per million was observed during a flood. Suspended sediment rates at Green Peter Reservoir should be approximately the same as those observed on the South Santiam River at Waterloo. On the basis of these suspended sediment data and prior reservoir surveys, it is estimated that the average annual silting of Green Peter Reservoir will not exceed 70 acre-feet. Consequently, loss of reservoir storage space will be small, and will not materially affect the storage capacities during the economic life of the project.

5-19. A system of nine permanent index-type sedimentation ranges for evaluating degradation and aggradation of the river channel above and below the reservoirs and future silting in the reservoirs has been established. Six of these ranges are in Green Peter Reservoir. The remaining ranges are located below Green Peter Dam in Foster Reservoir. Experience at existing reservoirs in Willamette River Basin indicates that silting will be a minor problem at Green Peter Reservoir and resurveys would be infrequent. Plate 17 shows a layout of the sediment ranges



TYPICAL RESERVOIR VIEW



TYPICAL SEDIMENT RANGE MONUMENT

established at Green Peter. For more information on the sedimentation ranges refer to the report: "Proposed Sedimentation Ranges, Green Peter and Foster Reservoirs," dated August 1963.

5-20. River temperatures. - Taking of water temperature was started in August 1963 at the two inflow stations at the head of Green Peter Reservoir. Records of temperatures of Middle Santiam River at the mouth near Foster, which is below Green Peter damsite, were started in September 1953. At the gaging station below Green Peter Dam, records show that during the 4-month period, December through March, water temperatures were generally below 43 degrees F. Water temperatures in July and August average about 62 degrees F., and remain fairly constant during these two months. The highest water temperature observed at the Foster gaging station was 77 degrees F. in July 1958. Charts 15 and 16 illustrate graphically the observed monthly maximum and minimum water temperatures for Middle Santiam River near Foster for the period 1953-1964 inclusive. Based on a single year of record at the two gaging stations above the reservoir, maximum river temperatures at the inflow stations are 2 to 8 degrees cooler than at the Foster station.

5-21. Reservoir temperatures. - Green Peter Reservoir is equipped with 12 recording thermometers, which are located at 25-foot intervals in the face of the dam between elevation 735 and elevation 1,010. Based on studies at Lookout Point and Detroit Reservoirs, release temperatures will probably vary from 50 degrees F. in June to 65 degrees F. in September. The higher temperatures will occur as the storage is depleted. The maximum temperature of the released water should be at least 10

degrees cooler than that of the inflow during July and August. Surface water in Green Peter Reservoir will generally be warmer than the air temperature. For a typical year the average monthly temperature of the surface water will range from 0.95 to 1.20 times that of the monthly air temperature. The higher ratios occur during the fall and the lower ratios occur during the spring. Outflow temperatures will reach a maximum of approximately 65 degrees F. in September. Starting in October the reservoir temperatures start to fall and the reservoir will become isothermal at about 40 degrees F. by January. From January to March the water in the reservoir will remain isothermal for the full depth of the reservoir. Frequent filling and emptying of the reservoir and the absence of surface heating keeps the reservoir contents completely mixed.

SECTION VI - FLOOD CONTROL REGULATION

6-01. General criteria. - Flood control regulation at Green Peter Reservoir will be closely coordinated with the regulation of Foster Reservoir on South Santiam River and Detroit Reservoir on North Santiam River. In addition, there will be coordination with all other flood control reservoirs in Willamette River Basin both during the regulation of a flood and the evacuation of stored water immediately following a flood.

6-02. ~~During the interim period before Cascadia Reservoir is constructed,~~ Green Peter Reservoir on Middle Santiam River will provide the principal flood regulation in the South Santiam River Basin. Foster Reservoir, which is located 7 miles downstream on South Santiam River will serve primarily as a reregulating reservoir for power generation at Green Peter Dam as the 30,000 acre-feet of flood control storage space in Foster Reservoir is inadequate to effectively regulate significant floods from the 217 square miles of intervening area between Green Peter and Foster. Optimum use of the 30,000 acre-feet of flood control storage space in Foster Reservoir requires that the storage be reserved to regulate the larger floods. After Foster Reservoir fills, which will frequently occur, release from Green Peter plus the runoff from the area between Green Peter and Foster will be passed unregulated through Foster Reservoir.

6-03. Green Peter Reservoir has 270,000 acre-feet of storage space allocated to flood control which has the capability to effectively regulate, at the reservoir site, the December 1964 flood which has a recurrence probability of less than once in 100 years. The watershed above

Green Peter Reservoir, 277 square miles, experiences a mean annual runoff of 78 inches, much greater than that experienced in most watersheds in the Willamette Basin. Therefore, regulation of floods on Middle Santiam River is essential to controlling floods in the lower South Santiam Basin. Downstream control points are Waterloo on South Santiam River, drainage area 640 square miles, and Jefferson on Santiam River, drainage area 1,790 square miles.

6-04. Flood control regulation schedule. - The normal flood control regulation schedule for Green Peter Reservoir is shown on chart 17. The basic criteria is to pass the inflow to Green Peter Reservoir as long as possible without exceeding bankfull discharges at either of the downstream control stations, 18,000 c.f.s. at Waterloo and 35,000 c.f.s. at Jefferson. Chart 17 shows the combined release from Foster and Detroit if bankfull stage is not to be exceeded at Jefferson, for various precipitation indices and corresponding runoffs from the 858 square miles of uncontrolled area below Foster and Detroit. Distribution of the indicated reduction in release from Foster and Detroit would take into consideration the flow at Waterloo in South Santiam River and the storage available in Detroit, Green Peter, and Foster. Normally the reduction would be proportioned equally between the two tributary basins, North Santiam and South Santiam.

6-05. Release from Green Peter Reservoir can be reduced to 100 c.f.s. if power generation in the system is not critical. Flood control storage in Foster Reservoir, downstream from Green Peter, should not be used until the modified flow at Foster has exceeded 10,000 c.f.s. A 10,000 c.f.s.

release at Foster should not be exceeded until the end of the flood or until special reservoir regulation curves indicate a greater release.

6-06. Evacuation of stored flood water should not be initiated until streams below the project have receded to within their banks and then the evacuation should be scheduled so as not to exceed overbank stages. An exception to this normal procedure would occur when the reservoir is full or near full and there are indications of another flood. In this situation a limited evacuation would be undertaken before the streams receded to bankfull in order to be prepared for a second flood. The evacuation, under no circumstances, should create a downstream flow greater than that experienced during the flood. Evacuation of Foster Reservoir should be completed before starting to evacuate Green Peter Reservoir. Foster Reservoir has such a limited amount of flood control storage space that to be effective the entire amount must be available to regulate even the smaller floods. ↑ Contradicts 3rd Sentence in Paragraph 6-02. } Not contradictory

6-07. Special flood regulation schedule. - A special situation exists when a flood cannot be completely regulated at the reservoir site with the available storage in the reservoir. An advance warning of such a situation can be detected by the special reservoir regulation curves shown on chart 18. These reservoir regulation curves indicate when the normal reservoir release should be increased and what the revised release should be if the remaining storage in the reservoir is to be used effectively and an uncontrolled spill avoided. The special curves should be entered with current pool elevation and reservoir inflow to determine what the outflow should be to make optimum use of the remaining storage.

The procedure results in a gradual increase in the outflow and a corresponding lower maximum reservoir release from that which would be experienced should no special action be taken. Maximum increase in outflow should be limited to 2,500 c.f.s. per hour. Experience indicates that a reduction in a previously established outflow should not be effected on the basis of one check period, otherwise the outflow could fluctuate excessively. Usually two check periods will establish a definite trend. This procedure only applies to reducing the outflow, not increasing the outflow, which should comply with the special curves or the maximum of 2,500 c.f.s. per hour. Maximum pool reached from using the special curves should be maintained until evacuation of stored water is initiated.

6-08. Primary and secondary flood control storage. - Flood regulation studies show that 200,000 acre-feet of storage space in Green Peter Reservoir controls all floods of record on Middle Santiam River except the December 1964 flood and the historical flood of December 1861. These latter floods occur infrequently, approximately once in 100 years on the average. Each year by 15 November, 200,000 acre-feet of storage space which is referred to as primary flood control storage, will be made available for flood regulation. For regulation of the larger floods an additional 70,000 acre-feet, referred to as secondary flood control storage, will be provided subject to special conditions.

6-09. After 15 November the 70,000 acre-feet of secondary flood control storage space will be attained by evacuating the 70,000 acre-feet utilizing maximum capacity of the turbines. However, the rate of

evacuation of secondary flood control storage shall not be less than 2,370 acre-feet per day. The ideal situation would be to accomplish this evacuation by discharging all the stored water and natural inflow through the turbines which have an average capacity of 4,600 c.f.s. for the heads involved.

6-10. When reservoir inflow plus an evacuation of 2,370 acre-feet per day is greater than the turbine capacity, 4,600 c.f.s., then the extra water would be released through the outlets if downstream channel conditions would permit a release of that magnitude. In instances where the regulation of a flood filled the space reserved for flood regulation, evacuation of the stored water would be made as rapidly as downstream conditions would permit for that portion of the stored water above the 70,000 acre-feet level. The 70,000 acre-feet or secondary flood control storage space would be evacuated in the same manner as that prescribed for the period after the 15 November, using only the turbines to evacuate the stored water if the storage can be evacuated at a minimum rate of 2,370 acre-feet per day. A maximum of 30 days would be involved in evacuating the 70,000 acre-feet below elevation 952 feet. Normally the 70,000 acre-feet would be evacuated in a two-week period. The 200,000 acre-feet above elevation 952 feet has the capability of completely regulating at the reservoir site, all floods of 50-year magnitude or smaller. This special regulation of the secondary flood control space is to provide optimum system power with little or no risk to the flood control effectiveness of the project.

6-11. Examples of regulation. - Examples of flood regulation are illustrated on plates 18 and 19 for the flood of December 1964, the

largest observed flood of record in Willamette River Basin; the flood of February 1961, a recent major flood with an unusually large runoff below the storage reservoirs; and the December 1945 flood, one of the larger floods of record for which observed streamflow records are available.

6-12. In studying each flood it was assumed that reservoirs at Hills Creek, Lookout Point, Fall Creek, Dorena, Cottage Grove, Fern Ridge, Cougar, Detroit, Green Peter, and Foster functioned and all were at minimum flood control pool at the beginning of each flood. Data shown for each example includes precipitation, Green Peter and Foster Reservoir inflows, regulated outflows, pool elevations, and discharge of South Santiam River at Waterloo, both natural and as modified by Green Peter and Foster. Flow of the Santiam River at Jefferson is shown for three conditions: (1) natural, (2) as modified by Detroit, and (3) as modified by Detroit, Green Peter, and Foster. Also illustrated are three flow conditions of Willamette River at Salem: (1) natural, (2) as modified by Hills Creek, Lookout Point, Fall Creek, Cottage Grove, Dorena, Fern Ridge, Cougar, and Detroit, and (3) as modified by reservoirs listed in condition (2) plus Green Peter and Foster.

6-13. The December 1964 flood had a peak discharge of 66,000 c.f.s. and an 8-day volume of 346,000 acre-feet at Green Peter damsite. The 1964 flood, based upon the maximum discharge and 8-day volume, is estimated to be slightly greater than a 100-year flood. As shown on plate 18, the Green Peter Reservoir release would have been maintained at 100 c.f.s. for the greater part of the flood, after which the special schedule would have prescribed a gradual increase in the outflow. The maximum release

which occurred near the end of the flood would have been held to 18,100 c.f.s. Foster Reservoir would have filled, but not until after the peak inflow, as modified by Green Peter. The modified peak inflow of 42,000 c.f.s. to Foster Reservoir would have been reduced to a maximum release of 26,800 c.f.s. by Foster regulation. At Waterloo, the natural peak discharge would have been reduced from 95,400 c.f.s. to 32,000 c.f.s. The natural discharge at Salem would have been reduced from 472,000 c.f.s. to 307,000 c.f.s. by the eight reservoirs listed in paragraph 6-12. Green Peter and Foster Reservoirs would have effected an additional reduction of 47,000 c.f.s., reducing the Salem regulated flow to 260,000 c.f.s.

6-14. The February 1961 flood, a recent major flood with an unusually large runoff below the storage reservoirs, had a total volume of 140,000 acre-feet at Green Peter damsite, and a peak discharge of 40,000 c.f.s. This flood which has a 10-year recurrence frequency, based on peak discharge, could have been completely controlled at Green Peter damsite using 50 percent of the flood control storage in the reservoir. Foster Reservoir would have filled just after the modified peak inflow. The peak discharge at Waterloo would have been reduced from 69,000 c.f.s. to 19,300 c.f.s. The natural discharge at Salem would have been reduced by reservoirs listed in paragraph 6-12 from 304,000 c.f.s. to 232,000 c.f.s. Green Peter and Foster effected an additional reduction of 32,000 c.f.s., and a regulated flow at Salem of 200,000 c.f.s.

6-15. Of the recent large floods for which observed data are available, the flood of December 1945, a 15-year flood, had a total

volume of 157,000 acre-feet and a peak discharge of 44,000 c.f.s. at Green Peter Dam. As shown on plate 19, the minimum release of 100 c.f.s. from Green Peter would have been maintained throughout the significant portion of the flood. The maximum water surface reached during the hypothetical reservoir regulation study was elevation 972.7 feet, mean sea level, or 42.3 feet below full pool elevation. At Waterloo, the natural peak discharge would have been reduced from 74,200 c.f.s. to 31,000 c.f.s. The natural discharge at Salem would have been reduced from 262,000 c.f.s. to 170,000 c.f.s. by reservoirs listed in paragraph 6-12. Green Peter and Foster regulation would have effected an additional reduction of 15,000 c.f.s. or a regulated flow at Salem of 155,000 c.f.s.

6-16. Regulation of the spillway design and standard project floods for Green Peter Reservoir which are shown on charts 20 and 21, respectively, offers unusual examples of flood regulation as both floods exceeded the flood control capacity of the project and special regulation had to be effected to make optimum use of the available storage. An empty reservoir at the start of the flood was assumed in both routings. Results of routing the two floods are as follows:

a. Spillway design flood. - As shown on chart 20, it was necessary to start using the special reservoir regulation curves about 3 hours after the inflow to the reservoir crested. The peak discharge from the reservoir, 32,000 c.f.s., occurred about 30 hours after the peak inflow and represented a reduction of 100,800 c.f.s. at the damsite.

b. Standard project flood. - The standard project flood, 87,000 c.f.s., shown on chart 21, was reduced to a maximum release of

53,300 c.f.s. Special reservoir regulation curves became effective before the inflow to the reservoir peaked. Maximum release occurred about 20 hours after the flood crested. The pre-flood condition added to the flood volume and resulted in an earlier filling of the reservoir than during the spillway design flood. The result was a higher regulated flow, 53,300 c.f.s. versus 32,000 c.f.s. for the spillway design flood.

SECTION VII - STORING FOR CONSERVATION

7-01. General. - Willamette River Basin is unique in that the same storage space can be scheduled for multiple-purpose use. Space reserved for flood control can gradually be filled for conservation purposes near the end of the flood season as the storm activity decreases without jeopardizing the flood control effectiveness of the project. After 1 February, storms over the Santiam River Basin decrease in both intensity and frequency. By mid-May the probability of a significant flood has become remote; therefore, during this period, 1 February through 10 May, storage space in Green Peter Reservoir will be gradually filled for conservation use.

7-02. Filling schedule. - The filling schedule for Green Peter Reservoir, shown on chart 12 and in table 10, permits storing at an average accumulative rate of 4,286 acre-feet per day during February and 1,831 acre-feet per day during the remainder of the filling season. The schedule insures filling of the reservoir to elevation 1,010, maximum conservation pool level, by 11 May and at the same time provides adequate storage space to control probable floods during the filling season. Scheduled pool elevations, shown on chart 12 and in table 10, should not be exceeded, except in case of a flood. Above elevation 1,010, 20,000 acre-feet of space is reserved for control of late-spring floods. The filling schedule shown on chart 12 is the upper limit line which should not be exceeded by more than a few feet except in case of a flood. This schedule reserves flood control storage space consistent with the normal decrease of the flood potential during the conservation storing season.

Flood control, the principal function of Green Peter Reservoir, would be jeopardized by indiscriminate encroachment above the filling schedule. There is no objection to filling at a lesser rate than indicated by the rule curve provided the action does not jeopardize the conservation filling, which can be forecast from the water content of the snowpack above Green Peter Reservoir. The minimum rate of storing, which will provide reasonable assurance of filling the reservoir, varies from year to year depending upon weather and snow conditions in the basin above the reservoir. Departures from the filling schedule shown on chart 12 may occur as the result of: (1) water supply in the basin snowpack more than adequate to fill the reservoir, (2) critical power situation, (3) inadequate water supply, and (4) occurrence of a flood. Each of the above conditions is discussed in the following paragraphs.

7-03. Water supply more than adequate. - Should an excessive snowpack exist above the reservoir, filling will be temporarily curtailed in the interest of providing greater flood reservation to insure adequate storage space for regulating a flood that might develop from the abnormal snowpack. An excessive snowpack would exist when the forecasted runoff based upon minimum precipitation for the remainder of the storing period indicates that the volume of runoff will exceed the storage space to be filled after providing for minimum downstream releases. The use of runoff forecast curves that would be used to effect this particular storage regulation is discussed in paragraph 7-09.

7-04. Critical power situation. - During a water year when the flow in Columbia River is critically low, extra power generation at Green

Peter Dam might be desirable to meet firm power commitments as late as April. Operation for the production of this extra power could affect the normal filling of Green Peter Reservoir to the extent that the reservoir might only be partially filled at the end of the filling season on 11 May. Should there be a shortage of stored water for irrigation and water supply following a period of curtailed filling in the interest of power generation, exclusive power storage, and possible inactive storage, may be used to supply irrigation and water supply requirements the following summer in the amount that the power generation interfered with the normal filling. Power interests would assume this risk in writing, should special regulation for power interfere with the normal filling of Green Peter Reservoir.

7-05. Inadequate water supply. - There may be times when the reservoir inflow will not be adequate to maintain both minimum releases and the desired filling rate. Minimum mean daily releases in c.f.s. from Green Peter Reservoir are as follows:

Period	Releases in c.f.s.
February-April	500
May	450
June-November	300

Any deficiency in filling, regardless of the reason, will be made up at a later date if there is an excess of streamflow after providing for downstream minimum flow requirements. Plate 20 illustrates a hypothetical regulation of Green Peter Reservoir, based on monthly flows during

a 30-year period, 1926-1955. This study shows that runoff during the filling seasons was sufficient to meet all water requirements and still fill the reservoir to maximum conservation pool, elevation 1,010, in all but 7 years. In 1941, the most critical storing year, the reservoir would have been less than half full at the end of the storing season. Plate 20 also shows the computed natural inflows, the regulated outflow, and the water stored. The storage capacity curve for Green Peter Reservoir is also shown on the same plate. Table 11 shows reservoir capacities in tabular form.

7-06. Occurrence of a flood. - Although the flood potential of the basin normally decreases as the spring season advances, floods can occur during the conservation storing season. Regulation of a flood during this, or any other season, will be in accordance with Section VI of this manual, using the schedules shown on Charts 17 and 18. Following any flood that might occur during the conservation storing season, excess flood water stored in Green Peter Reservoir will be evacuated and the pool will be drawn down to the pool elevation indicated by the rule curve.

7-07. Flexibility in seasonal filling schedule. - Flexibility in the filling schedule for Green Peter Reservoir makes it possible to generate extra power during the filling season when there is a surplus of water. Experience at existing power reservoirs in the Willamette River Basin has established the desirability of flexibility in the conservation storing schedule so that power may be generated when it is needed in the Federal system so long as the filling of the conservation storage is not jeopardized. This phase of flow regulation at Willamette Valley reservoirs will be given continuous attention.

7-08. The scheduled pool elevations, shown on chart 12 and in tables 10 and 12, should not be exceeded, except in case of a flood; or when the seasonal runoff forecast clearly indicates a limited storing above the scheduled pool level is desirable. Action of this latter type would require special authorization from higher authority. The annual filling schedule provides sufficient storage space to regulate all but the most infrequent floods during the February-May storing period. Frequent forecasts of residual runoff into the reservoir will be made during the filling season in order to establish the minimum storing rate which will provide reasonable assurances of filling the reservoir. Accurate forecasts of seasonal runoff will be important in years when extra water during the filling season could be used to advantage for power generation.

7-09. Residual runoff forecasts after February. - Any deviation in the rate of filling of Green Peter Reservoir will be made on the basis of residual runoff forecasts which will be made at about 15-day intervals, starting on 1 February. If the forecasted runoff is more than ample to fill the remaining conservation storage space and provide for the minimum downstream requirements, the extra runoff could be scheduled for additional power generation. This special regulation could result in a temporary situation wherein the conservation filling would be less than that scheduled. Whenever the extra release is made at the expense of filling, it would be based upon a 90 percent confidence forecast, which provides a substantial safety factor in the interest of filling the reservoir.

7-10. Chart 22 shows the required runoff in acre-feet to fill the reservoir and provide minimum releases from any specific date to the end of June. If the 95 percent confidence limit shows the runoff to be greater than that required, the difference can be scheduled for power generation. Charts 23, 24 and 25 are runoff forecast curves for 1 February, 1 March and 1 April respectively. The forecasts are based upon the average water content of 4 snow courses and the weighted precipitation for those months from the date of forecast through June. Chart 26 is used to determine the average basin snow water content. The 50 percent confidence forecast is based upon average precipitation amounts. The 5 and 95 percent confidence limits for the precipitation index are shown in the runoff forecast charts. Standard deviation for runoff forecasts on 1 February, 1 March and 1 April are 52,000 acre feet, 53,000 acre-feet, and 36,000 acre-feet, respectively. The runoff forecast curves evaluate both the runoff and precipitation index which accounts for the large variation between the mean runoff and the runoff shown for the 95 and 5 percent conficence limits.

SECTION VIII - UTILIZATION OF STORED WATER

8-01. General. - From 11 May through 30 November, stored water in Green Peter Reservoir will be released in the interest of the various conservation needs, which include fish life, irrigation, power production, navigation, water quality control, and public use. Conservation benefits from Green Peter project will be realized along lower South Santiam River, and Santiam River, as well as along Willamette River below the mouth of the Santiam River.

8-02. Total conservation storage in Green Peter Reservoir between minimum power pool, elevation 887, and maximum conservation pool, elevation 1,010, is 313,000 acre-feet; the lower 63,000 acre-feet is exclusive power storage and will only be drawn on in critical power situations.

8-03. Conservation release schedule. - The annual regulation schedule for Green Peter Reservoir, shown on chart 12, indicates the maximum pool elevations which should not be exceeded, except in cases of floods, to insure adequate flood control space during all seasons of the year.

8-04. Floods will rarely occur during the conservation release season from 11 May through 31 August, but 20,000 acre-feet of flood control storage space will be reserved for control of minor freshets during this period. As the reservoir is drawn down after 1 September, additional storage space is gradually made available for flood regulation, and by 16 November 200,000 acre-feet, all of primary flood control space, will be available, see chart 12 and table 12. The rate of evacuation of the 70,000 acre-feet of secondary flood control storage will depend upon

the meteorological and hydrological conditions in the basin and the need for power. Paragraph 8-14 contains a more complete discussion of the functional regulation in the interest of power generation between 16 November and 1 February.

8-05. Should a flood occur during the conservation release season, the reservoir will be regulated in accordance with Section VI of this manual, and flood water will be stored to effect downstream flood regulation. Following a flood, excess water will be evacuated and the reservoir will be drawn down to the indicated pool elevation for that date as soon as the downstream channel capacities will permit.

8-06. Demands for stored water during the conservation release season will vary widely from year to year. Because of this variable demand and the variations in precipitation and streamflow, it is not practicable to establish a fixed schedule of reservoir releases during the low-water season. A provisional schedule for Green Peter Reservoir, incorporating the basic principles outlined in the preceding paragraphs, will be prepared each year and submitted in June to higher authority for approval. This provisional schedule, which will be prepared on the basis of available stored water, will be reviewed periodically during the season and changes will be made should conditions warrant.

8-07. Water-use priorities. - The priority of the use of stored water in Green Peter Reservoir, consistent with serving authorized project functions, is as follows:

1. Domestic and municipal water supply
2. Maintenance of minimum flows

3. Irrigation

4. Power

5. Navigation

6. Water quality control

7. Recreation

The above priorities on stored water are consistent with authorized project functions, State water laws, or policy. At the present time there is no demand or plans for reserving stored water in Green Peter Reservoir for domestic or municipal water supply. The project is committed to maintaining downstream passage of fingerlings, and maintaining minimum flows for fish life below the dam. Irrigation has a high priority on stored water and the Bureau of Reclamation will file on multiple-use storage in Green Peter Reservoir for irrigation. However, as of December 1967, no contracts have been negotiated with irrigators for stored water from Green Peter Reservoir. Present system policy is to supply early season irrigation requirements and low-water augmentation from nonpower reservoirs. Only a nominal draft on stored water at the power reservoirs will be accomplished prior to the first of September. Except for the flow necessary to pass downstream migrants, most of the stored water in Green Peter Reservoir will be released through the generators to produce hydroelectric energy. No specific amount of storage is reserved for navigation or water quality control. Releases made for power and other nonconsumptive uses will benefit both navigation and water quality control. Recreation, although not an authorized primary project function, will be extended as much consideration as possible so

long as it does not jeopardize the functions which were used to justify the project.

8-08. Prior water rights. - The water laws of the State of Oregon provide that all water within the State from all sources of supply belongs to the public. Subject to existing water rights, and in accordance with the statutory provisions governing such matters, all natural flow within the State may be appropriated for beneficial use. Prior to January 1956, the administration of the water laws of the State of Oregon was vested in the State Engineer, who issued permits for the use of water and was generally recognized as the authority on all matters concerning adjudication and appropriation of water rights. Since January 1956, however, such administration has been vested in a 7-man Water Resources Board, created by the 1955 session of the Oregon State Legislature.

8-09. Prior water rights granted in accordance with Oregon law will be honored to the extent of the natural inflow into Green Peter Reservoir. The proposed minimum release of 300 c.f.s. from Green Peter Reservoir, during the July-November period, is well in excess of all existing water rights in the reach of the South Santiam River below Foster. No problems associated with appropriated flows are anticipated in the regulation of Green Peter.

8-10. Minimum reservoir releases. - Normal minimum releases from Green Peter Reservoir, other than during a flood, were discussed in a series of conferences with the U. S. Fish and Wildlife Service and the Oregon State Fish and Game Commission in 1946. The principal concern in selecting minimum flows below Green Peter Reservoir was to insure an

adequate flow of water for the normal resident fish population and the anadromous fish runs.

8-11. From 1 February to 30 November the planned minimum mean daily release from Green Peter will vary as follows: (1) February through April will be 500 c.f.s.; (2) May will be 450 c.f.s.; and (3) June through 30 November will be 300 c.f.s. Since peaking for power generation will be a regular procedure at Green Peter, the minimum release from Green Peter Reservoir will not be less than 50 c.f.s. This is a basic fish requirement. During December and January the reservoir will normally be maintained near minimum flood control pool, except in case of a flood, and the minimum mean daily release during the mid-winter period will be the natural discharge of the river except as regulated during a flood period. On the average, natural flows during that period are in excess of 500 c.f.s. The minimum observed discharge in December and January is 56 c.f.s. During a flood the release will be reduced to 100 c.f.s. when power is not critical, and 2,100 c.f.s. when power is critical. An exception would be when the difference between 2,100 c.f.s. and 100 c.f.s. was critical from the standpoint of flood regulation. Flood regulation would control and the release reduced to 100 c.f.s.

8-12. Irrigation. - The natural flow of Willamette River and its tributaries is low during the months of July, August, and September, when irrigation demands are greatest. As the acreage under irrigation increases, so does the dependence on stored water increase. The Bureau of Reclamation has estimated that 52,000 acres of productive land in the lower South Santiam plains could ultimately be irrigated with South

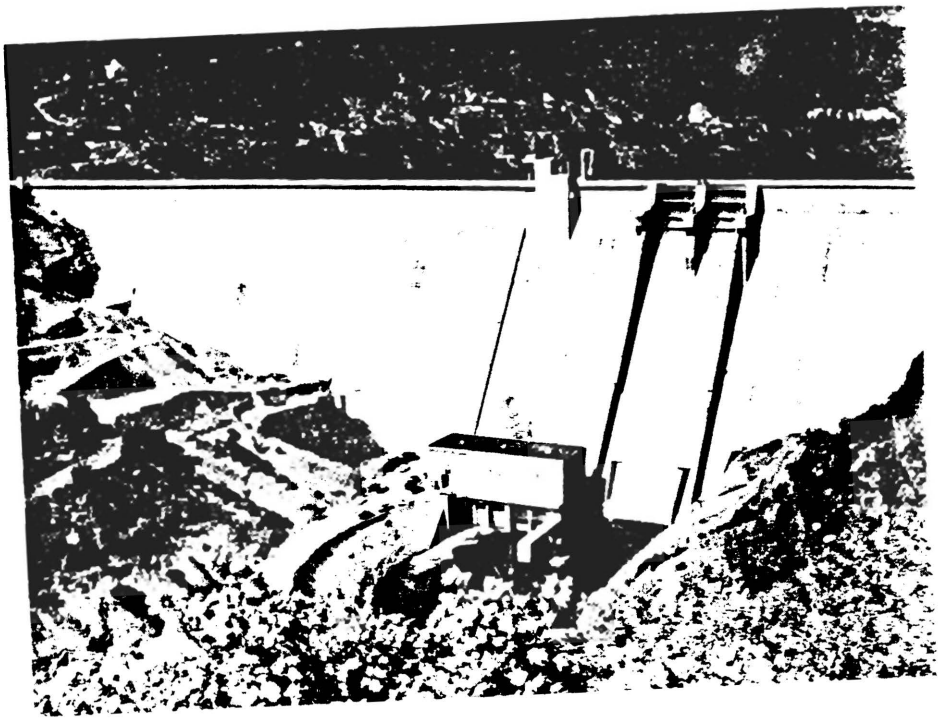
Santiam River storage. Green Peter Reservoir will supply water needed for irrigation during the interim period before Cascadia Reservoir is constructed on the South Santiam River. After Cascadia Reservoir is constructed, stored water for irrigation will come first from Cascadia, reserving storage in Green Peter Reservoir for production of power after 1 September. If irrigation demands are greater than what Cascadia can provide, Green Peter Reservoir will supply the deficiency. Should irrigation demands become excessive along the Willamette River below the mouth of Santiam River in the interim period before all authorized and recommended reservoirs are built in the Willamette River Basin, all the reservoirs in the Willamette system, including Green Peter, could be required to furnish irrigation water to the possible detriment of other conservation needs.

8-13. The Bureau of Reclamation, who is responsible for the sale of stored water for irrigation at government projects, receives all payments for the United States Government. That agency has filed with the State Engineer on all multiple-purpose conservation storage in five of the eight existing Willamette River Basin reservoirs: Lookout Point, Dorena, Cottage Grove, Fern Ridge, and Detroit. As of 1 December 1967, no filing has been made on storage in Hills Creek, Cougar, Fall Creek, or Green Peter projects. Filings on these latter reservoirs are temporarily being held in abeyance until the submission of the Willamette Review Report scheduled for completion in 1969. The Bureau will keep the Portland District informed of irrigation needs at those projects that have been filed on so that long-range and day-to-day reservoir releases

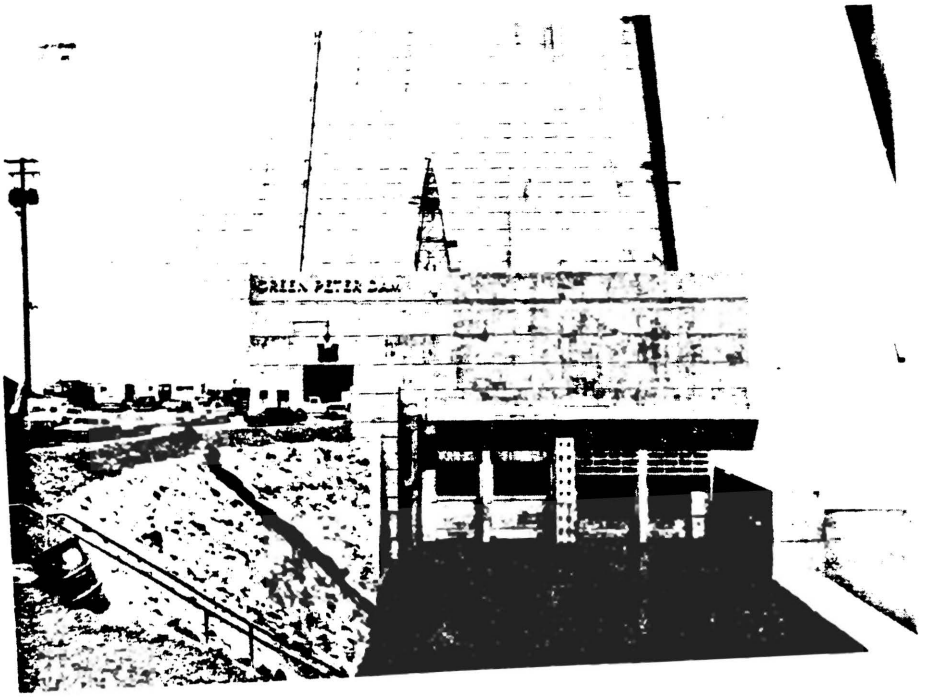
can include the irrigators' requirements. The Corps of Engineers will release stored water for irrigation at the request of the Bureau of Reclamation.

8-14. Power. - Power generated at Green Peter Dam will be integrated into the Northwest power system. The streamflow regimen of Middle Santiam River makes this arrangement highly beneficial because the Middle Santiam flows are high when flows in the Columbia are normally low. The critical power production period in the Northwest is from September through April. During the remainder of the year, power generation at Green Peter project will normally be incidental to other conservation uses. For this reason the general plan of reservoir regulation during the conservation releases season is to keep Green Peter pool high until 1 September. After that date, any release made for a conservation use other than power, will likewise benefit power. With the exception of Fern Ridge Reservoir, nonpower reservoirs in Willamette River Basin will be scheduled to augment low-water demands during July and August. Fern Ridge Reservoir is held as high as possible for recreation.

8-15. The power installation at Green Peter Dam consists of two 40,000-kilowatt power units, which will operate with heads between 319 and 185 feet. The power plant will be operated as a peaking plant with Foster Reservoir acting as a reregulating pool. Conservation storage above elevation 952, not allocated to a higher priority interest, would be available for power generation. However, the stored water above elevation 952 must be evacuated by 16 November in the interest of flood control. Between elevations 952 and 922, there are 70,000 acre-feet of secondary flood control storage which will be evacuated primarily through



DOWNSTREAM FACE



POWERHOUSE

the turbines after 16 November. A maximum of 30 days will be allowed for the evacuation of the secondary flood control storage space. This is to permit optimum use of the storage for power generation. This special operation is discussed in detail in paragraph 6-08. Storage space above elevation 952 which is adequate to regulate all but the very infrequent floods, such as the one that occurred in December 1964, will be evacuated for flood regulation prior to 16 November in accordance with the schedule shown on chart 12. Water stored above elevation 952 after 16 November, in the process of regulating a flood, will be evacuated as rapidly as downstream conditions will permit. Should a serious flood potential develop, while in the process of evacuating secondary flood control storage, stored water between elevations 952 and 922 would be evacuated immediately.

8-16. Exclusive power storage will be reserved between elevations 922 and 887. This 63,000 acre-feet of storage will be used in years of extreme power shortage. It is estimated that such a situation might occur on an average of once in a 10-year period. In a normal year the power storage will not be used, as the head is more beneficial than the stored water.

8-17. Navigation. - During the summer and early fall, low flows, which are being further depleted by pumping for irrigation, are usually inadequate for navigation. Release of stored water from Green Peter Reservoir, in conjunction with releases from other reservoirs in the Willamette River Basin, will materially increase the summer and fall low flows of Willamette River. Green Peter's contribution to navigation will be greater after 1 September, as most of the stored water in the

power reservoirs will normally be released in the fall. The nonpower reservoirs will be drafted first for irrigation, navigation, and low-water augmentation.

8-18. In the interim period before all authorized and recommended flood control dams are built, the objective will be to maintain as high a flow in Willamette River during the low-water season as is possible with the volume of stored water available, consistent with the needs of higher priority conservation functions. When all the presently authorized and recommended dams have been constructed, the goal is to maintain minimum flows of 5,000 c.f.s. at Albany and 6,000 c.f.s. at Salem which can be provided in 75 percent of the years. A simulated system operation study for 14 reservoirs in the Willamette Basin showed that these minimum scheduled flows at Albany and Salem could be maintained in all but 8 years during the period 1926-1955.

8-19. Water quality control. - Conservation releases from Green Peter Reservoir will benefit stream purification along both the Santiam River and Willamette River downstream from the mouth of Santiam River. In past years the Willamette River has been seriously polluted with domestic and industrial waste, but conditions have improved in recent years. There has been a considerable increase in the number of sewage and industrial waste treatment plants along Willamette River and its tributaries. The sewage, industrial wastes, and turbidity which still exist in the river are major problems for fish propagation, recreation, and domestic and industrial water supplies. The dilution which takes place when stored water is released from the Willamette River Basin

reservoirs during the low-water season greatly improves the quality of the river water.

8-20. No special regulation of Green Peter Reservoir is planned for water quality control, but water released for other nonconsumptive conservation uses, such as for navigation and power, will also be effective in alleviating pollution conditions in Willamette River. The maximum water needs for water quality control and navigation tend to occur simultaneously.

8-21. During the first years of operation a program to monitor the quality of the water in Green Peter Reservoir will be in effect. This is a precautionary measure to insure that the water released from Green Peter Reservoir is not lethal to downstream fish life and to ascertain the effect that the reservoir has on the quality of the water downstream from the project. The Federal Water Pollution Control Administration is taking an active part in this program.

8-22. Public use. - From a recreational standpoint it would be desirable to maintain the maximum conservation pool in Green Peter Reservoir throughout the summer. This will not be practical because other uses have a priority on the stored water. Evaporation and maintaining minimum flows for fish life will further deplete the storage several thousand acre-feet. No special regulation for recreation is contemplated, but as the larger conservation releases usually will not be made until after 1 September, the general reservoir regulation plan is favorable to recreation and public use.

8-23. Mosquito control. - There is no indication that Green Peter Reservoir will present a potential malaria hazard based on a report by

the U. S. Public Health Service for Lookout Point Reservoir which states that the area in the vicinity of the reservoir is not potentially hazardous because of the relatively steep terrain and sparse population along the reservoir shores. The terrain in the vicinity of Green Peter Reservoir is steeper than that near Lookout Point Reservoir and the population in the immediate Green Peter project area also is very sparse.

8-24. Establishment of special pool fluctuation schedules for mosquito control will be resorted to only if the mosquito problem should become serious and other control methods fail. In most years, the required conservation releases will cause Green Peter Reservoir to recede gradually during the low-water season. As the reservoir is drawn down at a more rapid rate later in the conservation release season, potential mosquito breeding areas should be eliminated.

SECTION IX - HYDROMETEOROLOGICAL FACILITIES

9-01. General. - Effective regulation of Green Peter Reservoir is dependent upon short- and long-range weather forecasts and daily quantitative precipitation forecasts for all zones in western Oregon during the rainy season, October through March. These forecasts are prepared in the Seattle office of the Weather Bureau and are relayed to the District office through the Weather Bureau office in Portland over the District teletype circuit.

9-02. In addition to the Weather Bureau weather analysis and forecasts, supplementary forecasts will be made by the District meteorologist as required. Weather maps are received in the District office over the national weather facsimile circuit, which provides service 24 hours a day, 7 days a week. Normally, one set of surface and upper air charts are received each morning, Monday through Friday. During critical flood situations additional sets of weather charts are made available at 6-hour intervals and over the weekends. In addition, there is close coordination with the local Weather Bureau offices during flood periods, so that special reservoir, hydrologic, and weather information can be interchanged with a minimum of delay.

9-03. Project weather station. - Maintenance and operation of the weather station at the Green Peter-Foster project is the responsibility of the Project Engineer. The station is located at Foster Dam and consists of an instrument shelter house, maximum and minimum thermometer, aerovane, hydrothermograph, psychrometer, manual precipitation gage, recording precipitation gage, and an evaporation pan with anemometer.

Weather stations are also operated at all manned flood control and multiple-purpose reservoirs in Willamette River Basin. The nearest first order Weather Bureau station from Green Peter project is at Salem which is about 40 miles north and west.

9-04. Precipitation stations. - A number of stations in the Santiam River Basin; namely Marion Forks, Detroit, and Detroit Dam; record both precipitation and snow data. Eleven other stations in the basin record either rain, snow, or climatological data. A station near Jordan in the North Santiam River Basin reports precipitation automatically each hour by radio to the Portland District office. The hourly precipitation reports have been most useful in regulating Detroit Reservoir for flood control, which likewise should be beneficial to the flood regulation at Green Peter Reservoir. In addition, special reports are received from several of the climatological stations, on a criteria basis. At the present time there are no reporting climatological stations located in the area tributary to Green Peter Reservoir. Precipitation data are available at Foster, elevation 550 feet, and Cascadia, elevation 796. At the present time it would be costly to establish climatological stations above Green Peter because there are no residents to hire as observers in these remote areas and communication facilities are unreliable during the flood season. When observers and communication facilities become available, climatological stations deemed necessary will be established. Locations, elevations, and periods of record of pertinent precipitation stations are shown on plate 1.

9-05. Snow courses. - Snow depth and water content of the snowpack are measured at a number of snow courses in the general area of the Green Peter Reservoir. None of these snow courses are located within the basin tributary to Green Peter Reservoir, but several are located in the North Santiam River Basin, and in adjoining areas. Snow conditions in these adjacent watersheds are considered representative of conditions at comparable elevations above Green Peter Reservoir. Locations, elevations, and periods of record of pertinent snow courses are shown on plate 1.

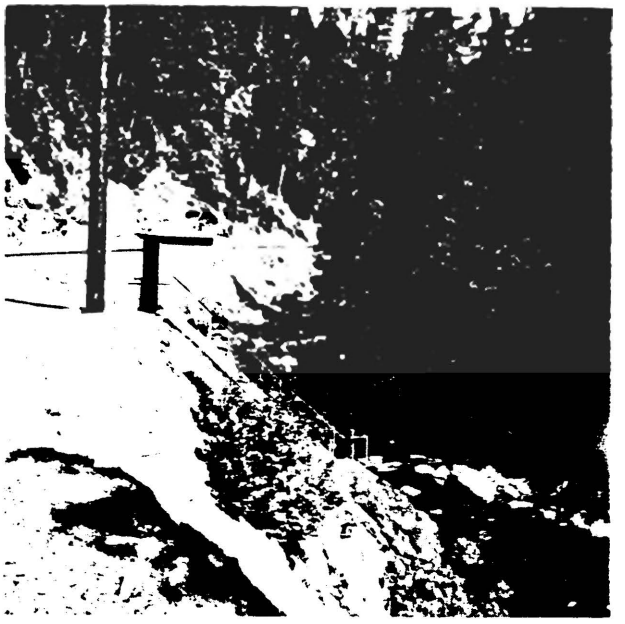
9-06. In addition to the standard snow courses, special snow measurements are made bi-monthly starting on 1 January and ending 1 May at Santiam Junction and Hogg Pass which are near the summit of passes over the Cascade Range, east of the Santiam Basin. Data from these snow courses, together with snow course data obtained at McKenzie Pass and at other locations will be utilized in estimating a profile of snow depth and water equivalent in the Green Peter Basin. Plate 1 shows the location of snow courses pertinent to the Green Peter project with the exception of those in McKenzie Pass. When necessary, reconnaissance flights will be made to determine the areal distribution of the snowpack and increase the accuracy of the forecasts of seasonal runoff from the basin above the reservoir.

9-07. Communication facilities. - A radio communication system between the Portland District office and the existing flood control and multiple-purpose dams in the Willamette Valley is now operating. This radio system supplements the commercial telephone which is used in normal communication with the dams. At the present time the commercial telephone

is still the primary means of communication with the Green Peter Dam. However, it is planned to study the feasibility of extending the radio network to include the Green Peter project.

9-08. Water stage recorders essential to the operation of the project and in the immediate vicinity of the reservoir are connected electrically to a recorder at Foster powerhouse. Composite data from these gages will be continuously recorded on charts located in the Foster powerhouse by means of telemetering equipment. Foster powerhouse is to serve as the central control point for operating all reservoirs in the South Santiam River Basin. The information in turn is transmitted by telephone or radio to the Engineering Division of the Portland District office where the data are used in formulating reservoir regulation instructions issued to the project.

9-09. There are a number of stream gaging stations in Willamette River Basin equipped with automatic telephone transmitting devices (telemarks) which transmit the gage height as a series of audible buzzes when the station is interrogated by telephone. The majority of the stations equipped with telemarks are operated by the Corps of Engineers, the remainder being operated by the U. S. Weather Bureau. The stations with telemarks which are most directly associated with the regulation of the Green Peter project are at Waterloo, approximately 20 miles downstream, at Cascadia on South Santiam River, and at Jefferson located on main Santiam River immediately below the confluence of North and South Santiam Rivers. No additional telemarks are anticipated for the Green Peter



QUARTZVILLE CREEK



MIDDLE SANTIAM RIVER

UPSTREAM GAGING STATIONS

project; however, should the need develop as a result of operating experiences, the required facilities will be provided.

9-10. Hydrologic reporting network. - Basic hydrologic data for forecasting floods and regulating the flood control reservoirs in Willamette River Basin originate from three categories of stations which go to make up the hydrologic reporting network. One group of stations is operated and financed by the Corps of Engineers as a project function. These stations are equipped with telemetering or telemarks and can be contacted without the services of an observer. Reports from this group of stations are collected by Corps of Engineers' personnel. Another group of stations, referred to as the FC-5 reporting network, is partially financed by the Corps of Engineers through a transfer of funds to the U. S. Weather Bureau who is responsible for their operation and the collection and dissemination of special reports during flood periods. Individual observers report by telephone on a criteria basis or on call. This information and that received from regular U. S. Weather Bureau stations are disseminated by teletype or telephone to those interested, which includes the Corps of Engineers. As a result of this coordinated network of reporting stations there is a free and continuous exchange of weather, reservoir, and streamflow information between the Weather Bureau and the Corps of Engineers. The following tabulation lists the stations in the reporting network that are most pertinent to the regulation of Green Peter Reservoir. Geographical location of those stations is shown on plate 1.

Station number	Station	Stream or watershed	Communication	Information reported
1859	Above Green Peter Reservoir	Quartzville Creek	Telemetering[1/]	River (reservoir inflow)
1858	Above Green Peter Reservoir	Middle Santiam R.	Telemetering[1/]	River (reservoir inflow)
	Green Peter Dam	Middle Santiam R.	Telemetering[1/]	Pool elevation
	Green Peter Dam below dam	Middle Santiam R.	Telemetering[1/]	Tailwater elevation
1850	Cascadia	South Santiam R.	Telemark[1/]	River (reservoir inflow)
	Foster Dam	South Santiam R.	Telemetering[1/]	Pool elevation
	Foster Dam below dam	South Santiam R.	Telemetering[1/]	Tailwater elevation
	Foster Dam	South Santiam R.	Telephone[2/]	Precip., temp., weather
1867	Foster Dam below dam	South Santiam R.	Telemetering[1/]	River (reservoir releases)
1875	Waterloo	South Santiam R.	Telemark[1/]	River stage
1890	Jefferson	Santiam River	Telemark[3/]	River stage
1815	Niagara	North Santiam R.	Telemetering[3/]	River (reservoir releases)
1830	Mehama	North Santiam R.	Telemetering[4/]	River stage
A	Jordan radio precipitation gage	North Santiam R.	Radio[5/]	Hourly precipitation
1910	Salem	Willamette River	Telemark[4/]	River stage

1/ Recorded at Foster Dam and relayed to District office by dam personnel.

2/ Collected and relayed to District office by dam personnel.

3/ Collected at Detroit Dam and relayed to District office by dam personnel.

4/ Collected by U. S. Weather Bureau and relayed to District office.

5/ Recorded in District office.

Tables 12 through 17 are rating tables for six gaging stations pertinent to the regulation of Green Peter Reservoir.

9-11. Data from the above stations are collected and forwarded to Portland on a daily basis, except during the summer low-water season when reports are not submitted over the weekends and holidays. Six-hour weather reports are received by Civil Aeronautics Administration teletype service from the first order Weather Bureau stations at Portland, Roseburg, Eugene, and Salem. Stream gaging stations equipped with telemarks may be called at any hour from any telephone but for reasons of economy they are usually called by the Corps of Engineers or Weather Bureau office in the vicinity of the telemark and the report transmitted to Portland as a part of a regular report, thus keeping long-distance telephone calls to a minimum. Special reports are received when the streams approach or exceed bankfull capacities, or on request.

SECTION X - RESPONSIBILITIES AND EMERGENCY INSTRUCTIONS

10-01. Organization for reservoir regulation. - Under authority contained in Sections 1 and 2 of the Flood Control Act of 22 June 1936, the Chief of Engineers is responsible for establishing overall policy for the regulation of reservoirs for flood control. In the Portland District, reservoir regulation plans and schedules for flood control projects are formulated in the Engineering Division in accordance with instructions contained in Engineering Manual 1110-2-3600, dated May 1959, and are submitted through the North Pacific Division to the Office, Chief of Engineers, for approval. Any future changes in the reservoir regulation plan that affect the authorized functions of the reservoirs, or constitute major changes in the approved regulation plan, will be submitted through the North Pacific Division to the Office, Chief of Engineers, for approval prior to field use.

10-02. Organization of the Portland District for the regulation of Green Peter project is shown on chart 27, which shows names and telephone

Coordination and liaison

are maintained with the U. S. Weather Bureau and U. S. Geological Survey at all times for the purpose of obtaining basic meteorologic and

hydrologic data essential to the regulation of Green Peter and other multiple-purpose reservoirs in Willamette River Basin.

10-03. Engineering Division. - In accordance with the provisions of Chapter 2 of EM 1110-2-3600, "Reservoir Regulation," functional regulation of Green Peter Reservoir and other multiple-purpose reservoirs in the Portland District is the responsibility of the Engineering Division with the primary responsibility delegated to the Water Control Section of the Planning Branch. Within the Water Control Section are personnel assigned to reservoir regulation and power scheduling. The project engineer at Foster Reservoir will be furnished with the names of District personnel authorized to issue reservoir regulation and power generation instructions to the project. This list will be revised as changes in personnel assigned to reservoir regulation are made. All significant reservoir regulation instructions issued by the Water Control Section will be confirmed in writing.

10-04. Duties of Engineering Division personnel assigned to regulation of Green Peter Reservoir are:

a. Develop a plan of operation including regulation schedules and rule curves which incorporates the concept of system regulation.

b. Maintain a continuing program of study to improve reservoir regulation technique and rule curves for more efficient operation of Green Peter Reservoir for flood control and conservation.

c. Prepare and distribute reservoir regulation manuals and make revisions when necessary.

d. Direct the functional regulation of the reservoir. During flood periods, Green Peter Reservoir will be subject to a 24-hour surveillance whereas water conservation is normally a day-to-day operation.

e. Develop schedules and coordinate the use of water impounded in Green Peter Reservoir. The Bureau of Reclamation is the Government agency responsible for the sale of stored water for irrigation. Stored water dispatched from Green Peter Reservoir for this purpose will be at the Bureau of Reclamation's request.

f. Develop a training program to improve technical proficiency and to enable the normal staff of reservoir regulation personnel to be supplemented during flood emergencies. Participate in mock-flood exercises to test the reservoir regulation training program, the flood emergency plan, reservoir regulation methods and schedules, and data reporting.

g. Prepare charts of Monthly Reservoir Regulation and provide applicable portions of special flood reports, survey reports, definite project reports, and design memorandums.

10-05. During the flood season, hydrologic reports are collected and analyzed on a continuous basis. Personnel assigned to reservoir regulation are responsible for keeping a constant surveillance of weather and streamflow conditions. Normally, a reduced staff is assigned to weekend and holiday duty with the off-duty personnel subject to call in an emergency. The employee on duty has authority to direct operation of the reservoir in accordance with the schedules in the manual, but is required

to obtain approval of the Chief, Water Control Section, or if he is not available, the Chief, Reservoir Regulation Subsection, before initiating significant deviations from the approved flood regulation schedules.

10-06. Operations Division. - Physical operation and maintenance of multiple-purpose projects in the Portland District is the responsibility of the Operations Division under the direct supervision of a Project Engineer, who is responsible to the Chief, Project Operations Division. The Project Engineer is also responsible for carrying out reservoir regulation instructions received from the Engineering Division through dam tenders and powerhouse operators, who normally are the direct recipients of the instructions from the District Water Control Section. All instructions pertaining to the regulation of Green Peter Reservoir shall be logged by the Foster dam attendant receiving the instructions and confirmed in writing by the party issuing the instructions. Date, time, and names of persons giving and receiving the instructions will be included in the confirmation, Form NPP FL 54 (Rev) August 1966. See chart 28.

10-07. Forms and reports. - Several reports pertaining to Green Peter-Foster project will be prepared by personnel at Foster. These reports are to keep the many interested parties informed on project activities and to provide a permanent record of these activities. In general, these reports are made on standard forms and have a prescribed distribution. Some are for project use only; others are prescribed by regulations and require off-the-project distribution. This manual is primarily concerned with those reports pertaining to flood control that

have an off-the-project distribution. The standard forms pertinent to this manual are shown in charts 28 through 32 and are listed in the following tabulation:

Forms for Reports	
Form number	Description and disposition
NPP FL 54 (Rev) August 1966	Confirmation of Reservoir and Power Regulation Instructions
Copies	2
Routing	1 - Foster Dam 1 - Office File
Frequency	Following each significant instruction to project
NPP Form 34G September 1966	Green Peter Project Daily Hydrometeorological and Power Data
Copies	3
Routing	1 - Engineering Division 1 - Operations Division 1 - File at Foster Dam
Frequency	Daily
NPP 315	Monthly Reservoir Regulation
Copies	11
Routing	1 - Office, Chief of Engineers 1 - North Pacific Division 1 - Mail and Records 1 - Operations Division 1 - Engineering Division 2 - Foster Dam 4 - Outside Agencies
Distribution will be made by Reservoir Regulation Subsection	

Forms for Reports (cont'd)	
Form number	Description and disposition
NPP 252 (Rev) RCS-NPPVK-57	Power Production Report
Copies	6
Routing	1 - Office, Chief of Engineers 1 - Multiple Purpose Projects Branch 1 - Engineering Division 1 - Operations Division 2 - Bonneville Power Administration
Frequency	Monthly
FPC No. 4 (FPC-1001)	Monthly Power Plant Report
Copies	2
Routing	1 - Federal Power Commission 1 - Foster Project Office
Frequency	Monthly

10-08. Responsibilities for maintenance of hydrologic and meteorologic stations. - Maintenance and operation of the weather station at Foster project is the responsibility of the Project Engineer at Foster. Project personnel at Foster will receive instructions from the U. S. Weather Bureau and the Reservoir Regulation Subsection regarding the method of taking and recording observations. They will also collect and transmit river and reservoir stage data used in the regulation of Green Peter Reservoir to the Reservoir Regulation Subsection. Project personnel will be responsible for making occasional inspection of the water stage and weather stations and will report to the Reservoir Regulation Subsection any equipment malfunction they are unable to repair.

In addition, the project personnel will take special observations as needed by the Reservoir Regulation Subsection for study purposes.

10-09. The Corps of Engineers contributes funds to the U. S. Weather Bureau and U. S. Geological Survey for installing, servicing, maintaining, processing, and disseminating hydrologic and meteorologic data required for the regulation of Green Peter Reservoir. Each agency inspects the condition of the equipment in which it has a direct interest from time to time and makes the necessary repairs and replacements deemed necessary to minimize failures. They also are responsible for instructing the project personnel regarding the care and operation of those instruments in the immediate vicinity of the project and the procedure in taking and recording observations. All supplies, such as parts, charts, forms, etc., necessary for recording and disseminating the hydrologic and meteorologic data are furnished by these agencies. They also supply the Corps of Engineers with special reports and publications needed in the regulation of Green Peter project and the study of special problems.

10-10. Collection and transmission of data. - The following hydrologic and power generation data are collected and transmitted to the Reservoir Regulation Subsection in the District office.

a. Reservoir inflow, outflow, and pool elevation. These data are automatically recorded in the Foster powerhouse control room.

b. Gross and net hourly power generation delivered to Bonneville Power Administration.

c. Weather data including precipitation, current weather conditions, maximum and minimum air temperatures, and wind, observed at Foster, the control center for the Green Peter-Foster project.

d. Temperature of released water.

10-11. During major storm periods, meteorological and hydrological reports may be required at 3-hour intervals, particularly if the special flood regulation curves are being used. Generally, 6-hour reports are adequate for flood regulation. In special situations similar to December 1964, reports at 2-hour intervals will be requested. During nonflood periods, daily reports are adequate. Special river and weather reports are sent to the Reservoir Regulation Subsection on request.

10-12. For the immediate future, the telephone will be the principal means of communicating between Foster Dam and the District office. At a later date radio will be provided to back up the telephone and for emergency situations when the normal communications are not functioning.

10-13. Emergency instructions. - It is impossible to anticipate every unusual flood, power emergency, or combination of events that will require special regulation; therefore, general instructions are provided in the following paragraphs for such contingencies. Should an emergency develop or appear imminent, the Project Engineer at Foster, or a subordinate, will promptly contact the District office, report existing field conditions and request instructions. In the event of a communication failure, repeated efforts will be made to contact the District office. If all efforts fail, the decision as to the action to be taken must be made in the field. Should such an event occur, all circumstances

and emergency actions taken will be reported in writing as soon as possible.

10-14. Should communications to Portland fail during a flood, but remain operative to the stream-gaging stations at Green Peter, Waterloo, and the inflow stations, the Project Engineer or an authorized representative will direct the regulation of Green Peter Reservoir, using the schedules shown on chart 17 or 18, whichever is applicable. Foster weather station will be used in computing the precipitation index.

10-15. Should the remote control facilities or communication facilities between Foster and Green Peter Dams fail during a major flood, the Project Engineer will dispatch an employee to Green Peter who is familiar with and capable of regulating the project as specified in this manual. During an emergency, the employee dispatched to Green Peter will operate it as follows:

a. Reduce the outflow to 100 c.f.s. immediately upon arrival at the project.

b. Determine the inflow. Use upstream gage data if available. If inflow data are not available, compute the inflow by means of the storage equation using chart 19.

c. Consult special curves. Every 2 hours, consult chart 18, and if the curves are applicable, adjust the reservoir release as indicated. Enter the curve with the current pool elevation and the average inflow for the preceding 3 hours to determine the required reservoir release.

d. Repeat step "c" every 2 hours, or until communications with Foster have been restored.

e. Limit any increase in release indicated by the special regulation curves so as not to exceed 2,500 c.f.s. in any 1-hour period.

f. Maintain a continuous hydrograph of computed or observed inflows as a check on the latest computed inflow. A graph of this type provides a simple tool for forecasting 12 to 24 hours in advance.

10-16. During the period that special regulation curves are applicable, the reservoir release will be determined every 2 hours on the average inflow for the preceding 2 hours and the current reservoir elevation. Adjustments, however, should not increase the outflow by more than 2,500 c.f.s. in any 1-hour period.

10-17. After the reservoir reaches maximum elevation, maintain that elevation by adjusting the reservoir release to equal the reservoir inflow until post-flood evacuation is initiated.

10-18. National emergency. - If all personnel are ordered to retire from the project during a national emergency, the outlets at Green Peter Reservoir should be adjusted to discharge the following flows before leaving the project:

June - October	1,000 c.f.s.
November - May	3,500 c.f.s.

At the same time the release at Green Peter is adjusted the release at Foster Reservoir should be adjusted to the following releases:

June - October	1,500 c.f.s.
November - May	5,000 c.f.s.

TABLE 1

Station, Quartzville 13 SW County, Linn State, Oregon

Latitude, 44° 29' Longitude, 122° 30' Elevation, 823 feet

Data, Precipitation 1939-1961 = 23 years

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL
1939	--	15.74	8.14	1.91	3.15	4.14	1.06	2 18	0.31	10.65	3.18	16.32	---
40	7.06	23.69	11.62	5.98	2.76	.44	2.41	.17	6.50	8.43	15.67	8.77	93.50
41	12.02	3.99	3.14	2.91	10.55	3.66	.03	2.99	9.01	6.20	13.09	19.79	87.38
42	7.51	8.88	4.01	4.23	7.42	---	1.03	.03	.30	8.27	26.75	25.65	---
43	12.47	6.87	11.50	7.55	4.01	4.50	.68	2.66	4.01	8.49	6.64	4.32	73.71
44	6.49	8.45	5.88	8.14	3.41	2.41	.15	.05	4.70	1.75	8.98	4.59	55.00
45	11.17	11.88	10.89	9.28	7.92	--	--	.78	4.81	2.86	18.00	14.00	---
46	12.34	9.72	11.76	4.39	1.61	3.53	1.12	.17	2.68	11.51	12.16	18.31	89.30
47	9.12	2.37	10.00	7.83	.53	8.15	2.72	.88	--	15.33	12.27	9.38	---
48	11.37	16.48	9.41	7.86	--	--	1.63	2.40	5.78	5.36	13.81	22.36	---
49	3.99	23.53	6.71	3.35	7.07	2.01	.49	.20	2.41	7.98	10.57	13.06	81.37
1950	20.52	13.00	14.64	6.43	2.74	2.95	.40	1.69	2.16	20.48	15.82	15.71	116.54
51	20.97	10.04	10.57	2.24	4.68	T	.17	.90	2.49	16.98	12.22	15.80	97.06
52	9.85	10.84	10.25	2.52	2.12	5.80	0	.31	1.63	.91	2.38	13.82	60.43
53	27.39	15.73	11.01	5.80	8.41	4.18	.06	3.15	2.77	4.89	18.60	21.02	123.01
54	18.75	8.43	6.02	7.76	3.08	5.46	1.11	2.49	4.19	6.29	7.00	15.29	85.87
55	7.18	7.14	15.41	13.61	3.25	2.20	2.56	0	3.74	14.58	16.33	24.25	110.24
56	18.51	10.26	13.87	2.98	3.80	3.04	.05	1.14	1.21	13.63	3.64	17.07	89.20
57	5.85	12.14	15.41	4.84	4.81	2.61	.60	1.58	1.05	6.31	6.87	22.79	84.86
58	14.11	13.12	4.44	9.11	1.85	4.82	.11	.42	3.50	4.32	19.70	13.33	88.83
59	17.56	6.57	10.43	5.00	7.13	3.05	1.12	.25	8.69	9.58	7.53	5.43	82.34
1960	7.43	11.15	14.41	8.98	11.39	1.20	.05	2.84	1.40	8.31	18.73	6.74	92.63
61	8.26	20.65	14.18	4.54	5.29	.92	.50	.77	4.84	9.03	11.07	14.75	94.80
	(Discontinued)												
Ave.	12.27	11.77	10.16	5.97	4.86	3.25	.82	1.24	3.55	8.79	12.22	14.89	89.79
Max	27.39	23.69	15.41	13.61	11.39	8.15	2.72	3.15	9.01	20.48	26.75	25.65	123.01
Year	1953	1940	1957	1955	1960	1947	1947	1953	1941	1950	1942	1942	1953
Min	3.99	2.37	3.14	1.91	.53	T	0	0	.30	.91	2.38	4.32	55.00
Year	1949	1947	1941	1939	1947	1951	1952	1955	1942	1952	1952	1943	1944

TABLE 2

Climatological Summary
Cascadia State Park, Oregon
(Elevation 850 feet m. s. l.)

Item and Description	Yrs of Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Precipitation, Inches														
Average, normal inches	1931-1960	8.31	6.97	7.32	4.83	3.93	3.05	0.57	0.82	2.23	5.84	8.05	9.34	61.26
Percent of normal annual		14	11	12	8	6	5	1	1	4	10	13	15	100
Maximum	1908-1965	15.82	15.83	13.00	10.38	9.97	7.09	4.06	5.46	9.78	15.58	20.91	20.45	82.02
Year of maximum		1965	1961	1916	1937	1915	1937	1916	1912	1920	1950	1942	1964	1950
Minimum	1908-1965	3.07	0.63	1.54	1.28	0.84	0.02	0	0	0.02	0.11	0.67	2.24	39.86
Year of minimum		1963	1920	1965	1951	1947	1951	1952+	1930+	1942	1917	1936	1914	1944
Greatest in 24 hours	1908-1965	4.00	3.46	3.10	2.19	1.92	1.92	1.51	1.89	2.87	3.32	4.69	3.90	4.69
Year of greatest 24 hours		1923	1961	1952	1914	1950	1952	1909	1912	1920	1955	1921	1929	Nov. 1921
Avg. no. days with .01 or more	1919-1965	19	18	19	16	13	10	3	4	7	12	16	19	156
Average snowfall	1914-1965	6.9	1.7	2.1	0.1	0	0	0	0	0	T	T	1.6	12.4
Maximum snowfall	1914-1965	56.7	9.7	29.2	2.0	T	T	0	T	0	1.0	4.0	12.0	37.7
Year of maximum snowfall		1950	1938	1951	1963+	1965+	1960		1951		1935	1961	1942	1937
Greatest 24 hour snowfall														
Year of greatest 24 hour snowfall														
Temperature, °F														
Average	1919-1965	37.1	39.9	44.1	49.8	53.2	60.3	65.1	64.8	60.2	52.1	43.5	39.7	50.8
Average of daily maximum	1929-1965	44.6	50.1	54.2	62.7	67.6	74.2	81.9	81.6	76.0	64.4	51.6	46.6	63.0
Average daily minimum	1929-1965	29.8	32.3	33.8	37.8	41.7	44.7	48.1	47.3	44.1	39.8	34.4	32.9	38.9
Absolute maximum	1919-1965	73	73	85	94	97	101	106	104	102	92	79	69	106
Year of absolute maximum		1961	1952	1923	1947	1963	1951+	1946	1944	1944	1952+	1923	1962	Jul 1946
Absolute minimum	1919-1965	1	4	19	24	25	32	33	34	26	24	11	1	1
Year of absolute minimum		1950	1950	1955	1951+	1954	1955+	1953	1965	1965	1954+	1952	1932	Jan 1950+

+ Earlier years also

TABLE 3

Climatological Summary
Salem, Oregon
(Elevation, 196 feet)

Item and Description	Period of record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
						Precipitation, Inches								
Normal	1931-1960	6.70	5.31	4.68	2.23	2.11	1.45	0.35	0 45	1.38	3.91	5.71	7.37	41.75
Percent of normal annual		16	13	11	5	5	4	1	1	3	9	14	18	100
Maximum	1893-1965	15.40	12.31	10.13	7.68	6.23	4.61	2.72	2.91	4.84	11.17	16.99	17.54	17.54
Year of maximum		1953	1949	1894	1937	1895	1937	1916	1899	1914	1947	1896	1933	Dec. 1933
Minimum	1893-1965	0.57	0.34	0.59	0.39	0.18	0.00	0.00	0.00	0.01	0.00	0.48	1.95	0.00
Year of minimum		1949	1920	1911	1939	1947	1918	1952	1928+	1942+	1917+	1936	1903	Jul 1952+
Greatest in 24 hours	1893-1965	3.86	3.16	3.03	2.21	1.84	1.60	1.12	1.25	2.11	2.84	3.60	4.30	4.30
Year of greatest 24 hours		1911	1949	1943	1937	1963	1950	1909	1943	1911	1955	1896	1933	Dec. 1933
Avg. No. days with .01 or more	1893-1965	18	16	17	13	11	8	2	3	7	12	17	19	146
Average snowfall	1910-1965	3.3	1.2	0.6	T	T	0.0	0.0	0.0	0.0	0.1	0.1	1.5	6.8
Maximum snowfall	1893-1965	32.8	25.2	10.9	T	T	T	0.0	T	0.0	5.0	5.8	23.0	32.8
Year of maximum snowfall		1950	1937	1951	1963+	1964+	1952	—	1951	—	1935	1955	1919	Jan. 1950
Greatest 24 hour snowfall	1893-1965	11.0	25.0	8.5	T	T	T	0.0	T	0.0	5.0	4.0	17.5	25.0
Year of greatest 24 hour snowfall		1930	1937	1960	1963+	1964+	1952	—	1951	—	1935	1955	1919	1937
						Temperature, Degrees F.								
Normal	1931-1960	38.5	41.9	45.3	51.1	56.3	60.6	66.1	66.1	62.5	54.1	45.2	41.5	52.4
Normal daily maximum	1931-1960	45.5	50.3	55.1	62.5	68.3	73.4	81.7	80.8	76.8	65.7	53.8	48.6	63.5
Normal daily minimum	1931-1960	31.5	33.5	35.5	39.6	44.2	47.8	50.4	51.3	48.1	42.5	36.6	34.3	41.3
Absolute maximum	1893-1965	68	68	80	93	95	102	108	105	103	92	70	72	108
Year of absolute maximum		1899+	1932+	1947+	1926	1956	1942	1941+	1920	1944	1932	1927	1929	Jul 1941+
Absolute minimum	1893-1965	-10	-4	22	24	25	32	35	30	26	23	9	-6	-10
Year of absolute minimum		1950	1950	1965+	1935	1954	1899	1932+	1920	1934	1902+	1955	1919	Jan 1950
						Miscellaneous Data								
Average number of days clear	1893-1965	3	4	5	6	7	9	17	16	13	8	4	3	96
Average number of days partly cldy	1893-1965	6	5	7	8	8	7	7	8	8	8	5	4	82
Average number of days cloudy	1893-1965	22	19	19	16	16	14	6	7	9	15	20	24	188
Average hourly wind speed, MPH	1848-1965	8.8	8.1	8.4	7.4	6.6	6.5	6.6	6.4	6.2	6.5	7.7	8.1	7.3
Prevailing wind direction	1893-1965	S	S	S	S	S	S	N	NW	S	S	S	S	S

+ Also on earlier dates.

TABLE 4

Climatological Summary of Selected Stations
Santiam River Basin

Item	Station, Elevation, and Period of Record				
	Quartzville 823 ft. 1939-1961	Cascadia State Park 850 ft. 1908-1965	Waterloo 420 ft. 1924-1965	Lacomb 665 ft. 1940-1965	Detroit 1590 ft. 1902-1965
Precipitation					
Average annual precipitation, inches	89.79	61.26	44.08	48.87	73.61
Maximum annual precipitation, inches	123.01	82.02	64.20	60.62	109.13
Year of maximum annual precipitation	1953	1950	1937	1950	1950
Minimum annual precipitation, inches	55.00	39.86	28.51	38.48	43.55
Year of minimum annual precipitation	1944	1944	1930	1949	1918
Maximum monthly precipitation, inches	27.39	20.91	15.75	14.81	30.86
Month and year of maximum monthly precipitation	Jan. 1953	Nov. 1942	Dec. 1955	Dec. 1964	Dec. 1964
Maximum 1-day recorded precipitation inches	4.58	4.69	4.04	3.60	5.37
Month and year of maximum 1-day precipitation	Dec. 1945	Nov. 1921	Feb. 1949	Feb. 1949	Jan. 1965
Greatest seasonal snowfall, inches	25.0	68.0	12.3	19.3	195.0
Season of greatest snowfall	1955-56	1916	1950-51	1955-56	1915-16
Temperature					
Average annual temperature, °F.	No temp. data available	50.8	No temp. data available	51.6	49.5
Average annual maximum temperature, °F.		63.0		61.8	61.0
Average annual minimum temperature, °F.		38.9		40.9	36.8
Absolute maximum temperature, °F.		106		104	107
Month and year of maximum temperature		July 1946		July 1958	June 1961
Absolute minimum temperature, °F.		1		0	-10
Month and year of minimum temperature		Jan. 1950		Feb. 1950	Feb. 1950
January average temperature, °F.		37.1		38.3	34.2
July average temperature, °F.		65.1		65.1	64.4

July 1966
JDH

TABLE 5

SNOW SURVEY SUMMARY
(Record through 1966)

Snow Course	Hogg Pass	Marion Forks	McKenzie Pass	Santiam Junction
Elevation, feet, m.s.l.	4755	2730	4800	3990
February 1				
Length of record, years	29	25	23	26
Average snow depth, inches	78	29	73	47
Average water equivalent, inches	26.5	9.4	27.2	16.5
Highest water equivalent, inches	49.1	27.9	42.7	36.5
Year of highest	1952	1950	1956 1/	1952
Lowest water equivalent, inches	7.0	0.6	5.1	1.1
Year of lowest	1963	1945	1940	1963
March 1				
Length of record, years	26	25	18	26
Average snow depth, inches	94	31	102	53
Average water equivalent, inches	36.2	12.6	40.0	20.8
Highest water equivalent, inches	70.9	32.9	64.2	44.6
Year of highest	1949	1949	1949	1949
Lowest water equivalent, inches	7.5	0	8.0	0
Year of lowest	1963	1963	1963	1963
April 1				
Length of record, years	29	25	27	26
Average snow depth, inches	106	30	104	56
Average water equivalent, inches	43.7	13.2	44.6	24.2
Highest water equivalent, inches	73.5	32.8	70.5	45.7
Year of highest	1956	1950	1956	1956
Lowest water equivalent, inches	11.5	0	12.6	0
Year of lowest	1963	1963 1/	1963	1941

1/ Earlier years also.

July 1966 S.M.

TABLE 6

Evaporation and Related Data

Item	Yrs Rec.[1]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
						FERN RIDGE RESERVOIR								
Average wind [2,3] speed (m.p.h.)	23	2.31	2.03	2.62	2.49	2.26	2.16	2.34	2.24	2.18	1.85	1.71	2.17	2.19
Mean air temperature	22	38.5	42.3	44.5	49.8	55.2	60.5	63.0	65.7	62.1	53.6	45.1	41.0	51.8
Class A Pan evaporation(ins.)[3]	23	0.36	0.73	1.69	2.86	4.84	5.81	8.13	6.79	4.60	1.80	0.55	0.37	38.53
						GREEN PETER RESERVOIR								
Pan coefficient[4]		0.76	0.13	0.51	0.39	0.52	0.65	0.67	0.77	0.93	0.90	1.32	1.06	
Evaporation[5] inches		0.27	0.09	0.86	1.12	2.52	3.78	5.45	5.23	4.28	1.62	0.73	0.39	26.34
Evaporation[5] acre-feet		50	20	100	300	800	1260	1730	1570	1180	400	160	80	7650

NOTES:

1. Record thru 1965.
2. Wind speed 6" above evaporation pan.
3. No record of evaporation and wind speed Oct thru March 1944 - 51 and 1956 - 63.
4. Pan coefficients are based on "Lake Heffner Study", U. S. Geological Survey Professional Paper No. 269.
5. Based on average scheduled pool elevations at Green Peter Reservoir.

July 1966
JDH

TABLE 6

Gage Established _____ Stream Middle Santiam River
Datum m.s.l. Station Green Peter Dam Site
Drainage Area 277 sq.mi.

Date 6/20/66
By HCL
CK. BHB
Sheet 1 of 2

Water Year	Discharge in _____ c.f.s. Mean Monthly												Mean Ann.	Extremes of Discharge									Annual Run-off	
														Max. Inst.			Max. Daily			Minimun				
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.		Date	Stage Ft.	Q c.f.s.	Date		Q c.f.s.	Date		Q c.f.s.	Ac. Ft.	Inches
1926	80	555	2170	1370	4670	1270	570	660	275	100	150	325	1016										735,600	49.79
1927	1030	3090	2280	3140	4770	1970	1670	1970	1550	295	130	530	1869										1,353,200	91.60
1928	1620	4560	2180	3250	930	3750	2840	1080	290	175	90	95	1722										1,250,200	84.63
1929	245	875	1370	1570	1000	2740	2740	1980	1120	250	125	85	1195										850,700	57.58
1930	90	70	2430	830	3910	1350	860	1120	690	185	100	95	977										707,300	47.88
1931	215	900	940	1420	710	2690	2840	470	445	190	90	90	900										651,600	44.11
1932	430	1620	2060	2600	1500	6100	2750	2090	1060	280	130	90	1726										1,253,100	84.82
1933	305	1730	2440	2330	1550	2660	2660	3100	3580	620	175	390	1878										1,359,700	92.04
1934	520	820	5700	4120	790	1970	1250	625	285	145	90	85	1367										989,700	66.99
1935	990	3460	3320	2100	2300	1840	2200	1440	540	230	100	90	1551										1,122,900	76.01
1936	250	700	1070	5430	1840	2000	2100	1760	730	270	125	125	1367										992,400	67.18
1937	75	70	1030	500	1850	2960	4100	2980	2230	460	190	140	1382										1,000,600	67.73
1938	580	3400	3200	3340	2030	3120	3250	1750	500	175	100	95	1795										1,299,600	87.97
1939	155	1950	2300	1710	2340	3000	1850	810	680	270	120	105	1232										892,000	60.38
1940	345	210	2120	1460	4100	2550	1250	755	225	130	80	120	1111										804,600	54.60
1941	320	1900	1670	2320	890	655	555	1170	645	265	160	590	928										671,900	45.48
1942	590	1840	3480	1820	2030	1320	930	1260	980	395	160	90	1241										898,500	60.82
1943	155	5470	5820	3260	3660	2030	3050	1230	1340	405	195	120	2228										1,613,100	109.19
1944	930	1260	1150	1090	1530	1380	1800	960	590	205	110	140	929										674,500	45.66
1945	135	755	590	2530	3670	2130	2690	2680	570	190	110	155	1350										977,400	66.16
1946	110	3070	4560	3420	2120	2710	1870	1400	790	340	135	130	1721										1,246,000	84.34
1947	960	3500	4800	2050	2700	2280	2430	495	1240	410	205	180	1771										1,282,200	86.79
1948	2950	3450	1800	4060	3200	1880	2380	2240	865	295	170	245	1961										1,423,700	96.37
1949	730	1980	4060	815	4060	2440	2330	2900	620	205	115	130	1699										1,230,100	83.27
1950	590	1370	1930	2840	4190	3950	2640	2300	1720	485	175	135	1860										1,346,600	91.15
Total																								
Mean																								
Max.																								
Min.																								

Remarks: See note on sheet 2

Sheet 1

TABLE 7

Gage Established _____ Stream Middle Santiam River Date 6/22/66
Datum m.s.l. Station Green Peter Dam Site By HCL
Drainage Area 277 sq.mi. CK. BHB
Sheet 2 of 2

Water Year	Discharge in c.f.s. Mean Monthly													Extremes of Discharge									Annual Run-off	
														Max. Inst.			Max. Daily			Minimum				
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Mean Ann.	Date	Stage Ft.	Q c.f.s.	Date		Q c.f.s.	Date		Q c.f.s.	Ac. Ft.	Inches
1951	2540	4300	3200	4420	3440	1810	1970	1500	370	175	110	100	1995										1,444,400	97.77
1952	2280	2100	3150	1400	3400	2180	2560	1630	900	475	165	125	1697										1,232,000	83.40
1953	85	125	1360	7150	4660	2040	1850	2400	1360	365	230	150	1815										1,314,100	88.95
1954	440	3270	5420	3530	3540	1580	2520	835	1270	410	220	360	1950										1,411,800	95.57
1955	695	1130	2200	1890	2010	2030	2890	2850	2130	700	210	220	1580										1,143,900	77.43
1956	1730	4605	6550	4640	1275	2710	3215	2365	1195	335	160	110	2407										1,747,500	118.29
1957	825	1445	3900	900	3310	3965	2060	1105	555	220	155	100	1545										1,118,600	75.72
1958	365	1110	5160	3705	4045	1280	2900	880	730	280	135	150	1728										1,251,100	84.69
1959	250	3940	2815	3920	2045	2230	2080	1930	795	285	140	740	1964										1,277,100	86.45
1960	1760	1490	1105	1155	3145	3425	3045	2980	880	240	180	145	1629										1,182,700	80.06
1961	430	4460	1905	2025	6330	3680	1760	1745	490	180	110	205	1943										1,406,700	95.22
1962	750	2350	4285	1910	1605	2555	3385	1900	690	225	195	205	1671										1,209,800	81.89
1963	1280	2890	2435	750	3400	1500	2595	2390	505	415	180	225	1549										1,120,000	75.81
1964	390	3425	1620	3565	1945	2175	2195	2050	1665	410	215	165	1652										1,199,400	81.19
Total	28,220	85,745	103,375	100,325	106,490	93,905	88,630	65,785	37,095	11,685	5,735	7,375	61,679										44,688,300	3024.98
Mean	724	2,199	2651	2572	2730	2408	2272	1681	951	300	147	189	1581										1,145,800	77.56
Max.	2950	5470	6550	7150	6330	6100	4100	3100	3580	700	230	740	2407										1,747,500	118.29
Min.	75	70	590	500	710	655	555	470	225	100	80	85	900										651,600	44.11

Remarks: Mean monthly discharges estimated from records observed on the Middle and South Santiam Rivers.

Sheet 2

TABLE 7

TABLE 8

MAXIMUM ANNUAL INSTANTANEOUS DISCHARGES

SOUTH SANTIAM RIVER BASIN

Water Year	Date	Discharge in C. F. S.						Remarks
		South Santiam River			Middle Santiam River		Wiley Creek near Foster	
		At Waterloo Obs. (643)	At Foster D.S. Est. (494)	Below Cascadia Obs. (174)	At Mouth Obs.[1] (272)[1] (267)	At Green Peter D.S. Est. (277)	Obs. (52)	
1926	Jan. 24	14,000						Note: Extremes of observed record are underlined.
1927	Feb. 5	41,500						
1924	Dec. 6	36,000	31,500			22,700		
1925	Nov. 22	29,100	24,000			18,400		1/ For period 1926 to 1947 inclusive, station was located 6 miles upstream from mouth.
1926	Feb. 6	33,800	29,800			21,900		
1927	Feb. 21	60,000	51,800			35,000		
1928	Nov. 25	38,400	33,800			23,400		2/ Peak flows on Middle Santiam River for period of no record were estimated from correlation curve.
1929	Mar. 21	21,200	19,400			13,600		
1930	Dec. 18	38,800	34,000			25,800		
1931	Mar. 31	70,000	60,000			40,500		3/ Dates of maximum flows which differ from those in the table are:
1932	Mar. 18	47,800	41,500		29,500	30,700		
1933	June 9	25,800	21,400		19,300	19,600		Water Year — Date
1934	Dec. 22	24,600	22,400		26,100	26,500		1941 — Feb. 28
1935	Dec. 20	29,400	27,100		21,700	22,100		1943 — Dec. 2
1936	Jan. 4	37,200	34,000	9,200	24,000	24,700		1944 — Jan. 22
1937	Apr. 15	34,500	30,000	9,200	19,400	19,700		1945 — Nov. 23
1938	Jan. 22	37,800	34,000	10,700	24,500	24,700		1946 — Nov. 29
1939	Feb. 15	23,800	22,000	5,700	21,400	15,700		1947 — (Feb. 5)
1940	Feb. 6	12,600	10,500	4,200	11,100	11,500		1948 — (Mar. 7)
1941	Nov. 29	19,500	18,000	4,800	13,200	13,500		1964 — Jan. 19
1942	Nov. 19	30,500	28,500	9,200	19,100	19,700		
1943	Jan. 1	60,700	52,600	17,000	33,800	34,300		
1944	Nov. 4	24,600	22,800	5,850	14,800	15,300		
1945	Feb. 8	32,500	29,000	8,577	19,600	19,900		
1946	Dec. 26	7-,[illegible]	[illegible]	23,400	42,500	42,500		
1947	Dec. 14	48,100	41,500	13,900	26,600	27,100		
1948	Jan. 7	58,800	51,300	17,600	35,800	34,300	5,410	
1949	Dec. 12	41,700	40,000	12,900	26,400	27,500	4,500	
1950	Feb. 25	42,000	37,000	10,000	27,100	26,100	4,000	
1951	Nov. 2	45,400	38,600	15,000	26,500	28,000	3,630	
1952	Oct. 28	27,000	24,400	7,700	16,900	16,000	2,960	
1953	Jan. 18	57,700	51,000	17,000	36,400	34,000	4,520	
1954	Nov. 22	61,000	53,700	18,900	38,400	37,400	5,200	
1955	Dec. 31	36,900	33,000	11,400	24,700	23,900	2,310	
1956	Dec. 22	62,800	55,000	20,900	38,500	34,700	6,290	
1957	Dec. 11	69,800	59,000	24,000	42,000	39,000	5,140	
1958	Dec. 20	55,500	46,000	17,800	30,700	30,500	4,820	
1959	Nov. 19	36,400	32,000	9,470	21,400	20,800	2,770	
1960	Feb. 8	20,700	13,000	6,880	12,200	11,800	1,610	
1961	Feb. 10	69,200	58,000	18,900	35,400	34,500	6,860	
1962	Nov. 22	34,900	31,000	11,400	26,000	27,000	2,600	
1963	Nov. 20	28,900	25,000	8,280	20,400	25,700	2,130	
1964	Nov. 8	33,100	28,8[illegible]	11,100	17,000	16,500	3,180	
1965	Dec. 22	85,500	84,000	27,600	67,800	66,000	8,370	

TABLE 9

GREEN PETER RESERVOIR

Service Outlet Rating Table

(Single Gate)

Gate Opening ft.	Pool Elevation in Feet, M.S.L.												Gate Opening ft.
	910	920	930	940	950	960	970	980	990	1000	1010	1015	
0.1	41	43	44	45	46	47	48	49	51	52	53	53	0.1
0.2	83	85	88	90	92	95	97	99	101	103	105	106	0.2
0.3	124	128	131	135	138	142	145	148	152	155	158	159	0.3
0.4	166	170	175	180	184	189	194	198	202	206	210	212	0.4
0.5	207	213	219	225	231	237	242	247	253	258	263	265	0.5
0.6	248	256	263	270	277	284	290	296	303	309	315	318	0.6
0.7	290	298	307	315	323	331	339	346	354	361	368	371	0.7
0.8	331	341	350	360	369	378	387	395	404	412	420	424	0.8
0.9	373	383	394	405	415	426	436	445	455	464	473	477	0.9
1.0	414	426	438	450	461	473	484	494	505	515	525	530	1.0
1.1	455	468	482	495	507	520	532	543	555	566	577	583	1.1
1.2	496	511	525	540	553	567	580	592	605	618	630	636	1.2
1.3	538	553	569	584	599	614	628	642	656	669	682	688	1.3
1.4	579	596	612	629	645	661	676	691	706	720	734	741	1.4
1.5	620	638	656	674	691	708	725	740	756	772	787	794	1.5
1.6	661	680	700	719	737	755	773	789	806	823	839	847	1.6
1.7	702	723	743	764	783	802	821	838	856	874	891	900	1.7
1.8	744	765	787	808	829	849	869	888	907	925	943	952	1.8
1.9	785	808	830	853	875	896	917	937	957	977	996	1005	1.9
2.0	826	850	874	898	921	943	965	986	1007	1028	1048	1058	2.0
2.1	868	893	919	944	968	991	1014	1036	1059	1081	1102	1112	2.1
2.2	910	937	963	990	1015	1039	1064	1087	1110	1133	1155	1166	2.2
2.3	952	980	1008	1035	1062	1086	1113	1137	1162	1186	1209	1220	2.3
2.4	994	1024	1052	1081	1109	1136	1162	1188	1213	1238	1262	1274	2.4
2.5	1037	1067	1097	1127	1156	1184	1212	1238	1265	1291	1316	1328	2.5
2.6	1079	1110	1142	1173	1203	1232	1261	1288	1316	1343	1370	1383	2.6
2.7	1121	1154	1186	1219	1250	1280	1310	1339	1368	1396	1423	1437	2.7
2.8	1163	1197	1231	1264	1297	1329	1359	1389	1419	1448	1477	1491	2.8
2.9	1205	1241	1275	1310	1344	1377	1409	1440	1471	1501	1530	1545	2.9
3.0	1247	1284	1320	1356	1391	1425	1458	1490	1522	1553	1584	1599	3.0
3.1	1288	1326	1364	1401	1437	1472	1506	1539	1572	1604	1636	1652	3.1
3.2	1329	1369	1407	1445	1483	1519	1554	1588	1622	1655	1689	1705	3.2
3.3	1370	1411	1451	1490	1528	1566	1602	1638	1672	1707	1741	1758	3.3
3.4	1411	1453	1494	1535	1574	1613	1650	1687	1722	1758	1794	1811	3.4
3.5	1453	1496	1538	1580	1620	1660	1699	1736	1773	1809	1846	1864	3.5
3.6	1494	1538	1581	1624	1666	1707	1747	1785	1823	1860	1898	1916	3.6
3.7	1535	1580	1625	1669	1712	1754	1795	1834	1873	1911	1951	1969	3.7
3.8	1576	1622	1668	1714	1757	1801	1843	1884	1923	1963	2003	2022	3.8
3.9	1617	1665	1712	1758	1803	1848	1891	1933	1973	2014	2056	2075	3.9
4.0	1658	1707	1755	1803	1849	1895	1939	1982	2023	2065	2108	2128	4.0
4.1	1701	1752	1801	1850	1897	1945	1990	2034	2076	2119	2163	2184	4.1
4.2	1744	1796	1847	1897	1946	1994	2040	2086	2129	2173	2218	2239	4.2
4.3	1788	1841	1893	1945	1994	2044	2091	2137	2182	2227	2273	2295	4.3
4.4	1831	1885	1938	1992	2042	2093	2142	2189	2235	2281	2328	2350	4.4
4.5	1874	1930	1985	2039	2091	2143	2193	2241	2288	2335	2384	2406	4.5
4.6	1917	1975	2030	2086	2139	2192	2243	2293	2341	2389	2439	2462	4.6
4.7	1960	2019	2076	2133	2187	2242	2294	2345	2394	2443	2494	2517	4.7
4.8	2004	2064	2122	2181	2235	2291	2345	2396	2447	2497	2549	2573	4.8
4.9	2047	2108	2168	2228	2284	2341	2395	2448	2500	2551	2604	2628	4.9
5.0	2090	2153	2214	2275	2332	2390	2446	2500	2553	2605	2659	2684	5.0
5.5	2324	2395	2464	2532	2596	2660	2722	2783	2841	2900	2960	2987	5.5
6.0	2558	2636	2713	2788	2859	2929	2998	3065	3129	3194	3261	3290	6.0
6.5	2793	2869	2954	3035	3113	3189	3264	3337	3407	3476	3551	3585	6.5
7.0	3008	3101	3194	3282	3366	3449	3530	3609	3685	3762	3840	3876	7.0
7.5	3250	3350	3451	3547	3638	3728	3816	3901	3983	4066	4151	4190	7.5
8.0	3491	3599	3707	3812	3910	4007	4101	4193	4281	4370	4462	4503	8.0
8.5	3763	3879	4000	4110	4216	4320	4422	4521	4617	4713	4812	4856	8.5
9.0	4035	4158	4283	4408	4521	4633	4743	4849	4952	5055	5161	5209	9.0
9.5	4550	4720	4864	4998	5127	5254	5378	5499	5617	5734	5850	5906	9.5
10.0	5124	5282	5445	5587	5733	5875	6013	6145	6282	6412	6537	6603	10.0

Source of data: Regulating Outlet Discharge Rating Curve, dated 1 August 1966.
Table is for single gate operation. For balanced operation using both gates, multiply tabulated discharges by 2.

Minimum flood control pool, el. 922
Maximum flood control pool, el. 1015

Green Peter Reservoir

Seasonal Filling Schedule

Revised February 1970

Date	February		March		April		May	
	Elev	Storage	Elev	Storage	Elev	Storage	Elev	Storage
Jan 31	922.00	159,859						
1	924.06	164,177	971,02	282,579	989.22	338,934	1005.40	393,472
2	926.10	168,495	971.63	284,397	989.78	340,752	1005.92	395,290
3	928.10	172,813	972.25	286,215	990.34	342,570	1006.44	397,108
4	930.07	177,131	972.86	288,032	990.90	344,388	1006.95	398,926
5	932.02	181,449	973.46	289,850	991,45	346,206	1007.46	400,743
6	933.93	185,767	974.07	291,668	992.01	348,024	1007.97	402,561
7	935.82	190,084	974.68	293,486	992.56	349,842	1008.48	404,379
8	937.68	194,402	975.28	295,304	993.11	351,660	1008.99	406,197
9	939.51	198,720	975.88	297,122	993.66	353,478	1009.49	408,015
10	941.32	203,038	976.48	298,940	994.21	355,295	1010.00	409,833
11	943.10	207,356	977.08	300,758	994.76	357,113		
12	944.86	211,674	977.67	302,576	995.31	358,931		
13	946.60	215,992	978.26	304,394	995.85	360,749		
14	948.32	220,310	978.86	306,212	996.39	362,567		
15	950.02	224,628	979.45	308,030	996.93	364,385		
16	951.69	228,946	980.03	309,847	997.47	366,203		
17	953.35	233,264	980.62	311,665	998.01	368,021		
18	954.99	237,582	981.20	313,483	998,55	369,839		
19	956.60	241,899	981.79	315,301	999.09	371,657		
20	958.20	246,217	982.37	317,119	999.62	373,475		
21	959.79	250,535	982.95	318,937	1000.16	375,293		
22	961.35	254,853	983.53	320,755	1000.69	377,111		
23	962.90	259,171	984.10	322,573	1001.22	378,928		
24	964.43	263,489	984.68	324,391	1001.75	380,746		
25	965.94	267.807	985.25	326,209	1002.27	382,564		
26	967.45	272,125	985.82	328,027	1002.80	384,382		
27	968.93	276,443	986.39	329,845	1003.32	386,200		
28	970.40	280,761	986.96	331,663	1003.85	388,018		
29			987.53	333,480	1004.37	389,836		
30			988.09	335,298	1004.89	391,654		
31			988.66	337,116				

Notes:

1. Pool elevation and corresponding acre-feet applicable to the 2400 observation.
2. In leap years, the reservoir will be one day ahead of the above schedule after 28 February.
3. February filling rate = 4318 acre-feet/day ~~= 2177~~ c.f.s./day ~~2158~~
   March-May filling rate = 1818 acre-feet/day = 917 c.f.s./day ~~909~~

This different than in the curve

Δhr = 916.52453

Green Peter Reservoir

Evacuation Schedule

Revised February 1970

Date	September		October		November			
	Elev.	Storage	Elev.	Storage	Elev.	Storage	Elev.	Storage
Aug 31	1010.00	409,833						
1	1009.34	407,465	988.44	336,423	964.26	263,012		
2	1008.68	405,097	987.71	334,054	963.42	260,644		
3	1008.02	402,729	986.97	331,686	962.58	258,276		
4	1007.35	400,361	986.23	329,318	961.73	255,908		
5	1006.69	397,993	985.48	326,950	960.88	253,540		
6	1006.02	395,625	984.74	324,582	960.02	251,172		
7	1005.34	393,256	983.99	322,214	959.15	248,804		
8	1004.67	390,888	983.24	319,846	958.28	246,435		
9	1003.99	388,520	982.48	317,478	957.41	244,067		
10	1003.31	386,152	981.73	315,110	956.53	241,699		
11	1002.63	383,784	980.97	312,742	955.64	239,331		
12	1001.94	381,416	980.20	310,374	954.75	236,963		
13	1001.25	379,048	979.44	308,006	953.86	234,595		
14	1000.56	376,680	978.67	305,637	952.95	232,227		
15	999.87	374,312	977.90	303,269	952.05	229,859		
16	999.17	371,944	977.12	300,901	950.24	225,192		
17	998.47	369,576	976.34	298,533	948.41	220,526		
18	997.77	367,208	975.56	296,165	946.55	215,859		
19	997.07	364,839	974.78	293,797	944.67	211,192		
20	996.36	362,471	973.99	291,429	942.76	206,526		
21	995.66	360,103	973.20	289,061	940.83	201,859		
22	994.95	357,735	972.41	286,693	938.86	197,192		
23	994.23	355,367	971.61	284,325	936.87	192,526		
24	993.52	352,999	970.81	281,957	934.85	187,859		
25	992.80	350,631	970.01	279,589	932.79	183,192		
26	992.08	348,263	969.20	277,221	930.71	178,526		
27	991.36	345,895	968.39	274,852	928.58	173,859		
28	990.63	343,527	967.57	272,484	926.43	169,192		
29	989.90	341,159	966.75	270,116	924.23	164,526		
30	989.18	338,791	965.92	267,748	922.00	159,859		
31			965.09	265,380				

Notes:

1. Pool elevation above mean sea level and corresponding storage in acre-feet applicable tc the midnight observation.
2. 1 Sep-15 nov. evacuation rate = 2368 acre-feet/day = 1194 c.f.s./day. 1184
   16-30 Nov. evacuation rate = 4667 acre-feet/day = 2353 c.f.s./day. 2333

CORPS OF ENGINEERS, U.S. ARMY TABLE 11 PORTLAND, OREGON DISTRICT

ENGINEERING DIV. Planning BRANCH Hydrology SECTION

PROJECT Green Peter Reservoir

SUBJECT Capacity Table (El. 700.0 - 887.0)

BY GEG DATE 4/3/61 CHECKED PART PAGE 1 OF 7

Pool El. in Ft.	Capacity Ac. Ft.	Diff.	Pool El. in Ft.	Capacity Ac. Ft.	Diff.	Pool El. in Ft.	Capacity Ac. Ft.	Diff
700.0	0		720.0	500		740.0	1000	
		25			25			25
701.0	25		721.0	525		741.0	1025	
702.0	50		722.0	550		742.0	1050	
703.0	75		723.0	575		743.0	1075	
704.0	100		724.0	600		744.0	1100	
705.0	125		725.0	625		745.0	1125	
706.0	150		726.0	650		746.0	1150	
707.0	175		727.0	675		747.0	1175	
708.0	200		728.0	700		748.0	1200	
709.0	225		729.0	725		749.0	1225	
710.0	250		730.0	750		750.0	1250	
711.0	275		731.0	775		751.0	1275	
712.0	300		732.0	800		752.0	1300	
713.0	325		733.0	825		753.0	1325	
714.0	350		734.0	850		754.0	1350	
715.0	375		735.0	875		755.0	1375	
716.0	400		736.0	900		756.0	1400	
717.0	425		737.0	925		757.0	1425	
718.0	450		738.0	960		758.0	1450	
719.0	475		739.0	975		759.0	1475	
		25			25			25
720.0	500		740.0	1000		760.0	1500	

TABLE 11

CORPS OF ENGINEERS, U.S. ARMY TABLE 11 PORTLAND, OREGON DISTRICT

ENGINEERING DIV. Planning BRANCH Hydrology SECTION

PROJECT Green Peter Reservoir

SUBJECT Capacity Table (El. 700.0-887.0)

BY GEG DATE 4/3/61 CHECKED PART PAGE 2 OF 7

Pool El. in Ft.	Capacity Ac. Ft.	Diff.	Pool El. in Ft.	Capacity Ac. Ft.	Diff.	Pool El. in Ft.	Capacity Ac. Ft.	Diff.
760.0	1500		780.0	4500		800.0	11,500	
		100			300			500
761.0	1600		781.0	4800		801.0	12,000	
762.0	1700		782.0	5100		802.0	12,500	
763.0	1800		783.0	5400		803.0	13,000	
764.0	1900		784.0	5700		804.0	13,500	
765.0	2000		785.0	6000		805.0	14,000	
766.0	2100		786.0	6300		806.0	14,500	
767.0	2200		787.0	6600		807.0	15,000	
768.0	2300		788.0	6900		808.0	15,500	
769.0	2400		789.0	7200		809.0	16,000	
		100			300			500
770.0	2500		790.0	7500		810.0	16,500	
		200			400			650
771.0	2700		791.0	7900		811.0	17,150	
772.0	2900		792.0	8300		812.0	17,800	
773.0	3100		793.0	8700		813.0	18,450	
774.0	3300		794.0	9100		814.0	19,100	
775.0	3500		795.0	9500		815.0	19,750	
776.0	3700		796.0	9900		816.0	20,400	
777.0	3900		797.0	10,300		817.0	21,050	
778.0	4100		798.0	10,700		818.0	21,700	
779.0	4300		799.0	11,100		819.0	22,350	
		200			400			650
780.0	4500		800.0	11,500		820.0	23,000	

CORPS OF ENGINEERS, U.S. ARMY TABLE 11 PORTLAND, OREGON DISTRICT

ENGINEERING DIV. Planning BRANCH Hydrology SECTION

PROJECT Green Peter Reservoir

SUBJECT Capacity Table (El. 700.0 - 887.0)

BY GEG DATE 4/3/61 CHECKED PART PAGE 3 OF 7

Pool El. in ft.	Capacity Ac. Ft.	Diff.	Pool El. in ft.	Capacity Ac. Ft.	Diff.	Pool El. in ft.	Capacity Ac. Ft.	Diff.
820.0	23,000		840.0	40,000		860.0	61,000	
		800			1000			1100
821.0	23,800		841.0	41,000		861.0	62,100	
								1200
822.0	24,600		842.0	42,000		862.0	63,300	
823.0	25,400		843.0	43,000		863.0	64,500	
824.0	26,200		844.0	44,000		864.0	65,700	
825.0	27,000		845.0	45,000		865.0	66,900	
826.0	27,800		846.0	46,000		866.0	68,100	
827.0	28,600		847.0	47,000		867.0	69,300	
								1200
828.0	29,400		848.0	48,000		868.0	70,500	
								1300
829.0	30,200		849.0	49,000		869.0	71,800	
		800			1000			
830.0	31,000		850.0	50,000		870.0	73,100	
		900			1100			
831.0	31,900		851.0	51,100		871.0	74,400	
832.0	32,800		852.0	52,200		872.0	75,700	
833.0	33,700		853.0	53,300		873.0	77,000	
834.0	34,600		854.0	54,400		874.0	78,300	
								1300
835.0	35,500		855.0	55,500		875.0	79,600	
								1400
836.0	36,400		856.0	56,600		876.0	81,000	
837.0	37,300		857.0	57,700		877.0	82,400	
838.0	38,200		858.0	58,800		878.0	83,800	
839.0	39,100		859.0	59,900		879.0	85,200	
		900			1100			1400
840.0	40,000		860.0	61,000		880.0	86,600	

CORPS OF ENGINEERS, U.S. ARMY TABLE 11 PORTLAND, OREGON DISTRICT

ENGINEERING DIV. Planning BRANCH Hydrology SECTION

PROJECT Green Peter Reservoir

SUBJECT Capacity Table (El. 700.0 - 887.0)

BY GEG DATE 4/3/61 CHECKED PART PAGE 4 OF 7

Pool El. in ft.	Capacity Ac. Ft.	Diff.	
880.0	86,600		
		1400	
881.0	88,000		
		1500	
882.0	89,500		
883.0	91,000		
884.0	92,500		
885.0	94,000		
886.0	95,500		
		1500	
887.0	97,000		(Minimum Power Pool)

TABLE NO. 11

CAPACITY OF GREEN PETER RESERVOIR

IN ACRE-FEET

Sheet 5 of 7

El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.
887.0	97,000	160	892.0	105,000	160	897.0	113,300	170	902.0	122,000	180	907.0	131,000	180	912.0	140,400	190	917.0	150,000	200	922.0	160,000	200	927.0	170,800	220	932.0	181,900	230
.1	97,160		.1	105,160		.1	113,470		.1	122,180		.1	131,180		.1	140,590		.1	150,200		.1	160,200		.1	171,020		.1	182,130	
.2	97,320		.2	105,320		.2	113,640		.2	122,360		.2	131,360		.2	140,780		.2	150,400		.2	160,400		.2	171,240		.2	182,360	
.3	97,480		.3	105,480		.3	113,810		.3	122,540		.3	131,540		.3	140,970		.3	150,600		.3	160,600		.3	171,460		.3	182,590	
.4	97,640		.4	105,640		.4	113,980		.4	122,720		.4	131,720		.4	141,160		.4	150,800		.4	160,800		.4	171,680		.4	182,820	
.5	97,800		.5	105,800		.5	114,150		.5	122,900		.5	131,900		.5	141,350		.5	151,000		.5	161,000		.5	171,900		.5	183,050	
.6	97,960		.6	105,960		.6	114,320		.6	123,080		.6	132,080		.6	141,540		.6	151,200		.6	161,200		.6	172,120		.6	183,280	
.7	98,120		.7	106,120		.7	114,490		.7	123,260		.7	132,260		.7	141,730		.7	151,400		.7	161,400		.7	172,340		.7	183,510	
.8	98,280		.8	106,280		.8	114,660		.8	123,440		.8	132,440		.8	141,920		.8	151,600		.8	161,600		.8	176,560		.8	183,760	
.9	98,440		.9	106,440		.9	114,830		.9	123,620		.9	132,620	180	.9	142,110		.9	151,800		.9	161,800	200	.9	172,780		.9	183,970	
888.0	98,600		893.0	106,600		898.0	115,000		903.0	123,800		908.0	132,800	190	913.0	142,300		918.0	152,000		923.0	162,000	220	928.0	173,000		933.0	184,280	
.1	98,760		.1	106,760		.1	115,170		.1	123,980		.1	132,990		.1	142,490		.1	152,200		.1	162,220		.1	173,220		.1	184,430	
.2	98,920		.2	106,920		.2	115,340		.2	124,160		.2	133,180		.2	142,680		.2	152,400		.2	162,440		.2	173,440		.2	184,660	
.3	99,080		.3	107,080		.3	115,510		.3	124,340		.3	133,370		.3	142,870		.3	152,600		.3	162,660		.3	173,660		.3	184,890	
.4	99,240		.4	107,240		.4	115,680		.4	124,520		.4	133,560		.4	143,060		.4	152,800		.4	162,880		.4	173,880		.4	185,120	
.5	99,400		.5	107,400		.5	115,850		.5	124,700		.5	133,750		.5	143,250		.5	153,000		.5	163,100		.5	174,100		.5	185,350	
.6	99,560		.6	107,560		.6	116,020		.6	124,880		.6	133,940		.6	143,440		.6	153,200		.6	163,320		.6	174,320		.6	185,580	
.7	99,720		.7	107,720		.7	116,190		.7	125,060		.7	134,130		.7	143,630		.7	153,400		.7	163,540		.7	174,540		.7	185,810	
.8	99,880		.8	107,880		.8	116,360		.8	125,240		.8	134,320		.8	143,820		.8	153,600		.8	163,760		.8	174,760		.8	186,040	
.9	100,040		.9	108,040	160	.9	116,530		.9	125,420		.9	134,510		.9	144,010		.9	153,800		.9	163,980		.9	174,980		.9	186,270	
889.0	100,200		894.0	108,200	160	899.0	116,700		904.0	125,600		909.0	134,700		914.0	144,200		919.0	154,000		924.0	164,200		929.0	175,200		934.0	186,500	
.1	100,360		.1	108,370	170	.1	116,870		.1	125,780		.1	134,890		.1	144,390		.1	154,200		.1	164,420		.1	175,420		.1	186,730	
.2	100,520		.2	108,540		.2	117,040		.2	125,960		.2	135,080		.2	144,580		.2	154,400		.2	164,640		.2	175,640		.2	186,960	
.3	100,680		.3	108,710		.3	117,210		.3	126,140		.3	135,270		.3	144,770		.3	154,600		.3	164,860		.3	175,860		.3	187,190	
.4	100,840		.4	108,880		.4	117,380		.4	126,320		.4	135,460		.4	144,960		.4	154,800		.4	165,080		.4	176,080		.4	187,420	
.5	101,000		.5	109,050		.5	117,550		.5	126,500		.5	135,650		.5	145,150		.5	155,000		.5	165,300		.5	176,300		.5	187,650	
.6	101,160		.6	109,220		.6	117,720		.6	126,680		.6	135,840		.6	145,360		.6	155,200		.6	165,520		.6	176,520		.6	187,880	
.7	101,320		.7	109,390		.7	117,890		.7	126,860		.7	136,030		.7	145,530		.7	155,400		.7	165,740		.7	176,740		.7	188,110	
.8	101,480		.8	109,560		.8	118,060		.8	127,040		.8	136,220		.8	145,720		.8	155,600		.8	165,960		.8	176,960		.8	188,340	
.9	101,640		.9	109,730		.9	118,230	170	.9	127,220		.9	136,410		.9	145,910		.9	155,800		.9	166,180		.9	177,180		.9	188,570	
890.0	101,800		895.0	109,900		900.0	118,400	180	905.0	127,400		910.0	136,600		915.0	146,100		920.0	156,000		925.0	166,400		930.0	177,400		935.0	188,800	230
.1	101,960			110,070		.1	118,580		.1	127,580		.1	136,790		.1	146,290		.1	156,200		.1	166,620		.1	177,620		.1	189,040	240
.2	102,120			110,260		.2	118,760		.2	127,760		.2	136,980		.2	146,480		.2	156,400		.2	166,840		.2	177,840		.2	189,280	
.3	102,280			110,410		.3	118,940		.3	127,940		.3	137,170		.3	146,670		.3	156,600		.3	167,060		.3	178,060		.3	189,520	
.4	102,440			110,580		.4	119,120		.4	128,120		.4	137,360		.4	146,860		.4	156,800		.4	167,280		.4	178,280		.4	189,760	
.5	102,600			110,750		.5	119,300		.5	128,300		.5	137,550		.5	147,050		.5	157,000		.5	167,500		.5	178,500		.5	190,000	
.6	102,760			110,920		.6	119,480		.6	128,480		.6	137,740		.6	147,240		.6	157,200		.6	167,720		.6	178,720		.6	190,240	
.7	102,920			111,090		.7	119,660		.7	128,660		.7	137,930		.7	147,430		.7	157,400		.7	167,940		.7	178,940		.7	190,480	
.8	103,080			111,260		.8	119,840		.8	128,840		.8	138,120		.8	147,620		.8	157,600		.8	168,160		.8	179,160		.8	190,720	
.9	103,240			111,430		.9	120,020		.9	129,020		.9	138,310		.9	147,810	190	.9	157,800		.9	168,380		.9	179,380	220	.9	190,960	
891.0	103,400		896.0	111,600		901.0	120,200		906.0	129,200		911.0	138,500		916.0	148,000	200	921.0	158,000		926.0	168,600		931.0	179,600	230	936.0	191,200	
.1	103,560			111,770		.1	120,380		.1	129,380		.1	138,690		.1	148,200		.1	158,200		.1	168,820		.1	179,830		.1	191,440	
.2	103,720			111,940		.2	120,560		.2	129,560		.2	138,880		.2	148,400		.2	158,400		.2	169,040		.2	180,060		.2	191,680	
.3	103,880			112,110		.3	120,740		.3	129,740		.3	139,070		.3	148,600		.3	158,600		.3	169,260		.3	180,290		.3	191,920	
.4	104,040			112,280		.4	120,920		.4	129,920		.4	139,260		.4	148,800		.4	158,800		.4	169,480		.4	180,520		.4	192,160	
.5	104,200			112,450		.5	121,100		.5	130,100		.5	139,450		.5	149,000		.5	159,000		.5	169,700		.5	180,750		.5	192,400	
.6	104,360			112,620		.6	121,280		.6	130,280		.6	139,640		.6	149,200		.6	159,200		.6	169,920		.6	180,980		.6	192,640	
.7	104,520			112,790		.7	121,460		.7	130,460		.7	139,830		.7	149,400		.7	159,400		.7	170,140		.7	181,210		.7	192,880	
.8	104,680			112,960		.8	121,640		.8	130,640		.8	140,020		.8	149,600		.8	159,600		.8	170,360		.8	181,440		.8	193,120	
.9	104,840			113,130	170	.9	121,820	180	.9	130,820	180	.9	140,210	190	.9	149,800	200	.9	159,800	200	.9	170,580	220	.9	181,670	230	.9	193,360	240
892.0	105,000	160	897.0	113,300	170	902.0	122,000	180	907.0	131,000	180	912.0	140,400	190	917.0	150,000	200	922.0	160,000	200	927.0	170,800	220	932.0	181,900	230	937.0	193,600	240

Remarks:

Minimum Power Pool _____ 887 ft.
Minimum Flood Control Pool _____ 922 "
Maximum Conservation Pool _____ 1010 "
Full and Maximum Pool _____ 1015 "

Compiled by G.E.G.
Checked by
Date 4/6/61

TABLE NO. 11

CAPACITY OF GREEN PETER RESERVOIR

IN ACRE-FEET

El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.
937.0	193,600	240	942.0	206,700	250	947.0	218,200	260	952.0	231,200	260	957.0	244,500	270	962.0	258,000	280	967.0	272,000	280	972.0	286,300	290	977.0	300,800	300	982.0	315,800	300
.1	193,840		.1	205,950		.1	218,460		.1	231,460		.1	244,770		.1	258,280		.1	272,280		.1	286,590		.1	301,100		.1	316,100	
.2	194,080		.2	206,200		.2	218,720		.2	231,720		.2	245,040		.2	258,560		.2	272,560		.2	286,880		.2	301,400		.2	316,400	
.3	194,320		.3	206,450		.3	218,980		.3	231,980		.3	245,310		.3	258,840		.3	272,840		.3	287,170		.3	301,700		.3	316,700	
.4	194,560		.4	206,700		.4	219,240		.4	232,240		.4	245,580		.4	259,120		.4	273,120		.4	287,460		.4	302,000		.4	317,000	
.5	194,800		.5	206,950		.5	219,500		.5	232,500		.5	245,850		.5	259,400		.5	273,400		.5	287,750		.5	302,300		.5	317,300	
.6	195,040		.6	207,200		.6	219,760		.6	232,760		.6	246,120		.6	259,680		.6	273,680		.6	288,040		.6	302,600		.6	317,600	
.7	195,280		.7	207,450		.7	220,020		.7	233,020		.7	246,390		.7	259,960		.7	273,960		.7	288,330		.7	302,900		.7	317,900	
.8	195,520		.8	207,700		.8	220,280		.8	233,280		.8	246,660		.8	260,240		.8	274,240		.8	288,620		.8	303,200		.8	318,200	
.9	195,760		.9	207,950		.9	220,540		.9	233,540		.9	246,930		.9	260,520		.9	274,520		.9	288,910		.9	303,500		.9	318,500	
938.0	196,000		943.0	208,200		948.0	220,800		953.0	233,800		958.0	247,200		963.0	260,800		968.0	274,800		973.0	289,200		978.0	303,800	320	983.0	318,800	320
.1	196,240		.1	208,450		.1	221,060		.1	234,060		.1	247,470		.1	261,080		.1	275,080		.1	289,490		.1	304,120		.1	319,110	
.2	196,480		.2	208,700		.2	221,320		.2	234,320		.2	247,740		.2	261,360		.2	275,360		.2	289,780		.2	304,440		.2	319,420	
.3	196,720		.3	208,950		.3	221,580		.3	234,580		.3	248,010		.3	261,640		.3	275,640		.3	290,070		.3	304,760		.3	319,730	
.4	196,960		.4	209,200		.4	221,840		.4	234,840		.4	248,280		.4	261,920		.4	275,920		.4	290,360		.4	305,080		.4	320,040	
.5	197,200		.5	209,450		.5	222,100		.5	235,100		.5	248,550		.5	262,200		.5	276,200		.5	290,650		.5	305,390		.5	320,350	
.6	197,440		.6	209,700		.6	222,360		.6	235,360		.6	248,820		.6	262,480		.6	276,480		.6	290,940		.6	305,690		.6	320,660	
.7	197,680		.7	209,950		.7	222,620		.7	235,620		.7	249,090		.7	262,760		.7	276,760		.7	291,230		.7	305,980		.7	320,970	
.8	197,920		.8	210,200		.8	222,880		.8	235,880		.8	249,360		.8	263,040		.8	277,040		.8	291,520		.8	306,280		.8	321,280	
.9	198,160		.9	210,450		.9	223,140		.9	236,140	260	.9	249,630		.9	263,320		.9	277,320	280	.9	291,810		.9	306,580		.9	321,590	
939.0	198,400		944.0	210,700		949.0	223,400		954.0	236,400	270	959.0	249,900		964.0	263,600		969.0	277,600	290	974.0	292,100		979.0	306,890		984.0	321,900	
.1	198,640		.1	210,950		.1	223,660		.1	236,670		.1	250,170		.1	263,880		.1	277,890		.1	292,390		.1	307,100		.1	322,210	
.2	198,880		.2	211,200		.2	223,920		.2	236,940		.2	250,440		.2	264,160		.2	278,180		.2	292,680		.2	307,400		.2	322,520	
.3	199,120		.3	211,450		.3	224,180		.3	237,210		.3	250,710		.3	264,440		.3	278,470		.3	292,970		.3	307,700		.3	322,830	
.4	199,360		.4	211,700		.4	224,440		.4	237,480		.4	250,980		.4	264,720		.4	278,760		.4	293,260		.4	308,000		.4	323,140	
.5	199,600		.5	211,950		.5	224,700		.5	237,750		.5	251,250		.5	265,000		.5	279,050		.5	293,550		.5	308,300		.5	323,450	
.6	199,840		.6	212,200		.6	224,960		.6	238,020		.6	251,520		.6	265,280		.6	279,340		.6	293,840		.6	308,600		.6	323,760	
.7	200,080		.7	212,450		.7	225,220		.7	238,290		.7	251,790		.7	265,560		.7	279,630		.7	294,130		.7	308,900		.7	324,070	
.8	200,320		.8	212,700		.8	225,480		.8	238,560		.8	252,060		.8	265,840		.8	279,920		.8	294,420		.8	309,200		.8	324,380	
.9	200,560		.9	212,950		.9	225,740		.9	238,830		.9	252,330		.9	266,120		.9	280,210		.9	294,710		.9	309,500		.9	324,690	
940.0	200,800		945.0	213,200		950.0	226,000		955.0	239,100		960.0	252,600		965.0	266,400		970.0	280,500		975.0	295,000		980.0	309,800		985.0	325,000	
.1	201,040		.1	213,450		.1	226,260		.1	239,370		.1	252,870		.1	266,680		.1	280,790		.1	295,290		.1	310,100		.1	325,310	
.2	201,280		.2	213,700		.2	226,520		.2	239,640		.2	253,140		.2	266,960		.2	281,080		.2	295,580		.2	310,400		.2	325,620	
.3	201,520		.3	213,950		.3	226,780		.3	239,910		.3	253,410		.3	267,240		.3	281,370		.3	295,870		.3	310,700		.3	325,930	
.4	201,760		.4	214,200		.4	227,040		.4	240,180		.4	253,680		.4	267,520		.4	281,660		.4	296,160		.4	311,002		.4	326,240	
.5	202,000		.5	214,450		.5	227,300		.5	240,450		.5	253,950		.5	267,800		.5	281,950		.5	296,450		.5	311,300		.5	326,550	
.6	202,240		.6	214,700		.6	227,560		.6	240,720		.6	254,220		.6	268,080		.6	282,240		.6	296,740		.6	311,602		.6	326,860	
.7	202,480		.7	214,950		.7	227,820		.7	240,990		.7	254,490		.7	268,360		.7	282,530		.7	297,030		.7	311,902		.7	327,170	
.8	202,720		.8	215,200		.8	228,080		.8	241,260		.8	254,760		.8	268,640		.8	282,820		.8	297,320		.8	312,200		.8	327,480	
.9	202,960	240	.9	215,450	250	.9	228,340	260	.9	241,530	270	.9	255,030	270	.9	268,920	280	.9	283,110	290	.9	297,610	300	.9	312,500	300	.9	327,790	310
941.0	203,200	240	946.0	215,700	250	951.0	228,600	260	956.0	241,800	270	961.0	255,300	270	966.0	269,200	280	971.0	283,400	290	976.0	297,900	300	981.0	312,800	300	986.0	328,100	310
.1	203,450		.1	215,950		.1	228,860		.1	242,070		.1	255,570		.1	269,480		.1	283,690		.1	298,190		.1	313,100		.1	328,410	
.2	203,700		.2	216,200		.2	229,120		.2	242,340		.2	255,840		.2	269,760		.2	283,980		.2	298,480		.2	313,400		.2	328,720	
.3	203,950		.3	216,450		.3	229,380		.3	242,610		.3	256,110		.3	270,040		.3	284,270		.3	298,770		.3	313,700		.3	329,030	
.4	204,200		.4	216,700		.4	229,640		.4	242,880		.4	256,380		.4	270,320		.4	284,560		.4	299,060		.4	314,000		.4	329,340	
.5	204,450		.5	216,950		.5	229,900		.5	243,150		.5	256,650		.5	270,600		.5	284,850		.5	299,350		.5	314,300		.5	329,650	
.6	204,700		.6	217,200		.6	230,160		.6	243,420		.6	256,920		.6	270,880		.6	285,140		.6	299,640		.6	314,600		.6	329,960	
.7	204,950		.7	217,450		.7	230,420		.7	243,690		.7	257,190		.7	271,160		.7	285,430		.7	299,930		.7	314,900		.7	330,270	
.8	205,200		.8	217,700		.8	230,680		.8	243,960		.8	257,460		.8	271,440		.8	285,720		.8	300,220		.8	315,200		.8	330,580	
.9	205,450	250	.9	217,950	250	.9	230,940	260	.9	244,230	270	.9	257,730	270	.9	271,720	280	.9	286,010	290	.9	300,510	300	.9	315,500	300	.9	330,890	310
942.0	205,700		947.0	218,200		952.0	231,200		957.0	244,500		962.0	258,000		967.0	272,000		972.0	286,300		977.0	300,800		982.0	315,800		987.0	331,200	

Remarks:

Minimum Power Pool _____ 887 ft.
Minimum Flood Control Pool ___ 922 "
Maximum Conservation Pool ___ 1010 "
Full and Maximum Pool ____ 1015 "

Compiled by J.S.G.
Checked by
Date 4/5/61

TABLE NO. 11

CAPACITY OF GREEN PETER RESERVOIR

IN ACRE-FEET

El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.	El. in ft.	Capacity	Diff.
987.0	331,280	310	992.0	347,100	320	997.0	363,500	330	1002.0	380,400	340	1007.0	396,400	380	1012.0	416,000	400	1017.0	436,000	400								
.1	331,510		.1	347,420		.1	363,830		.1	380,740		.1	396,780		.1	416,400		.1	436,400									
.2	331,820		.2	347,740		.2	364,160		.2	381,080		.2	399,160		.2	416,800		.2	436,800									
.3	332,130		.3	348,060		.3	364,490		.3	381,420		.3	399,540		.3	417,200		.3	437,200									
.4	332,440		.4	348,380		.4	364,820		.4	381,760		.4	399,920		.4	417,600		.4	437,600									
.5	332,750		.5	348,700		.5	365,150		.5	382,100		.5	400,300		.5	418,000		.5	438,000									
.6	333,060		.6	349,020		.6	365,480		.6	382,440		.6	400,680		.6	418,400		.6	438,400									
.7	333,370		.7	349,340		.7	365,810		.7	382,780		.7	401,060		.7	418,800		.7	438,800									
.8	333,680		.8	349,660		.8	366,140		.8	383,120		.8	401,440		.8	419,200		.8	439,200									
.9	333,990	310	.9	349,980	320	.9	366,470	330	.9	383,460	340	.9	401,820		.9	419,600		.9	439,600									
988.0	334,300	320	993.0	350,300	330	998.0	366,800	330	1003.0	383,800	340	1008.0	402,200		1013.0	420,000		1018.0	440,000									
.1	334,620		.1	350,630		.1	367,140		.1	384,160		.1	402,580		.1	420,400		.1	440,400									
.2	334,940		.2	350,960		.2	367,480		.2	384,520		.2	402,960		.2	420,800		.2	440,800									
.3	335,260		.3	351,290		.3	367,820		.3	384,880		.3	403,340		.3	421,200		.3	441,200									
.4	335,580		.4	351,620		.4	368,160		.4	385,240		.4	403,720		.4	421,600		.4	441,600									
.5	335,900		.5	351,950		.5	368,500		.5	385,600		.5	404,100		.5	422,000		.5	442,000									
.6	336,220		.6	352,280		.6	368,840		.6	385,960		.6	404,480		.6	422,400		.6	442,400									
.7	336,540		.7	352,610		.7	369,180		.7	386,320		.7	404,860		.7	422,800		.7	442,800									
.8	336,860		.8	352,940		.8	369,520		.8	386,680		.8	405,240		.8	423,200		.8	443,200									
.9	337,180		.9	353,270		.9	369,860		.9	387,040		.9	405,620	380	.9	423,600		.9	443,600									
989.0	337,500		994.0	353,600		999.0	370,200		1004.0	387,400		1009.0	406,000	400	1014.0	424,000		1019.0	444,000									
.1	337,820		.1	353,930		.1	370,540		.1	387,760		.1	406,400		.1	424,400		.1	444,400									
.2	338,140		.2	354,260		.2	370,880		.2	388,120		.2	406,800		.2	424,800		.2	444,800									
.3	338,460		.3	354,590		.3	371,220		.3	388,480		.3	407,200		.3	425,200		.3	445,200									
.4	338,780		.4	354,920		.4	371,560		.4	388,840		.4	407,600		.4	425,600		.4	445,600									
.5	339,100		.5	355,250		.5	371,900		.5	389,200		.5	408,000		.5	426,000		.5	446,000									
.6	339,420		.6	355,580		.6	372,240		.6	389,560		.6	408,400		.6	426,400		.6	446,400									
.7	339,740		.7	355,910		.7	372,580		.7	389,920		.7	408,800		.7	426,800		.7	446,800									
.8	340,060		.8	356,240		.8	372,920		.8	390,280		.8	409,200		.8	427,200		.8	447,200									
.9	340,380		.9	356,570		.9	373,260		.9	390,640		.9	409,600		.9	427,600		.9	447,600									
990.0	340,700		995.0	356,900		1000.0	373,600		1005.0	391,000		1010.0	410,000		1015.0	428,000		1020.0	448,000									
.1	341,020		.1	357,230		.1	373,940		.1	391,360		.1	410,400		.1	428,400												
.2	341,340		.2	357,560		.2	374,280		.2	391,720		.2	410,800		.2	428,800												
.3	341,660		.3	357,890		.3	374,620		.3	392,080		.3	411,200		.3	429,200												
.4	341,980		.4	358,220		.4	374,960		.4	392,440		.4	411,600		.4	429,600												
.5	342,300		.5	358,560		.5	375,300		.5	392,800		.5	412,000		.5	430,000												
.6	342,620		.6	358,880		.6	375,640		.6	393,160		.6	412,400		.6	430,400												
.7	342,940		.7	359,210		.7	375,980		.7	393,520		.7	412,800		.7	430,800												
.8	343,260		.8	359,540		.8	376,320		.8	393,880		.8	413,200		.8	431,200												
.9	343,580		.9	359,870		.9	376,660		.9	394,240	360	.9	413,600		.9	431,600												
991.0	343,900		996.0	360,200		1001.0	377,000		1006.0	394,600	360	1011.0	414,000		1016.0	432,000												
.1	344,220		.1	360,530		.1	377,340		.1	394,960		.1	414,400		.1	432,400												
.2	344,540		.2	360,860		.2	377,680		.2	395,320		.2	414,800		.2	432,800												
.3	344,860		.3	361,190		.3	378,020		.3	395,740		.3	415,200		.3	433,200												
.4	345,180		.4	361,520		.4	378,360		.4	396,120		.4	415,600		.4	433,600												
.5	345,500		.5	361,850		.5	378,700		.5	396,500		.5	416,000		.5	434,000												
.6	345,820		.6	362,180		.6	379,040		.6	396,880		.6	416,400		.6	434,400												
.7	346,140		.7	362,510		.7	379,380		.7	397,260		.7	416,800		.7	434,800												
.8	346,460		.8	362,840		.8	379,720		.8	397,640		.8	417,200		.8	435,200												
.9	346,780	320	.9	363,170	330	.9	380,060	340	.9	398,020	380	.9	417,600	400	.9	435,600	400											
992.0	347,100		997.0	363,500		1002.0	380,400		1007.0	398,400		1012.0	418,000		1017.0	436,000												

Remarks:

Minimum Power Pool ..... 887 ft.
Minimum Flood Control Pool ..... 922 "
Maximum Conservation Pool ..... 1010 "
Full and Maximum Pool ..... 1015 "

Compiled by G.S.G.
Checked by .....
Date 4/6/61

9-210
(Rev. 5 63)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 14-1858.00

Rating table for Middle Santiam River near Cascadia, Oreg. (In use 7-5-66)

, from Dec. 22, 1964, to , 19, from , 19, to , 19

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
.00			2.00	183	27	4.00	1,060	60	6.00	2,780	110	8.00	5,400	160	10.00	8,800	200	12.00	13,000	240
.10			.10	210	30	.10	1,120	70	.10	2,890	110	.10	5,560		.10	9,000		.10	13,240	
.20			.20	240		.20	1,190		.20	3,000	120	.20	5,720		.20	9,200		.20	13,480	
.30			.30	270	30	.30	1,260		.30	3,120		.30	5,880		.30	9,400		.30	13,720	
.40			.40	300	35	.40	1,330	70	.40	3,240		.40	6,040		.40	9,600		.40	13,960	
.50			.50	335		.50	1,400	80	.50	3,360	120	.50	6,200		.50	9,800		.50	14,200	
.60			.60	370		.60	1,480		.60	3,480	130	.60	6,360		.60	10,000		.60	14,440	
.70			.70	405	35	.70	1,560		.70	3,610		.70	6,520		.70	10,200		.70	14,680	
.80			.80	440	40	.80	1,640		.80	3,740		.80	6,680		.80	10,400		.80	14,920	
.90			.90	480	40	.90	1,720	80	.90	3,870	130	.90	6,840	160	.90	10,600	200	.90	15,160	240
1.00			3.00	520	50	5.00	1,800	90	7.00	4,000	140	9.00	7,000	180	11.00	10,800	220	13.00	15,400	2600
.10	27	11	.10	570		.10	1,890		.10	4,140		.10	7,180		.10	11,020		14.00	18,000	2,800
.20	38	12	.20	620		.20	1,980		.20	4,280		.20	7,360		.20	11,240		15.00	20,800	2,800
.30	50	14	.30	670		.30	2,070	90	.30	4,420		.30	7,540		.30	11,460		16.00	23,600	
.40	64	16	.40	720		.40	2,160	100	.40	4,560		.40	7,720		.40	11,680		.40		
.50	80	17	.50	770	50	.50	2,260		.50	4,700		.50	7,900		.50	11,900		.50		
.60	97	18	.60	820	60	.60	2,360		.60	4,840		.60	8,080		.60	12,120		.60		
.70	115	20	.70	880		.70	2,460	100	.70	4,980		.70	8,260		.70	12,340		.70		
.80	135	23	.80	940		.80	2,560	110	.80	5,120		.80	8,440		.80	12,560		.80		
.90	158	25	.90	1,000	60	.90	2,670	110	.90	5,260	140	.90	8,620	180	.90	12,780	220	.90		

This table is applicable for open-channel conditions. It is based on discharge measurements ~~made during~~ 16 to 23

and is well defined between cfs and cfs. Comp by WPH date 11/3/65

Ckd by GBS date 2/9/66

Table No. 4

TABLE 13

U.S. GOVERNMENT PRINTING OFFICE 1963 O—680 399

Provisional

9-210
(Rev. 5-63)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 14-1859

Rating table for Quartzville Creek near Cascadia, Oreg. (In use 7-5-66)
, from Oct. 16, 1965, to , 19 , from , 19 , to , 19

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
.00			5.00			7.00	315	40	9.00	1,650	100	11.00	4,000	160	13.00	7,600	290	.00		
.10			.10			.10	355	40	.10	1750		.10	4,160		.10	7,840		.10		
.20			.20			.20	395	45	.20	1,850		.20	4320		.20	8,080		.20		
.30			.30			.30	440	50	.30	1,950		.30	4,480		.30	8320		.30		
.40			.40			.40	490	50	.40	2,050	100	.40	4,640		.40	8,560		.40		
.50			.50	12	7	.50	540	50	.50	2,150	110	.50	4,800		.50	8,800		.50		
.60			.60	19	7	.60	590	60	.60	2260		.60	4,960		.60	9,040		.60		
.70			.70	26	10	.70	650		.70	2370		.70	5,120		.70	9,280		.70		
.80			.80	36	11	.80	710		.80	2480		.80	5,280		.80	9,520		.80		
.90			.90	47	14	.90	770	60	.90	2590	110	.90	5440	160	.90	9,760	240	.90		
6.00			6.00	61	15	8.00	830	75	10.00	2700	120	12.00	5,600	200	14.00	10,000		.00		
.10			.10	76	18	.10	905		.10	2820		.10	5,800		.10			.10		
.20			.20	94	20	.20	980		.20	2940		.20	6,000		.20			.20		
.30			.30	114	21	.30	1,056	75	.30	3060		.30	6,200		.30			.30		
.40			.40	135	25	.40	1,130	80	.40	3180	120	.40	6,400		.40			.40		
.50			.50	160	25	.50	1,210	80	.50	3300	140	.50	6,600		.50			.50		
.60			.60	185	30	.60	1,290	90	.60	3440		.60	6,800		.60			.60		
.70			.70	215	30	.70	1,380		.70	3580		.70	7,000		.70			.70		
.80			.80	245	35	.80	1,470		.80	3720		.80	7,200		.80			.80		
.90			.90	280	35	.90	1,560	90	.90	3860	140	.90	7400	200	.90			.90		

This table is applicable for open-channel conditions. It is based on ..... discharge measurements ~~made during~~ 18-21 ..... and is ..... well defined between ..... cfs and ..... cfs. Comp by PW date 1-4-66

Ckd by JAA date 1-4-66

NEW SITE Table No. 1A

TABLE 14

* U.S. GOVERNMENT PRINTING OFFICE : 1963 O—688-399

mellen 5/24/67

9-210
(Rev. 5-63)

UNITED STATES DEPART IT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 14-1850.00

Rating table for South Santiam River below Cascadia, Oreg.

..... from Aug. 22, 1967, to ....., 19....., from ....., 19....., to ....., 19.....

Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs
.00			2.00	134	15	4.00	890	65	6.00	2,530	100	8.00	4,800	120	10.00	7,230	170	12.0	11,300	2,000
.10			.10	149	16	.10	955	65	.10	2,630		.10	4,920	120	.10	7,900		13.0	13,300	
.20			.20	165	20	.20	1,020	70	.20	2,730	100	.20	5,040	130	.20	8,070		14.0	15,300	2,000
.30			.30	185	20	.30	1,090		.30	2,830	110	.30	5,170		.30	8,240		15.0	17,300	2,100
.40			.40	205	25	.40	1,160		.40	2,940		.40	5,300		.40	8,410		16.0	19,400	2,200
.50			.50	230	25	.50	1,230		.50	3,050		.50	5,430	130	.50	8,580		17.0	21,600	
.60			.60	255	25	.60	1,300	70	.60	3,160		.60	5,560	140	.60	8,750	170	18.0	23,800	2,200
.70			.70	280	30	.70	1,370	80	.70	3,270		.70	5,700		.70	8,920	180	19.0	26,000	2,400
.80			.80	310	35	.80	1,450		.80	3,380		.80	5,840		.80	9,100		20.0	28,400	
.90			.90	345	40	.90	1,530		.90	3,490	110	.90	5,980	140	.90	9,280		.00		
1.00	44	5	3.00	385	40	5.00	1,610		7.00	3,600	120	9.00	6,120	150	11.00	9,460		.10		
.10	49	6	.10	425	45	.10	1,690	80	.10	3,720		.10	6,270		.10	9,640		.20		
.20	55	6	.20	470		.20	1,770	90	.20	3,840		.20	6,420	150	.20	9,820		.30		
.30	61	7	.30	515	45	.30	1,860		.30	3,960		.30	6,570	160	.30	10,000		.40		
.40	68	8	.40	560	50	.40	1,950		.40	4,080		.40	6,730		.40	10,180		.50		
.50	76	10	.50	610	50	.50	2,040	90	.50	4,200		.50	6,890	160	.50	10,360	180	.60		
.60	86	10	.60	660	55	.60	2,130	100	.60	4,320		.60	7,050	170	.60	10,540	190	.70		
.70	96	11	.70	715	55	.70	2,230		.70	4,440		.70	7,220		.70	10,730		.80		
.80	107	13	.80	770	60	.80	2,330		.80	4,560		.80	7,390		.80	10,920		.90		
.90	120	14	.90	830	60	.90	2,430	100	.90	4,680	120	.80	7,560	170	.90	11,110	190	.00		

This table is applicable for open-channel conditions. It is based on —— discharge measurements ~~made during~~ 253-259 ..... f.....
previous rating above 9.5 ft. ~~and is~~ ..... well defined between ..... cfs and ..... cf.

Comp by DLG date .....
Ckd by WAH date 8-22-67
Table No. 11 A

TABLE 15

9-210 1
(Rev. 5-63)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 14-1870.00

Rating table for Wiley Creek near Foster, Oreg.

, from Jan. 6, 1966, to , 19, from , 19, to , 19

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
.00			2.00	96	19	4.00	970	70	6.00	2,780	110	8.00	5,240	140	10.00	8,370							
.10			.10	115	22	.10	1,040	70	.10	2,890		.10	5,380		.10			.10			.10		
.20			.20	137	25	.20	1,110	80	.20	3,000		.20	5,520	140	.20			.20			.20		
.30			.30	162	27	.30	1,190		.30	3,110	110	.30	5,660	150	.30			.30			.30		
.40			.40	189	29	.40	1,270		.40	3,220	120	.40	5,810	150	.40			.40			.40		
.50			.50	218	31	.50	1,350		.50	3,340		.50	5,960	160	.50			.50			.50		
.60			.60	249	34	.60	1,430	80	.60	3,460		.60	6,120		.60			.60			.60		
.70			.70	283	37	.70	1,510	90	.70	3,580		.70	6,280		.70			.70			.70		
.80	40	1.9	.80	320	40	.80	1,600		.80	3,700		.80	6,440		.80			.80			.80		
.90	59	2.3	.90	360	45	.90	1,690		.90	3,820	120	.90	6,600		.90			.90			.90		
1.00	82	3.1	3.00	405	45	5.00	1,780		7.00	3,940	130	9.00	6,760		.00			.00			.00		
.10	113	3.7	.10	450	50	.10	1,870	90	.10	4,070		.10	6,920		.10			.10			.10		
.20	150	4.5	.20	500		.20	1,960	100	.20	4,200		.20	7,080		.20			.20			.20		
.30	195	5.5	.30	550		.30	2,060		.30	4,330		.30	7,240		.30			.30			.30		
.40	25	7	.40	600	50	.40	2,160		.40	4,460		.40	7,400		.40			.40			.40		
.50	32	9	.50	650	60	.50	2,260		.50	4,590		.50	7,560		.50			.50			.50		
.60	41	11	.60	710		.60	2,360		.60	4,720		.60	7,720		.60			.60			.60		
.70	52	13	.70	770	60	.70	2,460	100	.70	4,850		.70	7,880		.70			.70			.70		
.80	65	14	.80	830	70	.80	2,560	110	.80	4,980		.80	8,040	160	.80			.80			.80		
.90	79	17	.90	900	70	.90	2,670	110	.90	5,110	130	.80	8,200	170	.90			.90			.90		

This table is applicable for open-channel conditions. It is based on 8 discharge measurements ~~made during~~ 187 - 194, and previous rating above 5.4 ft. ~~and between~~ ~~of~~

Compd DLG date 12-9-66

Ckd by WAH date 12-19-66

Table No. 11

GOVERNMENT PRINTING OFFICE 1963 O

TABLE 16

9-210
(Rev. 5-63)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 14-1875 00

Rating table for South Santiam River at Waterloo, Oreg.
, from Mar. 10, 1966, to , 19, from , 19, to , 19

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
1.00			3.00	900	110	5.00	3,900	200	7.00	8,600	300	9.00	15,000	350	11.00	22,100	370	13.0	29,700	4,100
.10			.10	1,010	110	.10	4,100		.10	8,900		.10	15,350		.10	22,470		14.0	33,800	4,300
.20			.20	1,120	120	.20	4,300		.20	9,200		.20	15,700		.20	22,840		15.0	38,100	4,600
.30			.30	1,240	120	.30	4,500	200	.30	9,500		.30	16,050		.30	23,210		16.0	42,700	4,900
.40			.40	1,360	120	.40	4,700	220	.40	9,800		.40	16,400		.40	23,580		17.0	47,600	5,200
.50			.50	1,480	130	.50	4,920		.50	10,100		.50	16,750		.50	23,950		18.0	52,800	5,500
.60			.60	1,610	130	.60	5,140		.60	10,400		.60	17,100		.60	24,320		19.0	58,300	5,800
.70	43	30	.70	1,740	130	.70	5,360		.70	10,700		.70	17,450		.70	24,690		20.0	64,100	6,100
.80	73	34	.80	1,870	140	.80	5,580	220	.80	11,000		.80	17,800		.80	25,060		21.0	70,200	6,500
.90	107	41	.90	2,010	140	.90	5,800	240	.90	11,300	300	.90	18,150	350	.90	25,430	370	22.0	76,700	7,000
2.00	148	47	4.00	2,150	150	6.00	6,040		8.00	11,600	340	10.00	18,500	360	12.00	25,800	390	23.0	83,700	7,500
.10	195	55	.10	2,300	160	.10	6,280		.10	11,940		.10	18,860		.10	26,190		24.0	91,200	8,000
.20	250	60	.20	2,460	170	.20	6,520		.20	12,280		.20	19,220		.20	26,580		25.0	99,200	
.30	310	65	.30	2,630	170	.30	6,760	240	.30	12,620		.30	19,580		.30	26,970		.30		
.40	375	75	.40	2,800	180	.40	7,000	260	.40	12,960		.40	19,940		.40	27,360		.40		
.50	450	80	.50	2,980		.50	7,260		.50	13,300		.50	20,300		.50	27,750		.50		
.60	530	85	.60	3,160		.60	7,520		.60	13,640		.60	20,660		.60	28,140		.60		
.70	615	90	.70	3,340		.70	7,780	260	.70	13,980		.70	21,020		.70	28,530		.70		
.80	705	95	.80	3,520	180	.80	8,040	280	.80	14,320		.80	21,380		.80	28,920		.80		
.90	800	100	.90	3,700	200	.90	8,320	280	.90	14,660	340	.90	21,740	360	.90	29,310	390	.90		

This table is applicable for open-channel conditions. It is based on — discharge measurements ~~made during~~ 324-328 and previous high-water ratings. ~~and is well defined between of and of.~~

Same as rating 8 above 4.0 ft.

Comp by WAH date 10/21/66
Ckd by E.N.C. date 11/7/66
Table No. 9

TABLE 17

* 9-210
(Rev. 2-66)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 14-1880.00

-o Krueger
10/13/67

Rating table for Santiam River at Jefferson, Oreg.

from Jan. 6, 1966 to ..... , from ..... to ..... , from ..... to .....

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
0.00			2.00	1,400	90	4.00	3,970	160	6.00	8,000	240	8.00	13,500	350	10.00	20,500	400	12.00	29,000	500
.10			.10	1,490	90	.10	4,130	170	.10	8,240		.10	13,850		.10	20,900		.10	29,500	
.20			.20	1,580	100	.20	4,300		.20	8,480		.20	14,200		.20	21,300		.20	30,000	
.30			.30	1,680	110	.30	4,470	170	.30	8,720		.30	14,550		.30	21,700		.30	30,500	
.40	560	90	.40	1,790	110	.40	4,640	180	.40	8,960	240	.40	14,900		.40	22,100		.40	31,000	
.50	590	30	.50	1,900	120	.50	4,820		.50	9,200	260	.50	15,250		.50	22,500		.50	31,500	
.60	620	30	.60	2,020		.60	5,000	180	.60	9,460		.60	15,600		.60	22,900		.60	32,000	
.70	650	40	.70	2,140		.70	5,180	190	.70	9,720		.70	15,950		.70	23,300		.70	32,500	
.80	690	40	.80	2,260	120	.80	5,370	190	.80	9,980		.80	16,300		.80	23,700		.80	33,000	
.90	730	50	.90	2,380	130	.90	5,560	200	.90	10,240	260	.90	16,650		.90	24,100	400	.90	33,500	500
1.00	780		3.00	2,510	130	5.00	5,760	200	7.00	10,500	300	9.00	17,000		11.00	24,500	450	13.00	34,000	550
.10	830		.10	2,640	140	.10	5,960	210	.10	10,800		.10	17,350		.10	24,950		.10	34,550	
.20	880		.20	2,780		.20	6,170	210	.20	11,100		.20	17,700		.20	25,400		.20	35,100	
.30	930	50	.30	2,920		.30	6,380	220	.30	11,400		.30	18,050		.30	25,850		.30	35,650	
.40	980	60	.40	3,060	140	.40	6,600	220	.40	11,700		.40	18,400		.40	26,300		.40	36,200	
.50	1,040	60	.50	3,200	150	.50	6,820	230	.50	12,000		.50	18,750		.50	26,750		.50	36,750	
.60	1,100	70	.60	3,350		.60	7,050	230	.60	12,300		.60	19,100		.60	27,200		.60	37,300	
.70	1,170	70	.70	3,500	150	.70	7,280	240	.70	12,600		.70	19,450		.70	27,650		.70	37,850	
.80	1,240	80	.80	3,650	160	.80	7,520		.80	12,900		.80	19,800		.80	28,100		.80	38,400	
.90	1,320	80	.90	3,810	160	.90	7,760	240	.90	13,200	300	.90	20,150	350	.90	28,550	450	.90	38,950	550

This table is applicable for open-channel conditions. It is based on 11 discharge measurements ~~made during~~ 227-237 and .....
rating table 9 above 11.0 ft. ..... ~~and to~~ ..... ~~well-defined between~~ ..... ~~cfs and~~ ..... cfs. Comp by OLG date 12-20-66
same as provisional table 9A above 8.7 ft. Ckd by WAH date 12-23-66
..... Table No. 10

TABLE 18
Sheet 1

Sheet 1 of 2

U.S. GOVERNMENT PRINTING OFFICE : 1966 O—000,000

9-910
(Rev. 5-63)

UNITED STATES DEPART .IT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 14-1890.00

Rating table for Santiam River at Jefferson, Oreg.

....., from Jan. 6, 19 66, to ....., 19 ....., from ....., 19 ....., to ....., 19 .....

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
14.00	39,500	650	16.00	53,700	800	18.00	70,500	950	20.00	95,000	1,800	22.00	135,000	2,600	24.00	190,000	3,100	.02		
.10	40,150		.10	54,500		.10	71,450	950	.10	96,800		.10	137,600		.10	193,100		.10		
.20	40,800		.20	55,300		.20	72,400	1,000	.20	98,600		.20	140,200		.20	196,200		.20		
.30	41,450		.30	56,100		.30	73,400		.30	100,900		.30	142,800		.30	199,300	3100	.30		
.40	42,100		.40	56,900		.40	74,400	1,000	.40	102,200		.40	145,400		.40	202,400		.40		
.50	42,750		.50	57,700		.50	75,400	1,100	.50	104,000		.50	148,000		.50			.50		
.60	43,400		.60	58,500		.60	76,500		.60	105,800		.60	150,600		.60			.60		
.70	44,050		.70	59,300	800	.70	77,600	1,100	.70	107,600		.70	153,200		.70			.70		
.80	44,700		.80	60,100	850	.80	78,700	1,200	.80	109,400		.80	155,800		.80			.80		
.90	45,350	650	.90	60,950		.90	79,900		.90	111,200	1,800	.90	158,400	2,600	.90			.90		
15.00	46,000	750	17.00	61,800		19.00	81,100	1,200	21.00	113,000	2,200	23.00	161,000	2,900	.00			.00		
.10	46,750		.10	62,650		.10	82,300	1,300	.10	115,200		.10	163,900		.10			.10		
.20	47,500		.20	63,500		.20	83,600		.20	117,400		.20	166,800		.20			.20		
.30	48,250		.30	64,350		.30	84,900	1,300	.30	119,600		.30	169,700		.30			.30		
.40	49,000		.40	65,200		.40	86,200	1,400	.40	121,800		.40	172,600		.40			.40		
.50	49,750	750	.50	66,050	850	.50	87,600		.50	124,000		.50	175,500		.50			.50		
.60	50,500	800	.60	66,900	900	.60	89,000	1,400	.60	126,200		.60	178,400		.60			.60		
.70	51,300		.70	67,800		.70	90,400	1,500	.70	128,400		.70	181,300		.70			.70		
.80	52,100		.80	68,700		.80	91,900	1,500	.80	130,600		.80	184,200		.80			.80		
.90	52,900	800	.90	69,600	900	.90	93,400	1,600	.90	132,800	2,200	.90	187,100	2,900	.90			.90		

TABLE 18 12345

This table is applicable for open-channel conditions. It is based on ..... discharge measurements made during .....
..... and is ..... well defined between ..... cfs and ..... cfs.

Comp by WHH date 8-2-66
Ckd by DLG date 12-20-66
Table No. 10

U.S. GOVERNMENT PRINTING OFFICE : 1963 O—688-390

Sheet 2 of 2

CBT	USGS SITE NUMBER	STATION NAME
GPR	14186100	Green Peter Lake Nr Foster
QCCO	14185900	Quartzville Cr. Nr Cascadia

Bald Peter

Thistle Creek Access

Whitcomb Creek Park

Foots Canyon

Green Peter Peninsula

Whitcomb Island

Green Peter Lake

GREEN PETER DAM

GPR

Power house

Billings Park

Haul Rd

QCCO

Rocky Top Rd

Rocky Top

Forest Boundary

National

T. 12 S., R. 2 E., W.M.
T. 13 S., R. 2 E., W.M.
R. 2 E.
R. 3 E.
T. 12 S., R. 3 E., W.M.
T. 12 S., R. 4 E., W.M.

SCALE IN FEET
3300 0 3300 6600
CONTOUR INTERVAL 200 FEET

STREAM GAGES

GREENPETER LAKE
Lane County, Oregon

SIGNIFICANT PROJECT FEATURES

- Project Boundary
- Green Peter Dam
- Maximum Pool (Elev. 1,015.0 Ft.)
- Minimum Flood Control Pool (Elev. 922.0 Ft.)
- Stream gage (point of triangle at location)
- Precipitation Station
- Telemetered
- Mountain Peak

Produced by GIS, Survey and Mapping Section, Geotechnical Engineering Branch
U.S. Army Engineer District, Portland
CENPP-PE-HR

CBT	USGS SITE NUMBER	STATION NAME
FOS	14186600	Foster Lake at Foster
SSFO	14187200	S. Santiam River Nr Foster

N

Morgan Creek

Johnson Creek

Sunnyside Road

Sunnyside Creek

Gedney Creek

Lewis Cr.

Hugus Cr.

Coast Creek

Big Alder Cr.

Green Peter Lake

GREEN PETER DAM

Road

Sunnyside Park

Lewis Cr. Park

Gedney Creek Park

FOS

FOSTER DAM

FOSTER LAKE

SSFO

Andrew Wiley Park

Shea Point

Calkins Park

Menear Bend Park

Oregon Electric

To Sweet Home

FOSTER

Willey Creek

Ralston Cr.

T 13 S R 1 E.

T 13 S R 2 E.

Cheadle

Cheadle Ridge Road

Hufford

HUFFORD

SANTIAM RIVER

MIDDLE SANTIAM RIVER

SOUTH SANTIAM RIVER

Dunbar Flat

To Bend

Produced by GIS, Survey and Mapping Section, Geotechnical Engineering Branch

SCALE IN FEET

3000 0 3000 6000

CONTOUR INTERVAL 200 FEET

STREAM GAGES

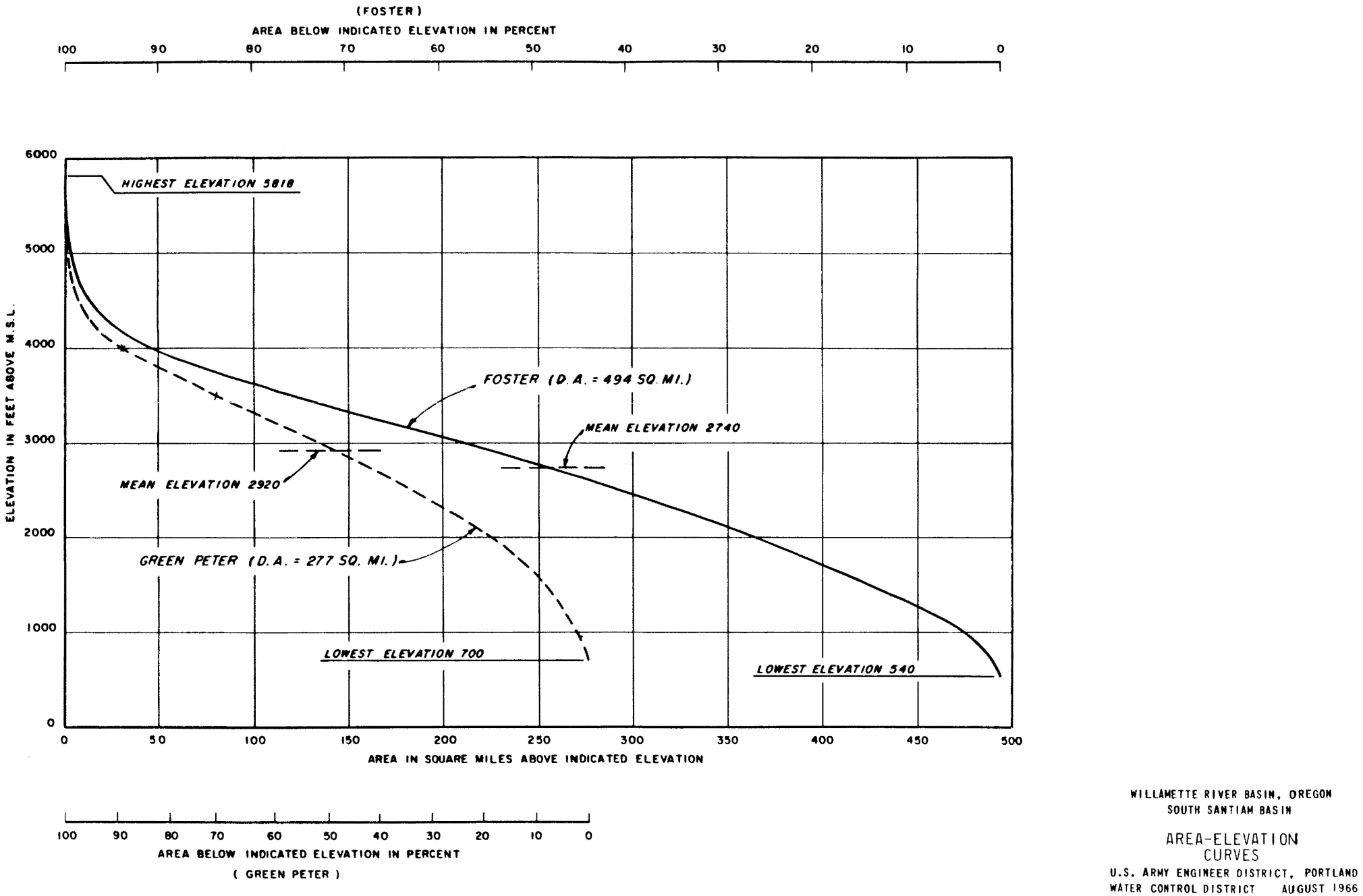
FOSTER LAKE

Lane County, Oregon

SIGNIFICANT PROJECT FEATURES

- Project Boundary
- Foster Dam
- Maximum Pool (Elev. 637.0 Ft.)
- Minimum Flood Control Pool (Elev. 613.0 Ft.)
- Stream gage (point of triangle at location)
- Precipitation Station
- Telemetered
- Mountain Peak

U.S. Army Engineer District, Portland CENPP-PE-HR



WILLAMETTE RIVER BASIN, OREGON
SOUTH SANTIAM BASIN

AREA-ELEVATION CURVES

U.S. ARMY ENGINEER DISTRICT, PORTLAND
WATER CONTROL DISTRICT AUGUST 1966
PREPARED: CEJ, PBB CHECKED: GEG

GP-20-24/4

CHART 1

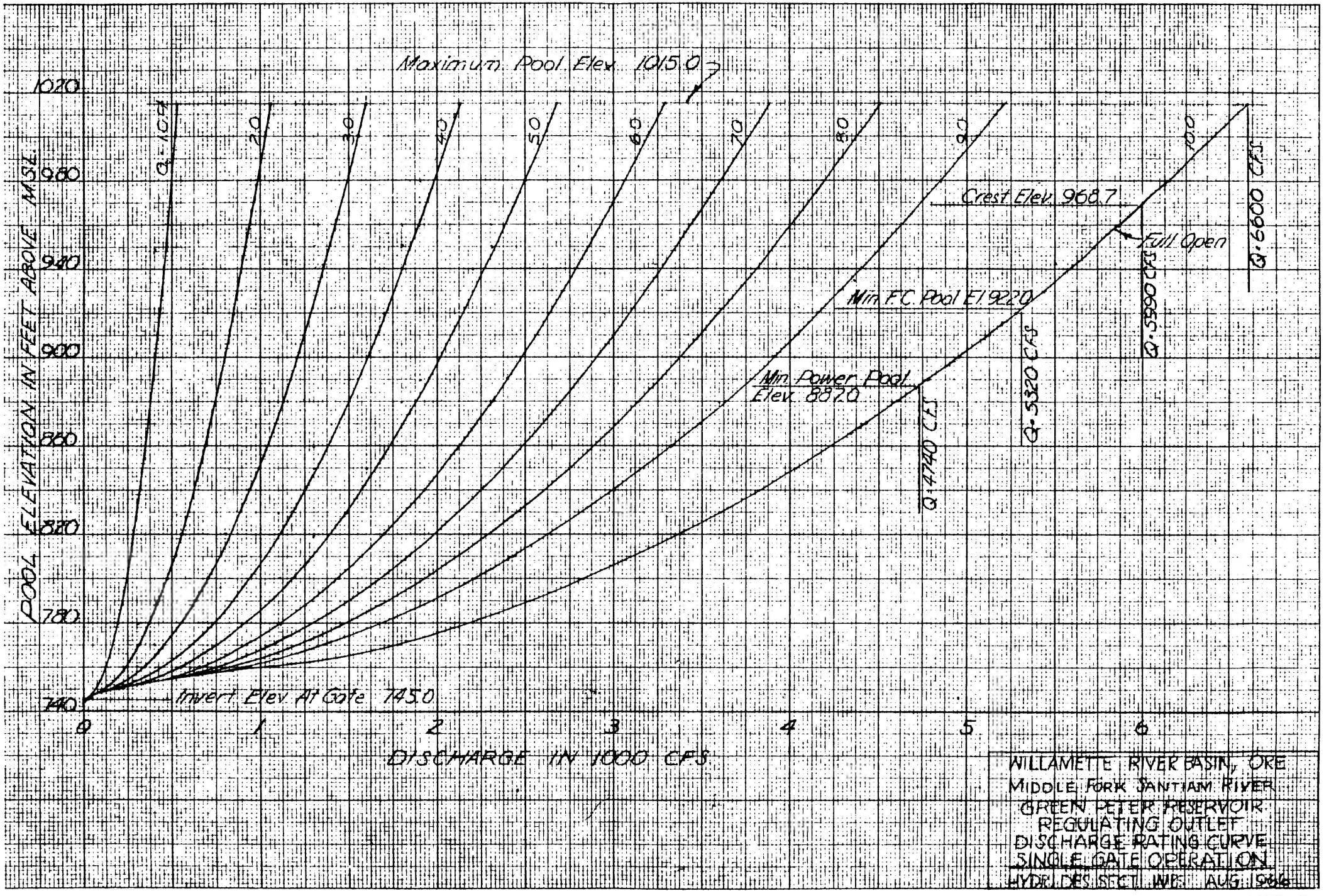
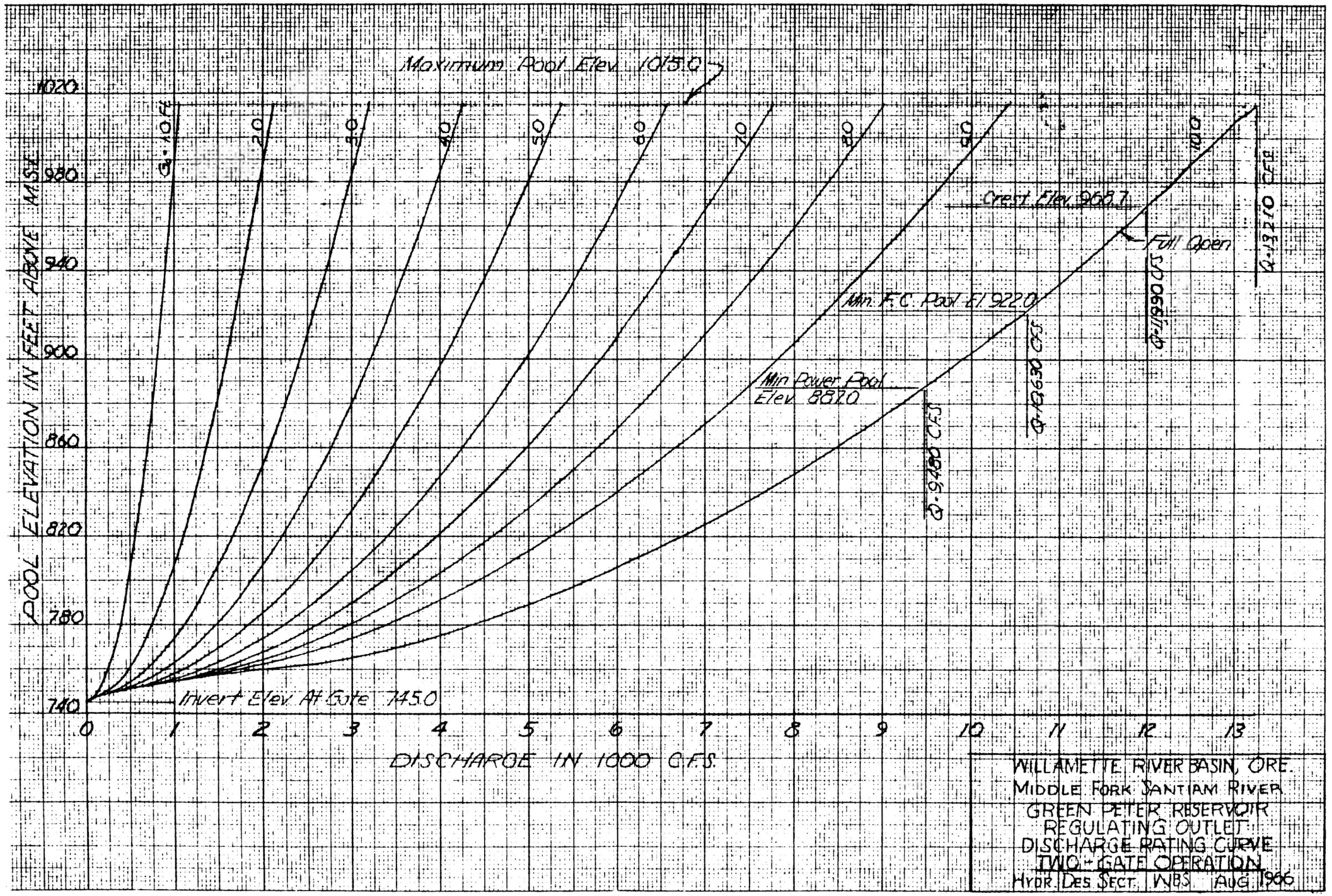

Maximum Pool Elev 1015.0
1020
980
940
900
860
820
780
740
POOL ELEVATION IN FEET ABOVE MSL
Q=1074
20
30
40
50
60
70
80
90
100
Crest Elev 968.7
Full Open
Q=6600 CFS
Q=5550 CFS
Min F.C. Pool El 922.0
Q=5320 CFS
Min Power Pool
Elev 887.0
Q=4740 CFS
Invert Elev At Gate 745.0
0
1
2
3
4
5
6
DISCHARGE IN 1000 CFS
WILLAMETTE RIVER BASIN, ORE
MIDDLE FORK SANTIAM RIVER
GREEN PETER RESERVOIR
REGULATING OUTLET
DISCHARGE RATING CURVE
SINGLE GATE OPERATION
HYDR DES SECT WPB AUG 1966

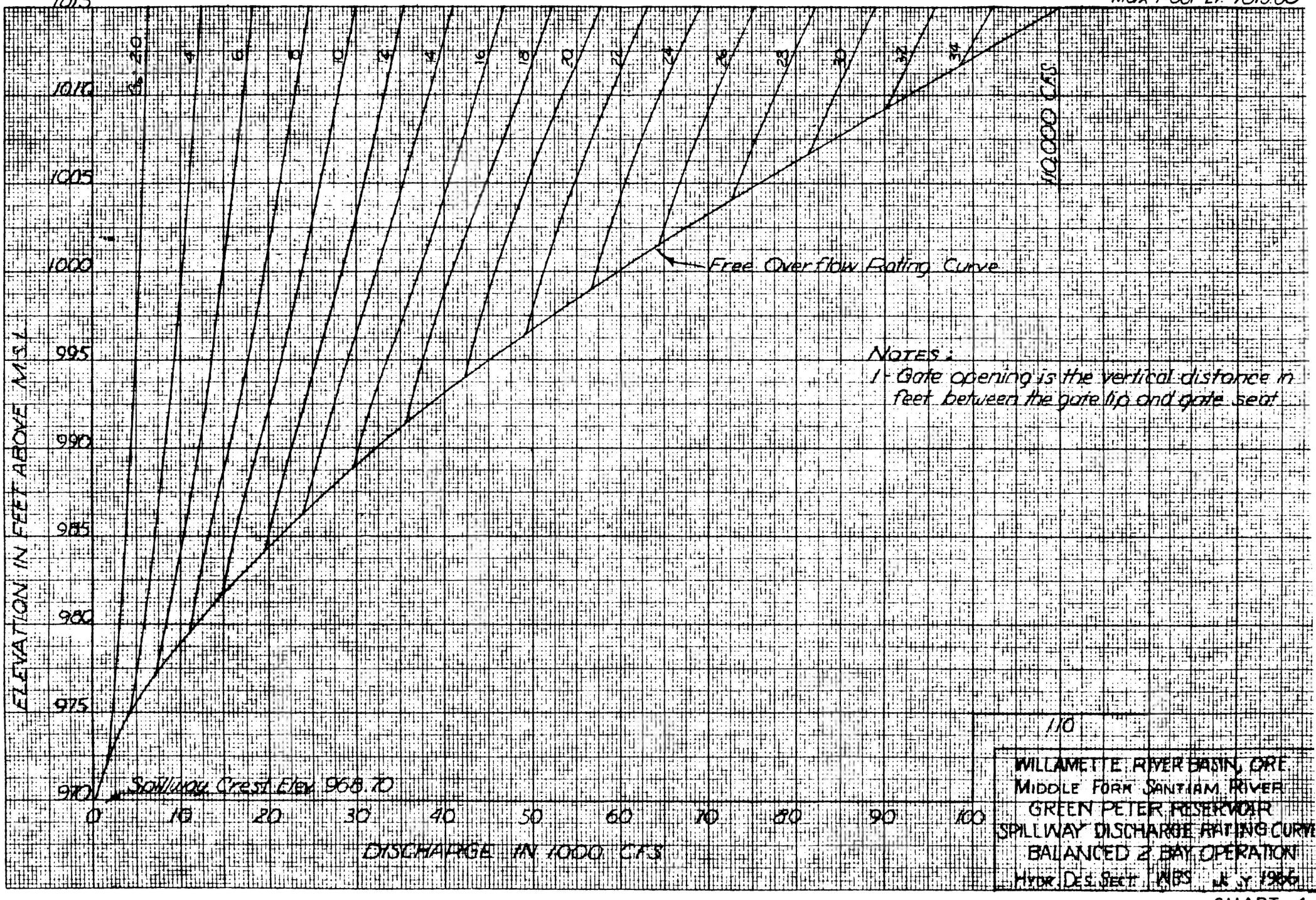
CHART 2

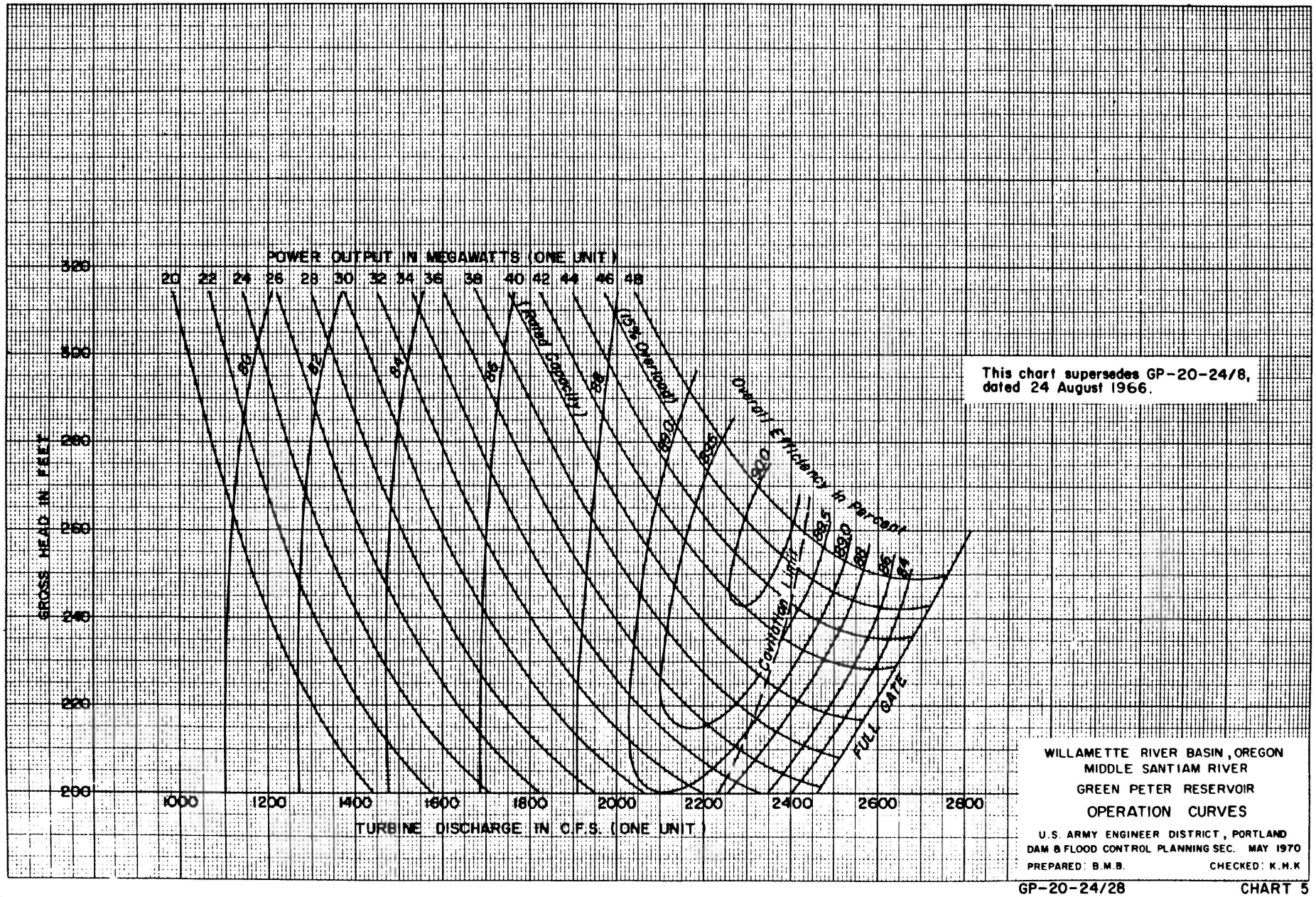


WILLAMETTE RIVER BASIN, ORE.
MIDDLE FORK SANTIAM RIVER
GREEN PETER RESERVOIR
REGULATING OUTLET
DISCHARGE RATING CURVE
TWO-GATE OPERATION
HYDR. DES SECT. WBS AUG. 1966

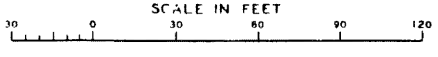
GP-20-24/6

CHART 3


Max Pool El. 1015.00
1015
1010
1005
1000
995
990
985
980
975
970
ELEVATION IN FEET ABOVE M.S.L.
Spillway Crest Elev. 968.70
0
10
20
30
40
50
60
70
80
90
100
110
DISCHARGE IN 1000 C.F.S.
10,000 C.F.S.
Free Overflow Rating Curve
Notes:
1- Gate opening is the vertical distance in feet between the gate lip and gate seat
WILLAMETTE RIVER BASIN, ORE.
MIDDLE FORK SANTIAM RIVER
GREEN PETER RESERVOIR
SPILLWAY DISCHARGE RATING CURVE
BALANCED 2 BAY OPERATION
HYDR. DES. SECT. NPD'S JULY 1966
GP-20-24/7
CHART 4


POWER OUTPUT IN MEGAWATTS (ONE UNIT)
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
GROSS HEAD IN FEET
300
280
260
240
220
200
1000 1200 1400 1600 1800 2000 2200 2400 2600 2800
TURBINE DISCHARGE IN C.F.S. (ONE UNIT)
Rated Capacity (13% Overload)
Overall Efficiency in Percent
Cavitation Limit
FULL GATE
This chart supersedes GP-20-24/8, dated 24 August 1966.
WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER RESERVOIR
OPERATION CURVES
U.S. ARMY ENGINEER DISTRICT, PORTLAND
DAM & FLOOD CONTROL PLANNING SEC. MAY 1970
PREPARED: B.M.B. CHECKED: K.M.K
GP-20-24/28 CHART 5

11-28-70



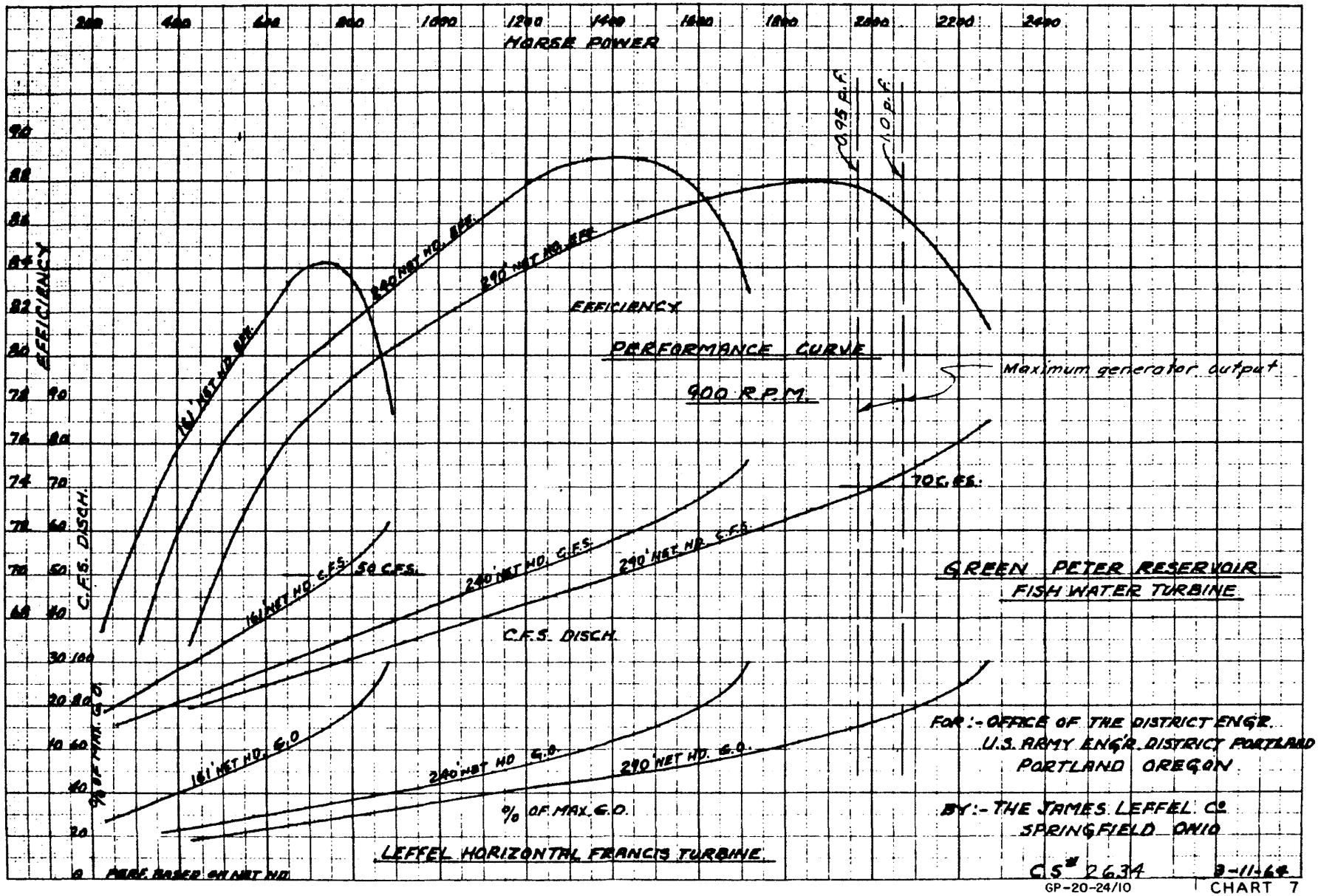
WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER DAM

UPSTREAM MIGRANT FISH FACILITIES

U. S. ARMY ENGINEER DISTRICT, PORTLAND
OCTOBER 1966

GP-20-24/9

CHART 6


HORSE POWER
EFFICIENCY
C.F.S. DISCH.
% OF MAX. G.O.
0.95 P.F.
1.0 P.F.
161' NET HD. EFF.
240' NET HD. EFF.
290' NET HD. EFF.
EFFICIENCY
PERFORMANCE CURVE
900 R.P.M.
Maximum generator output
70 C.F.S.
50 C.F.S.
161' NET HD. C.F.S.
240' NET HD. C.F.S.
290' NET HD. C.F.S.
GREEN PETER RESERVOIR
FISH WATER TURBINE
C.F.S. DISCH.
161' NET HD. G.O.
240' NET HD. G.O.
290' NET HD. G.O.
% OF MAX. G.O.
LEFFEL HORIZONTAL FRANCIS TURBINE
FOR:- OFFICE OF THE DISTRICT ENGR.
U.S. ARMY ENG'R. DISTRICT PORTLAND
PORTLAND OREGON
BY:- THE JAMES LEFFEL Co.
SPRINGFIELD OHIO
CS# 26314
9-11-62
GP-20-24/10
CHART 7

SCALE IN FEET

30 0 30 60 90 120

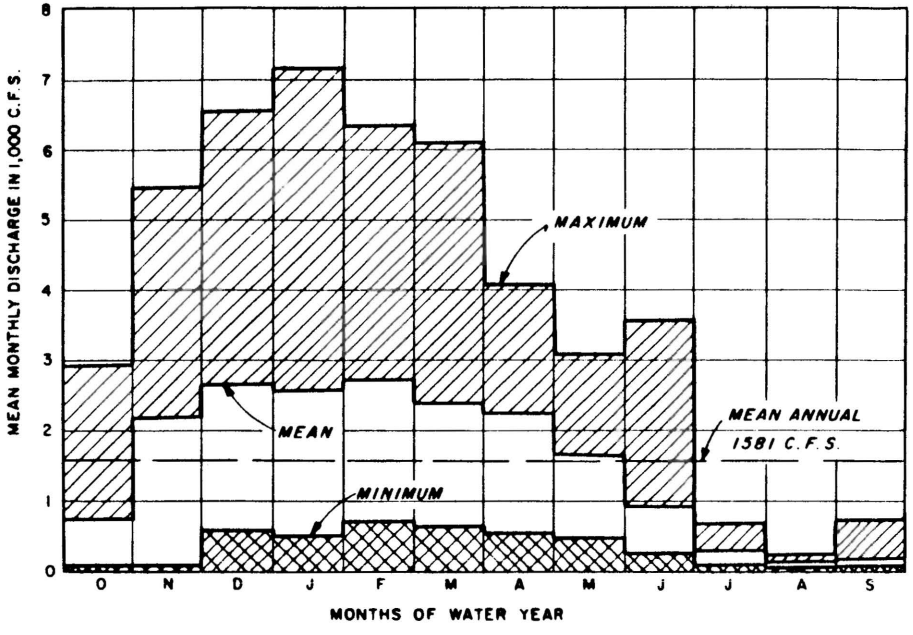
WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER DAM

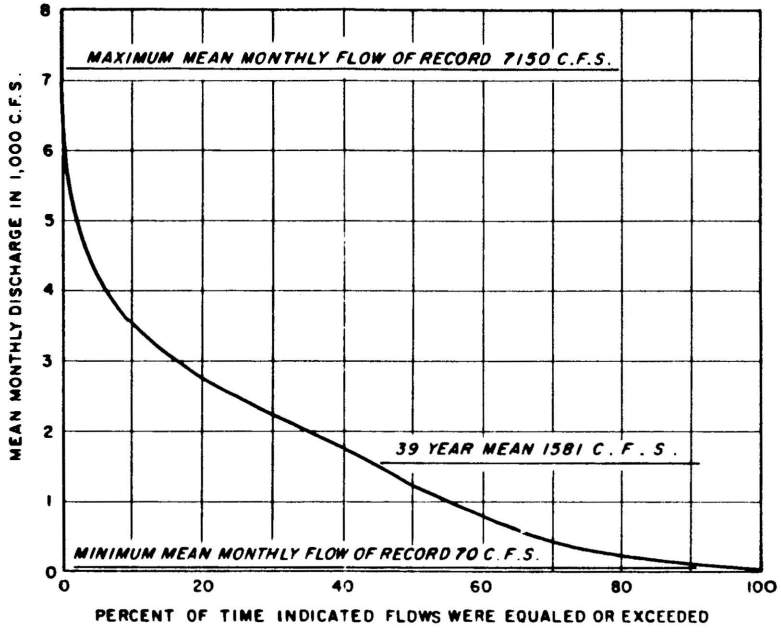
DOWNSTREAM MIGRANT FISH FACILITIES

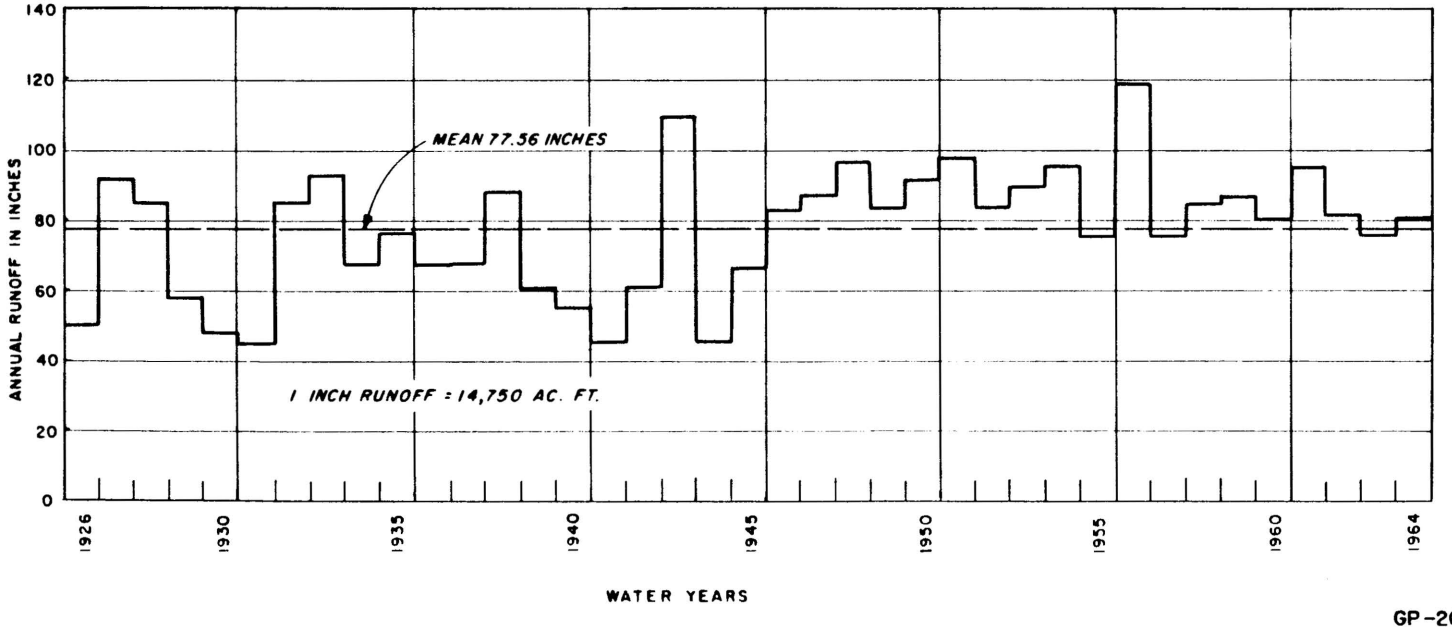
U. S. ARMY ENGINEER DISTRICT, PORTLAND
OCTOBER 1966

GP-20-24/11

CHART 8







NOTE:

MEAN MONTHLY DISCHARGES ESTIMATED FROM RECORDS OBSERVED ON THE MIDDLE AND SOUTH SANTIAM RIVERS.

WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER RESERVOIR

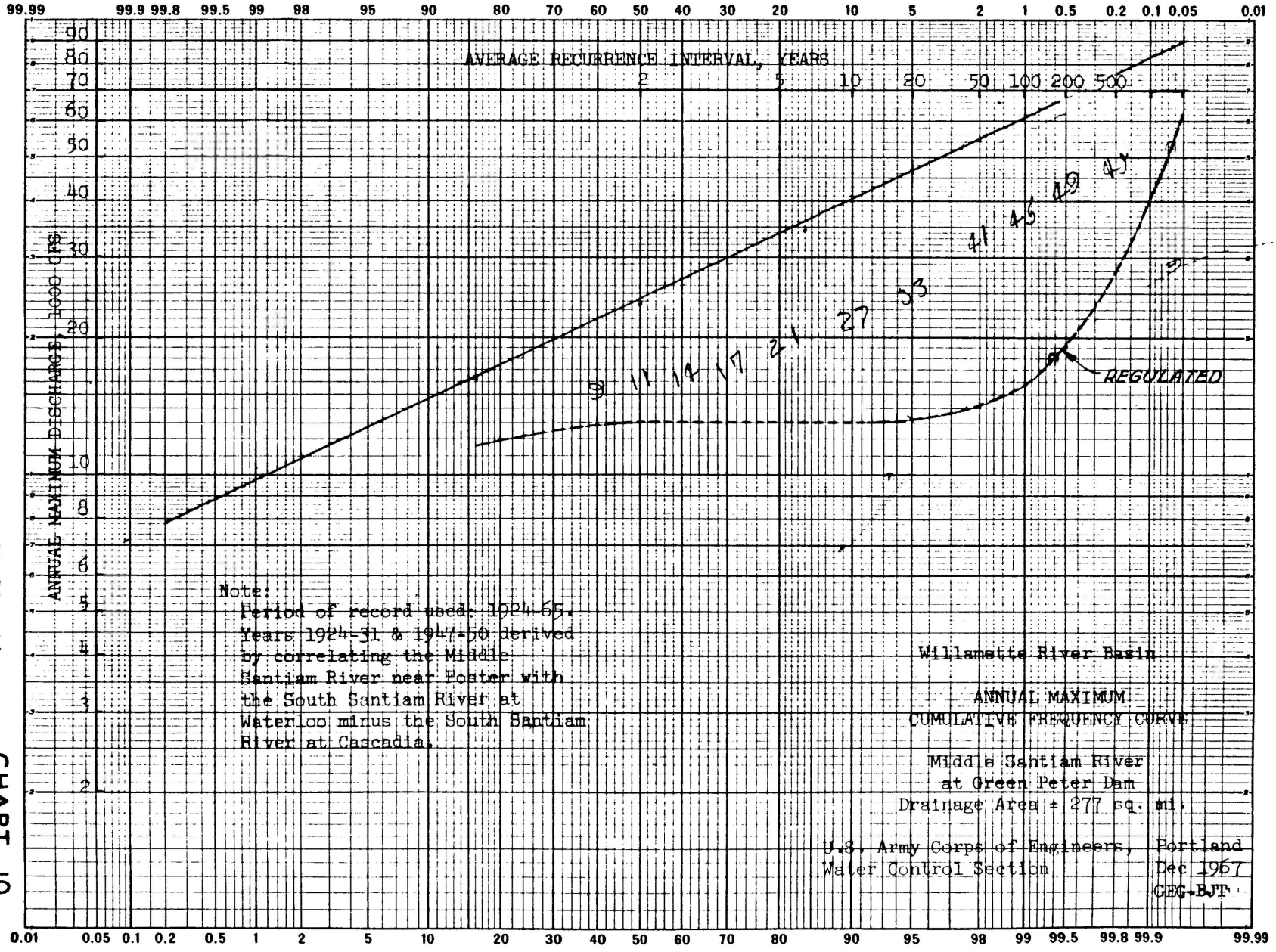
RUNOFF SUMMARY

DRAINAGE AREA 277 SQUARE MILES

U.S. ARMY ENGINEER DISTRICT, PORTLAND
WATER CONTROL SECTION AUGUST 1966
PREPARED: R.L.W. CHECKED: J.W.H.

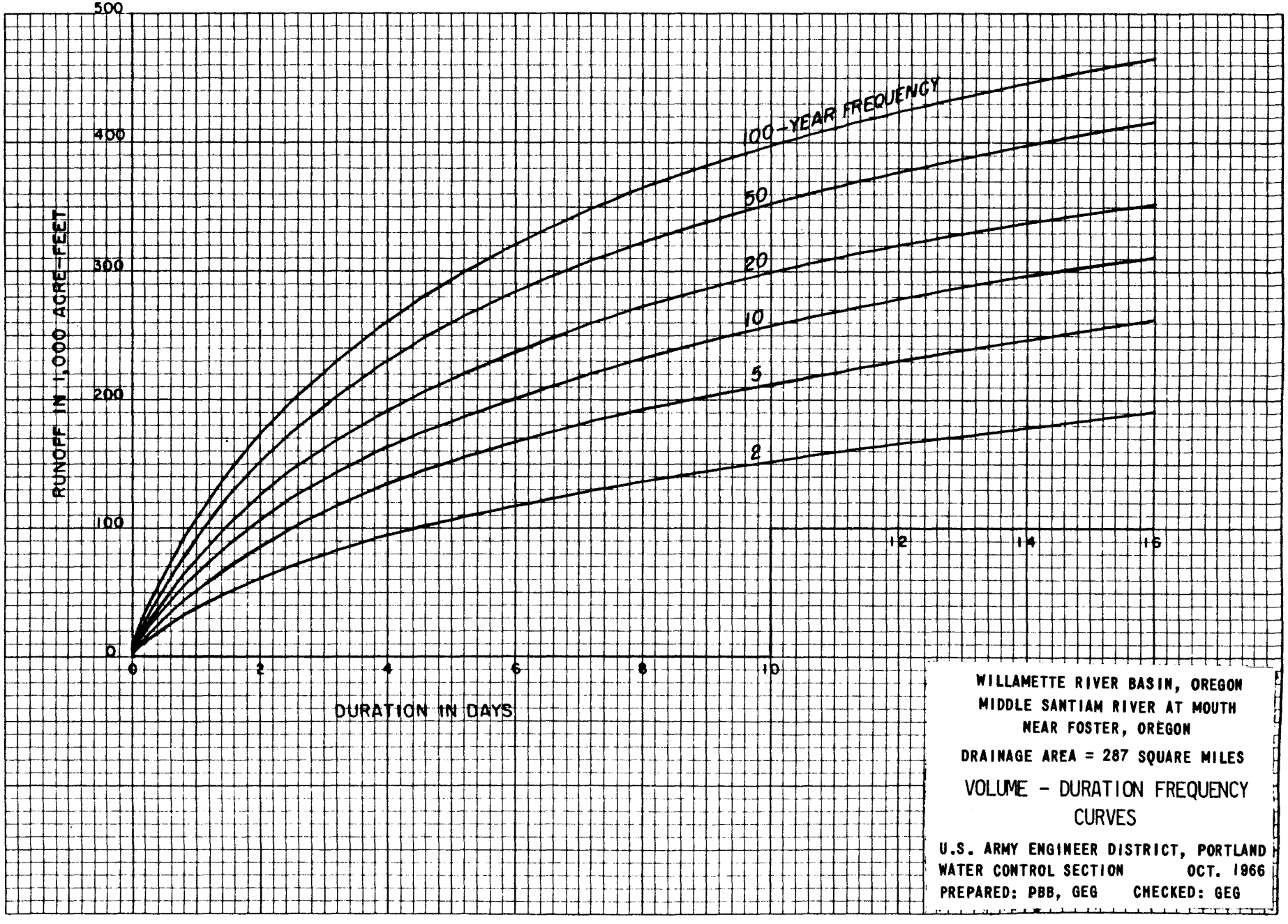
GP-20-24/12

CHART 9



GP-20-24/13

CHART 10



GP-20-24/14

CHART 11

JANUARY 5 10 15 20 25 | FEBRUARY 5 10 15 20 25 | MARCH 5 10 15 20 25 | APRIL 5 10 15 20 25 | MAY 5 10 15 20 25 | JUNE 5 10 15 20 25 | JULY 5 10 15 20 25 | AUGUST 5 10 15 20 25 | SEPTEMBER 5 10 15 20 25 | OCTOBER 5 10 15 20 25 | NOVEMBER 5 10 15 20 25 | DECEMBER 5 10 15 20 25

MAJOR FLOOD PERIOD
Hold evacuated for flood control

CONSERVATION STORING PERIOD
Hold reservoir full for conservation purposes. Do not exceed schedule except as required to regulate floods during this period.

CONSERVATION RELEASE PERIOD
Release stored water for conservation as required

MAJOR FLOOD PERIOD
Hold evacuated for flood control

Full and maximum pool
El. 1015, 430,000 acre-feet

Summer Flood Control Reservation, 20,000 ac-ft.

Maximum conservation pool
El. 1010, 410,000 acre-feet

Outflow equals inflow

500 C.F.S.

450 C.F.S.

MINIMUM LOW-WATER RELEASE
300 C.F.S.

Outflow equals inflow

Note:
Minimum flows are mean daily values. Instantaneous minimum limited to not less than 50 c.f.s.

Filling Rate 1,831 acre-feet/day

Primary Flood Control Storage
200,000 acre-feet

Stored water should not be retained later than indicated by this schedule, except in case of a flood

Filling Rate 4,286 acre-feet/day

Top of secondary flood control storage El. 952
230,000 acre-feet

Minimum rate that secondary flood control storage will be evacuated. Full generator capacity shall be used to evacuate secondary flood control storage, which normally will be accomplished at a faster rate than the indicated minimum. The above schedule applies to any time that stored water in the secondary flood control storage space has to be evacuated.

Secondary Flood Control Storage
70,000 acre-feet

Minimum flood control pool
El. 922, 160,000 acre-feet

Exclusive Power Storage
63,000 acre-feet

Minimum power pool
El. 887, 97,000 acre-feet

Inactive Storage (El. 735-887) 95,875 acre-feet
Dead Storage (El. 700-748) 1,125 acre-feet
97,000 acre-feet

Inactive and Dead Storage
97,000 acre-feet

STORAGE IN 1,000 ACRE-FEET

0 40 80 120 160 200 240 280 320 360 400 440

WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER RESERVOIR
ANNUAL REGULATION SCHEDULE
DRAINAGE AREA 277 SQUARE MILES
U.S. ARMY ENGINEER DISTRICT, PORTLAND
WATER CONTROL SECTION — JUNE 1961
REVISED DEC 1967 — J.W.H., C.E.O.

GP-20-11/5

CHART 12

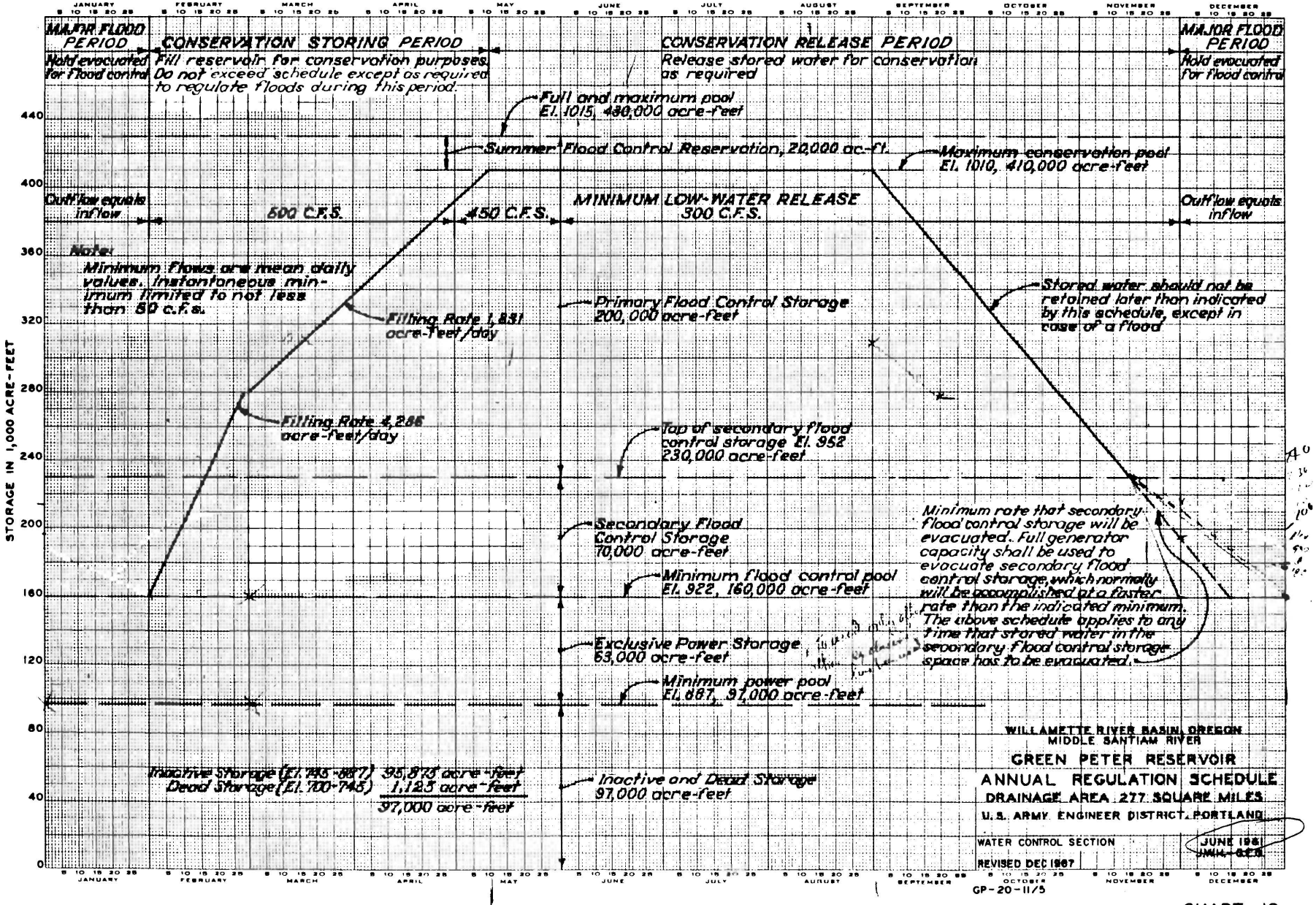

JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
MAJOR FLOOD PERIOD
Hold evacuated for flood control
CONSERVATION STORING PERIOD
Fill reservoir for conservation purposes. Do not exceed schedule except as required to regulate floods during this period.
CONSERVATION RELEASE PERIOD
Release stored water for conservation as required
MAJOR FLOOD PERIOD
Hold evacuated for flood control
Full and maximum pool El. 1015, 430,000 acre-feet
Summer Flood Control Reservation, 20,000 ac-ft.
Maximum conservation pool El. 1010, 410,000 acre-feet
Outflow equals inflow
500 C.F.S.
450 C.F.S.
MINIMUM LOW-WATER RELEASE 300 C.F.S.
Outflow equals inflow
Note: Minimum flows are mean daily values. Instantaneous minimum limited to not less than 80 c.f.s.
Filling Rate 1,831 acre-feet/day
Primary Flood Control Storage 200,000 acre-feet
Stored water should not be retained later than indicated by this schedule, except in case of a flood
Filling Rate 4,286 acre-feet/day
Top of secondary flood control storage El. 952 230,000 acre-feet
Secondary Flood Control Storage 70,000 acre-feet
Minimum flood control pool El. 922, 160,000 acre-feet
Minimum rate that secondary flood control storage will be evacuated. Full generator capacity shall be used to evacuate secondary flood control storage, which normally will be accomplished at a faster rate than the indicated minimum. The above schedule applies to any time that stored water in the secondary flood control storage space has to be evacuated.
Exclusive Power Storage 63,000 acre-feet
Minimum power pool El. 887, 97,000 acre-feet
Inactive Storage (El. 745-887) 95,875 acre-feet
Dead Storage (El. 700-745) 1,125 acre-feet
97,000 acre-feet
Inactive and Dead Storage 97,000 acre-feet
STORAGE IN 1,000 ACRE-FEET
0
40
80
120
160
200
240
280
320
360
400
440
WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER RESERVOIR
ANNUAL REGULATION SCHEDULE
DRAINAGE AREA 277 SQUARE MILES
U.S. ARMY ENGINEER DISTRICT, PORTLAND
WATER CONTROL SECTION
JUNE 1961
REVISED DEC 1967
GP-20-11/5

CHART 12

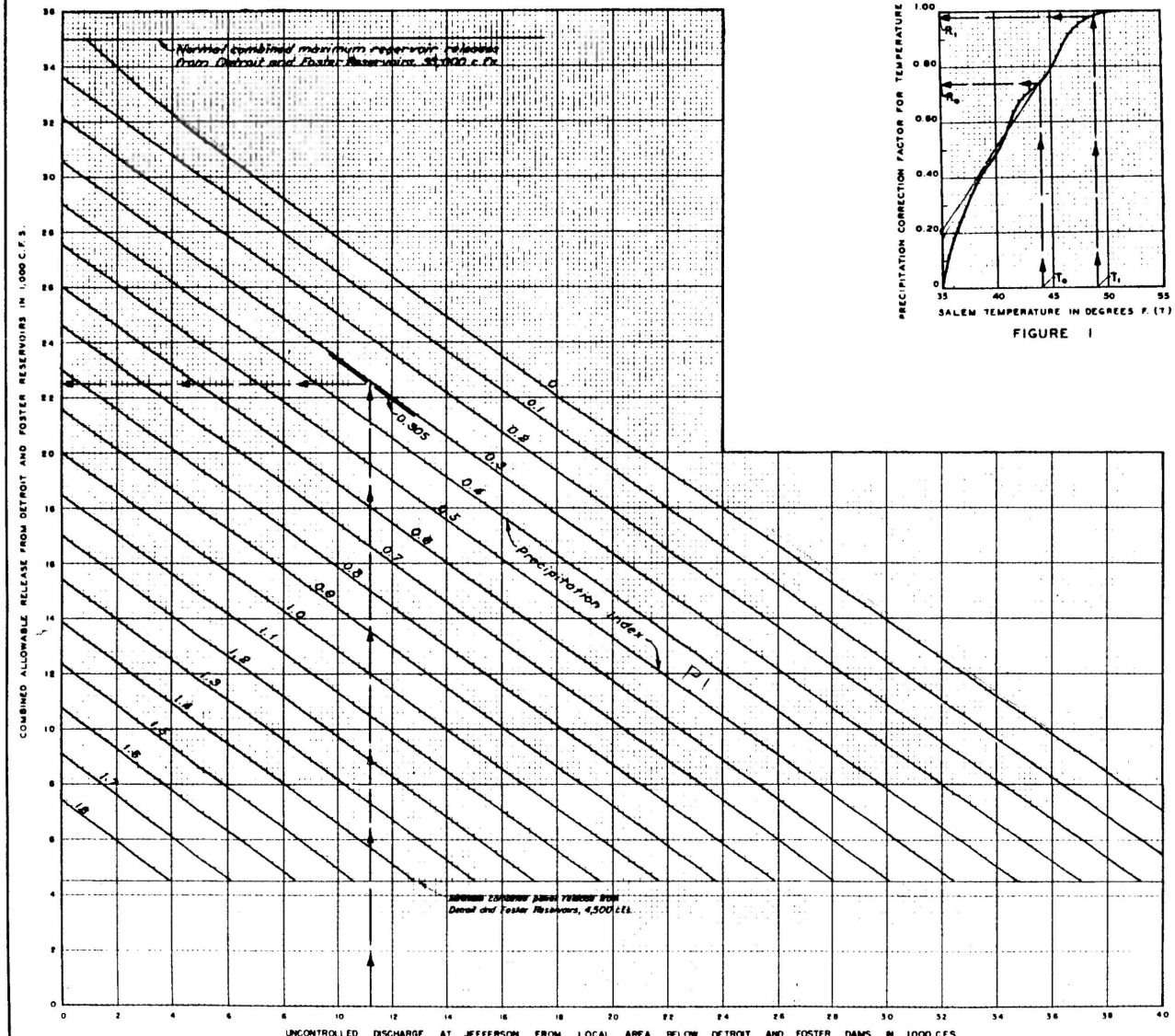


FIGURE 2

FIGURE 1

FORMULA FOR PRECIPITATION INDEX, (PI):

$$PI = P_0 R_0 + \frac{P_1 R_1}{4}$$

Where P_0 and P_1 are the average precipitation amounts recorded at Detroit and Foster Dams during the last (most recent) 6-hour period, and the previous 6-hour period, respectively. R_0 and R_1 are the ratios from Figure 1 for values of T_0 and T_1 which are average temperatures at Salem for the last 6-hour period, and the previous 6-hour period, respectively.

EXAMPLE DETERMINATION OF COMBINED ALLOWABLE RELEASE AT DETROIT AND FOSTER DAMS

GIVEN:

T_0 = 44° F. Average Salem temperature for the last (most recent) 6-hour period
T_1 = 49° F. Average Salem temperature for the previous 6-hour period
P_0 = 0.28 inches
P_1 = 0.40 inches
R_0 = 0.74 (From Figure 1)
R_1 = 0.98 (From Figure 1)

1. COMPUTATION OF PRECIPITATION INDEX (PI):

$$PI = P_0 R_0 + \frac{P_1 R_1}{4}$$

$$= (0.28 \times 0.74) + \frac{(0.40 \times 0.98)}{4}$$

$$PI = 0.305$$

2. COMPUTATION OF UNCONTROLLED LOCAL FLOW AT JEFFERSON

Present flow at Jefferson	= 22,200 c.f.s.
Release from Detroit 9 hours previously plus release from Foster 12 hours previously	= 11,000 c.f.s.
Present uncontrolled flow at Jefferson	= 11,200 c.f.s.

3. TO USE FIGURE 2:

Given: PI = 0.305 LOCAL = 11,200 c.f.s.

Enter "JEFFERSON LOCAL" on horizontal scale at 11,200 c.f.s.
Follow up to where this line intersects a precipitation index of 0.305
From this intersection point, follow a horizontal line to the vertical scale "COMBINED ALLOWABLE RELEASE" which reads 22,500 c.f.s. - the combined allowable release from Detroit and Foster Reservoirs.

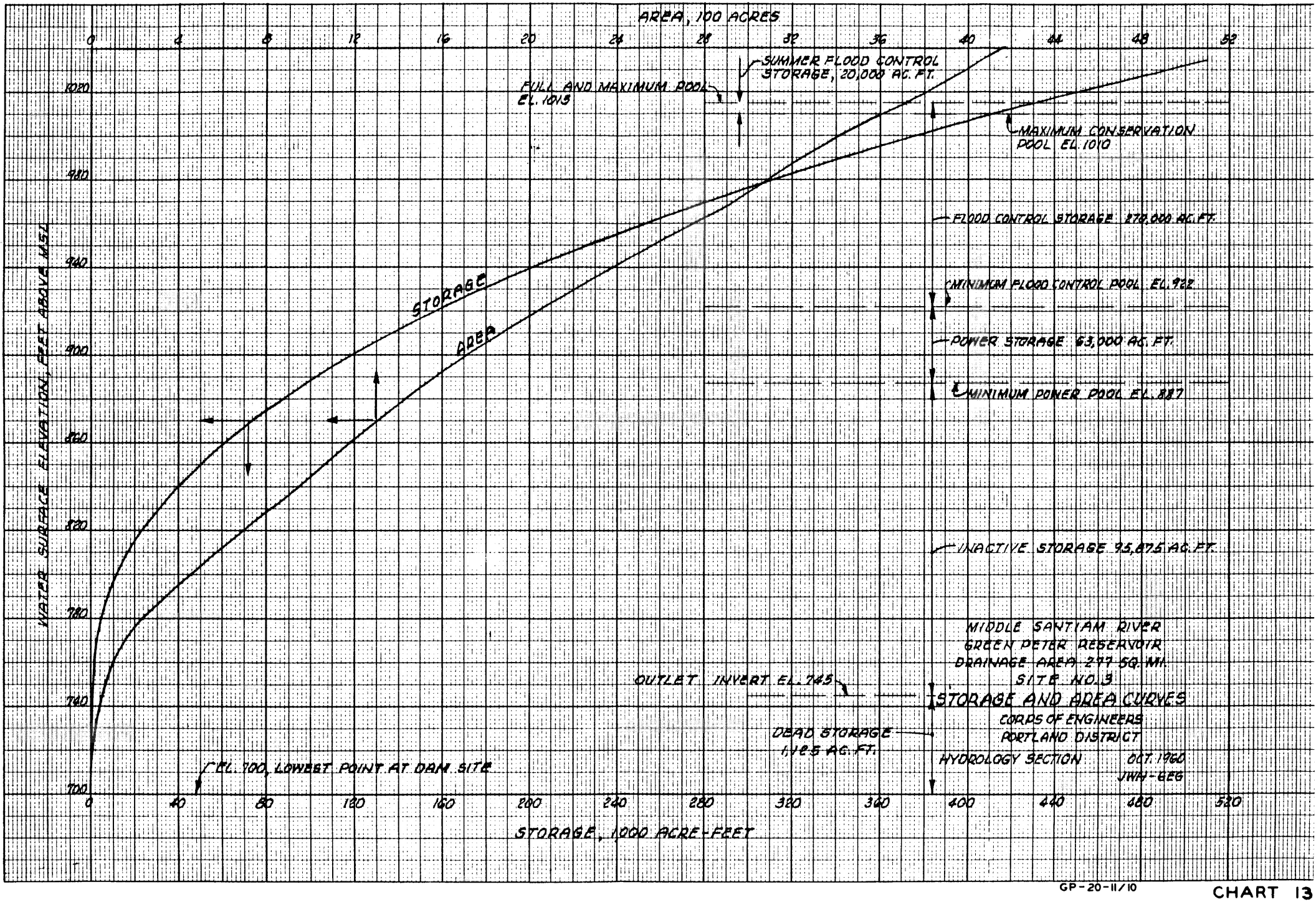
WILLAMETTE RIVER BASIN, OREGON
SANTIAM RIVER BASIN
GREEN PETER PROJECT

FLOOD CONTROL REGULATION SCHEDULES

U.S. ARMY ENGINEER DISTRICT, PORTLAND

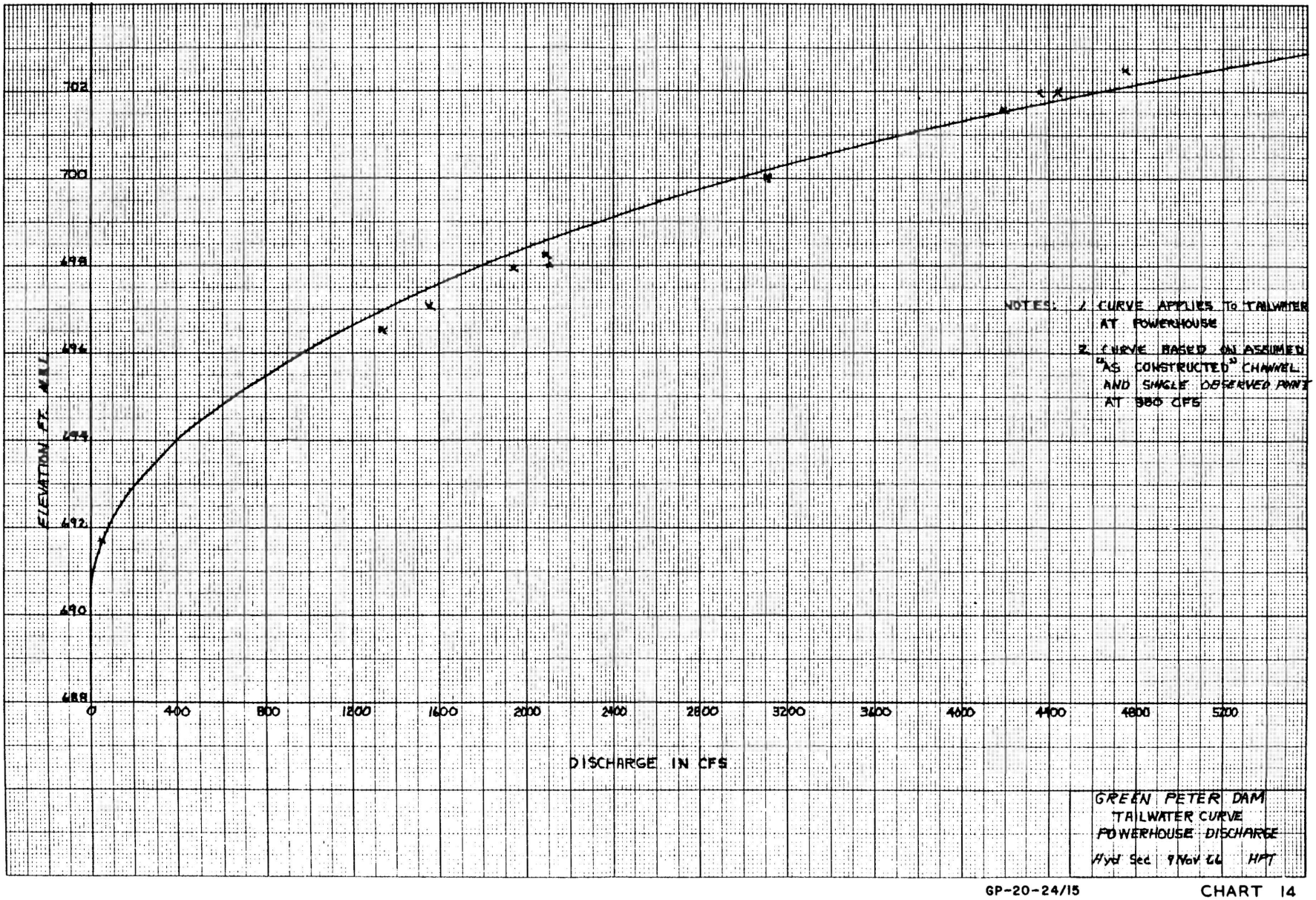
REVISED OCT 1967	WATER CONTROL SECTION PREPARED C.E.J.-JWM	JUNE 1961 CHECKED JWM

GP-20-11/7 CHART 13



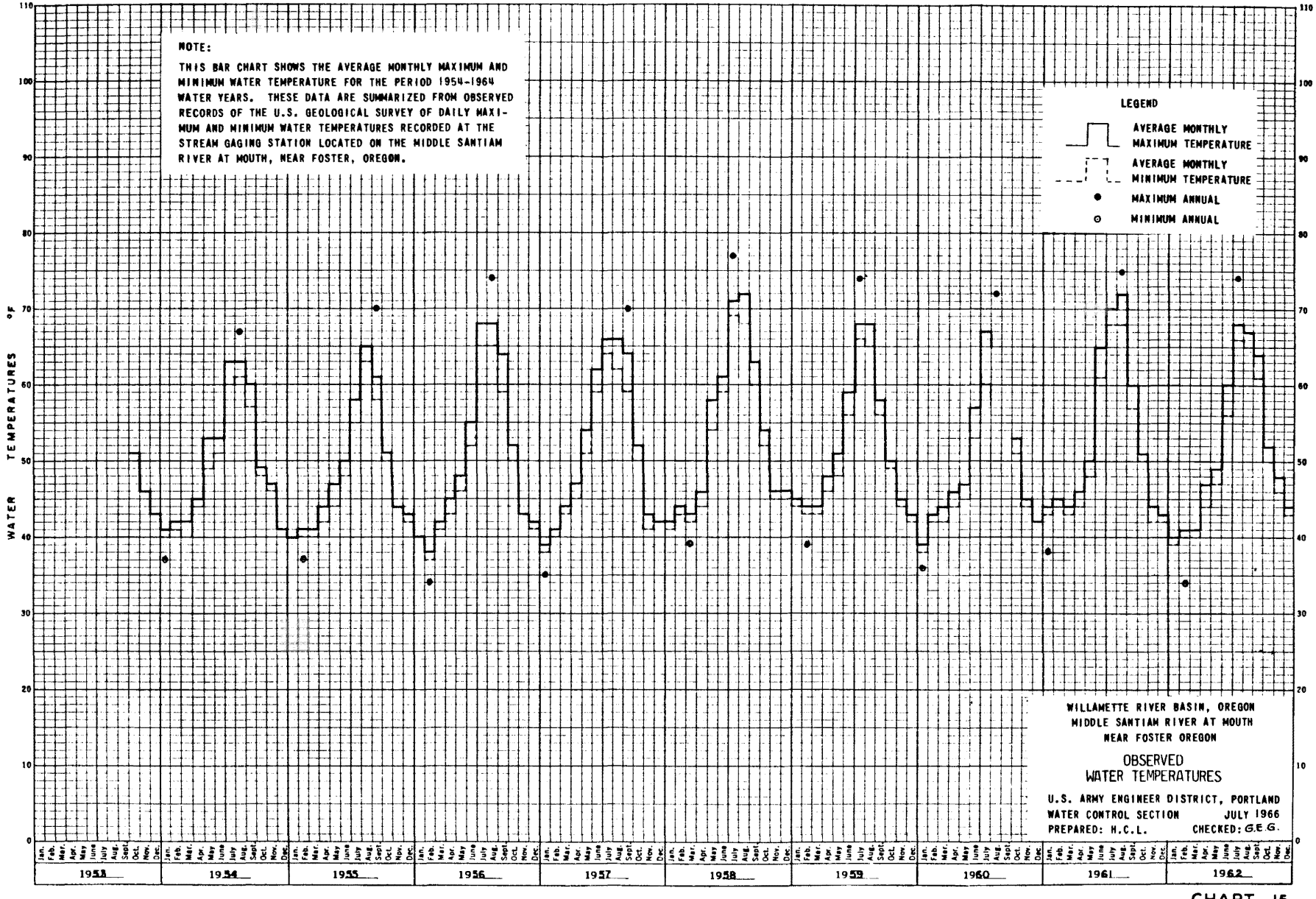
GP-20-11/10

CHART 13



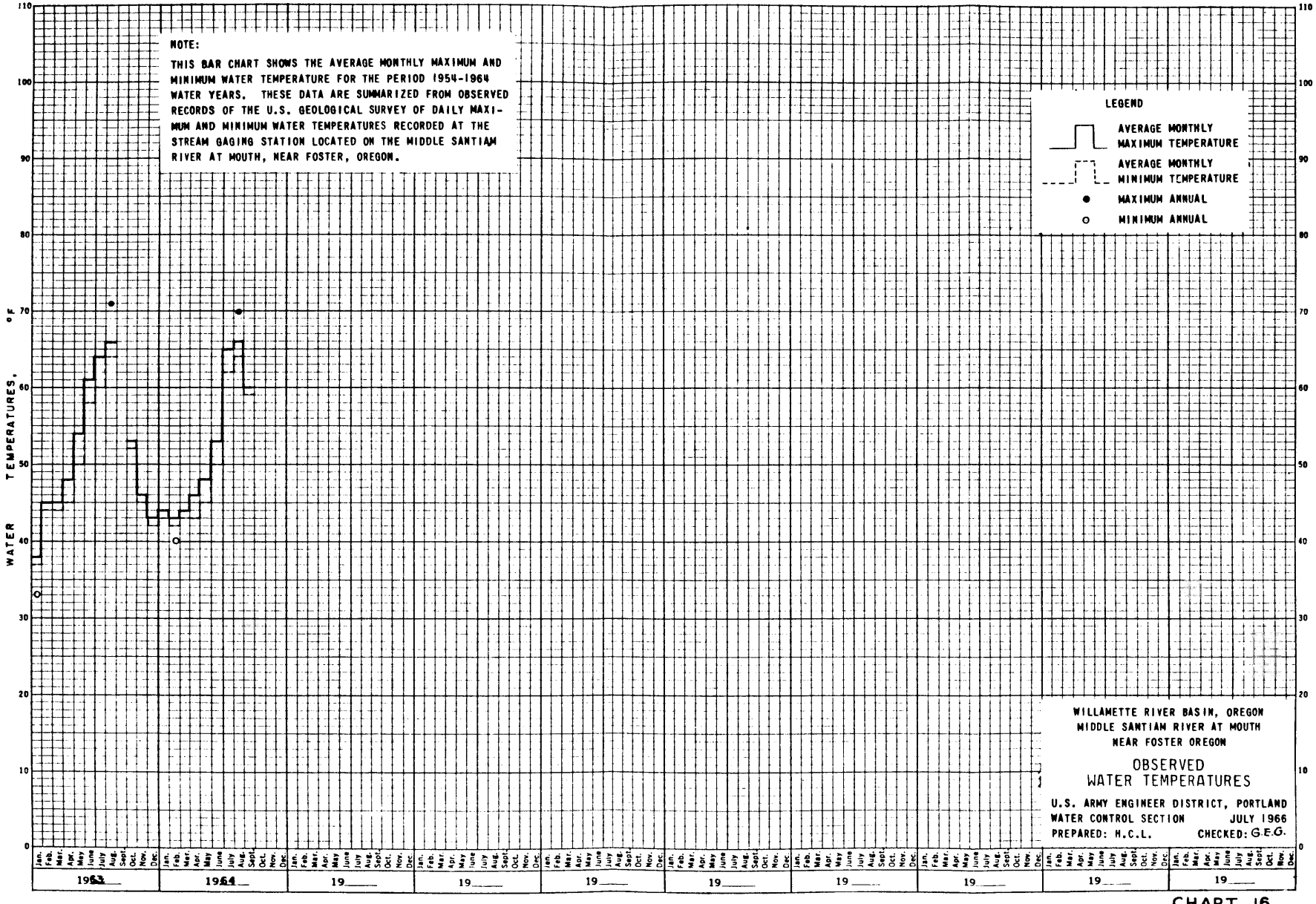
GP-20-24/15

CHART 14



GP-20-24/16

CHART 15



WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER AT MOUTH
NEAR FOSTER OREGON

OBSERVED WATER TEMPERATURES

U.S. ARMY ENGINEER DISTRICT, PORTLAND
WATER CONTROL SECTION JULY 1966
PREPARED: H.C.L. CHECKED: G.E.G.

GP-20-24/17

CHART 16

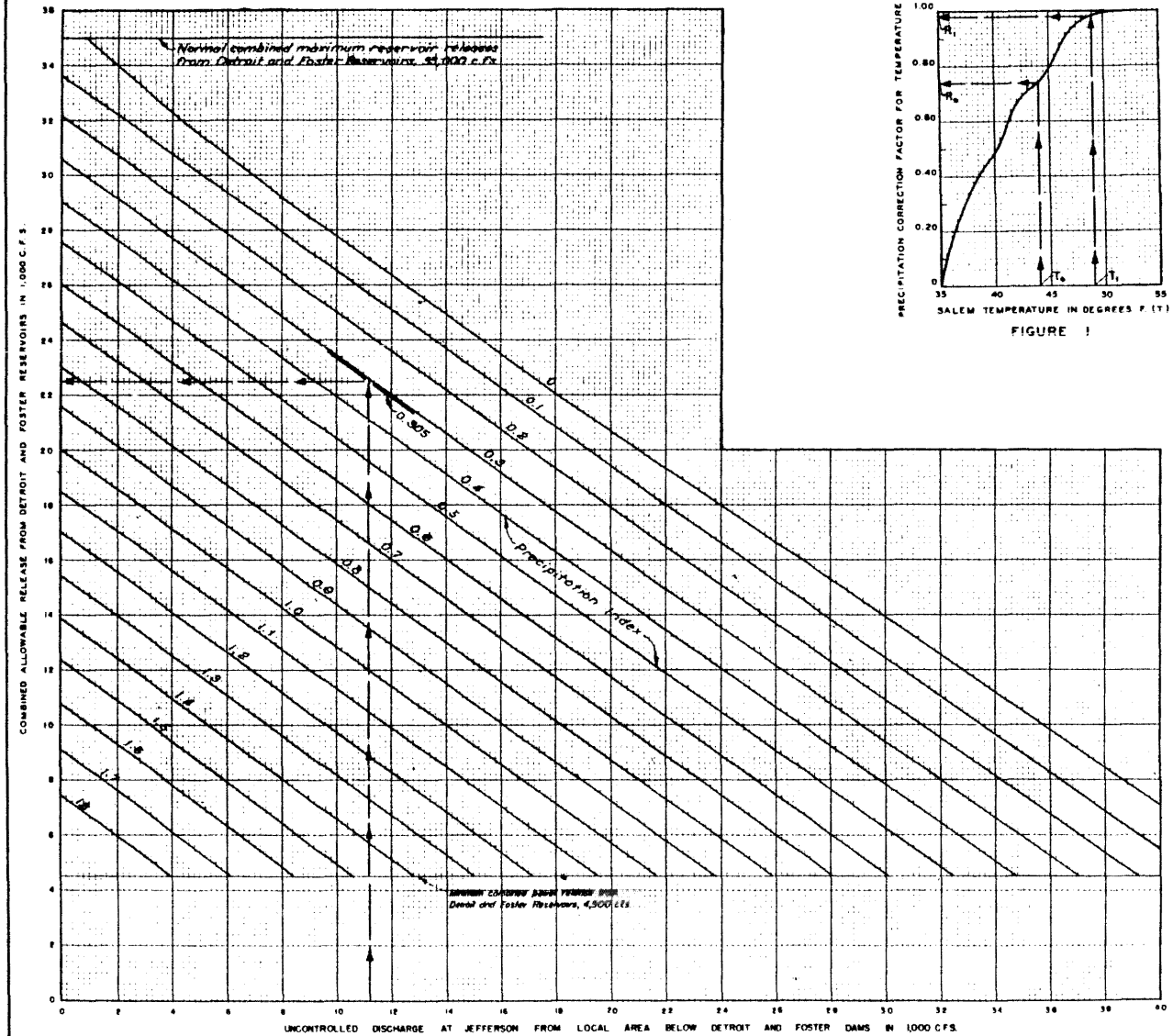


FIGURE 2

FIGURE 1

FORMULA FOR PRECIPITATION INDEX, (PI):

$$PI = P_1 R_0 + \frac{P_0 R_1}{4}$$

Where P_1 and P_0 are the average precipitation amounts recorded at Detroit and Foster Dams during the last (most recent) 6-hour period, and the previous 6-hour period, respectively. R_0 and R_1 are the ratios from Figure 1 for values of T_0 and T_1 which are average temperatures at Salem for the last 6-hour period, and the previous 6-hour period, respectively.

EXAMPLE: DETERMINATION OF COMBINED ALLOWABLE RELEASE AT DETROIT AND FOSTER DAMS

GIVEN:

T_0 = 44° F. Average Salem temperature for the last (most recent) 6-hour period
T_1 = 49° F. Average Salem temperature for the previous 6-hour period
P_0 = 0.28 inches
P_1 = 0.40 inches
R_0 = 0.74 (From Figure 1)
R_1 = 0.98 (From Figure 1)

1. COMPUTATION OF PRECIPITATION INDEX (PI):

$$PI = P_1 R_0 + \frac{P_0 R_1}{4}$$

$$= (0.28 \times 0.74) + \frac{(0.40 \times 0.98)}{4}$$

$$PI = 0.305$$

2. COMPUTATION OF UNCONTROLLED LOCAL FLOW AT JEFFERSON

Present flow at Jefferson	= 22,200 c.f.s.
Release from Detroit 6 hours previously plus release from Foster 12 hours previously	= 11,000 c.f.s.
Present uncontrolled flow at Jefferson	= 11,200 c.f.s.

3. TO USE FIGURE 2:

Given: PI = 0.305 LOCAL = 11,200 c.f.s.

Enter "JEFFERSON LOCAL" on horizontal scale at 11,200 c.f.s. Proceed up to where this line intersects a precipitation index of 0.305.

From this intersection point, follow a horizontal line to the vertical scale "COMBINED ALLOWABLE RELEASE" which reads 22,500 = 1.8. = the combined allowable release from Detroit and Foster Reservoirs.

WILLAMETTE RIVER BASIN, OREGON
SANTIAM RIVER BASIN
GREEN PETER PROJECT

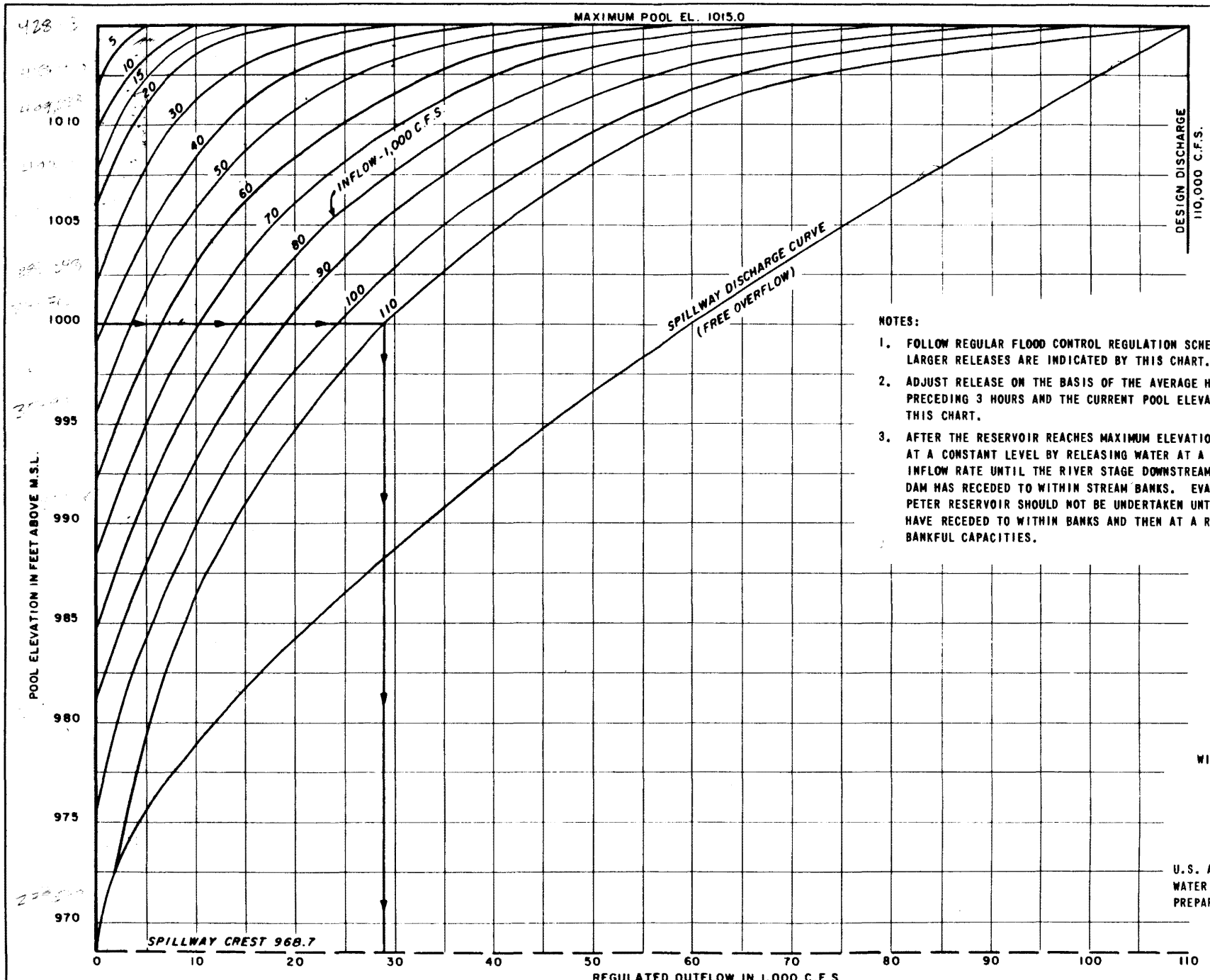
FLOOD CONTROL REGULATION SCHEDULES

U.S. ARMY ENGINEER DISTRICT, PORTLAND

REVISED OCT 1967

WATER CONTROL SECTION PREPARED CEJ - JWH JUNE 1961 CHECKED JWH

GP-20-11/7 CHART 17



NOTES:

1. FOLLOW REGULAR FLOOD CONTROL REGULATION SCHEDULE ON CHART 17 - UNTIL LARGER RELEASES ARE INDICATED BY THIS CHART.
2. ADJUST RELEASE ON THE BASIS OF THE AVERAGE HOURLY INFLOW FOR THE PRECEDING 3 HOURS AND THE CURRENT POOL ELEVATION AS INDICATED BY THIS CHART.
3. AFTER THE RESERVOIR REACHES MAXIMUM ELEVATION, MAINTAIN THE POOL AT A CONSTANT LEVEL BY RELEASING WATER AT A RATE EQUAL TO THE INFLOW RATE UNTIL THE RIVER STAGE DOWNSTREAM FROM GREEN PETER DAM HAS RECEDED TO WITHIN STREAM BANKS. EVACUATION OF GREEN PETER RESERVOIR SHOULD NOT BE UNDERTAKEN UNTIL DOWNSTREAM STAGES HAVE RECEDED TO WITHIN BANKS AND THEN AT A RATE NOT TO EXCEED BANKFUL CAPACITIES.

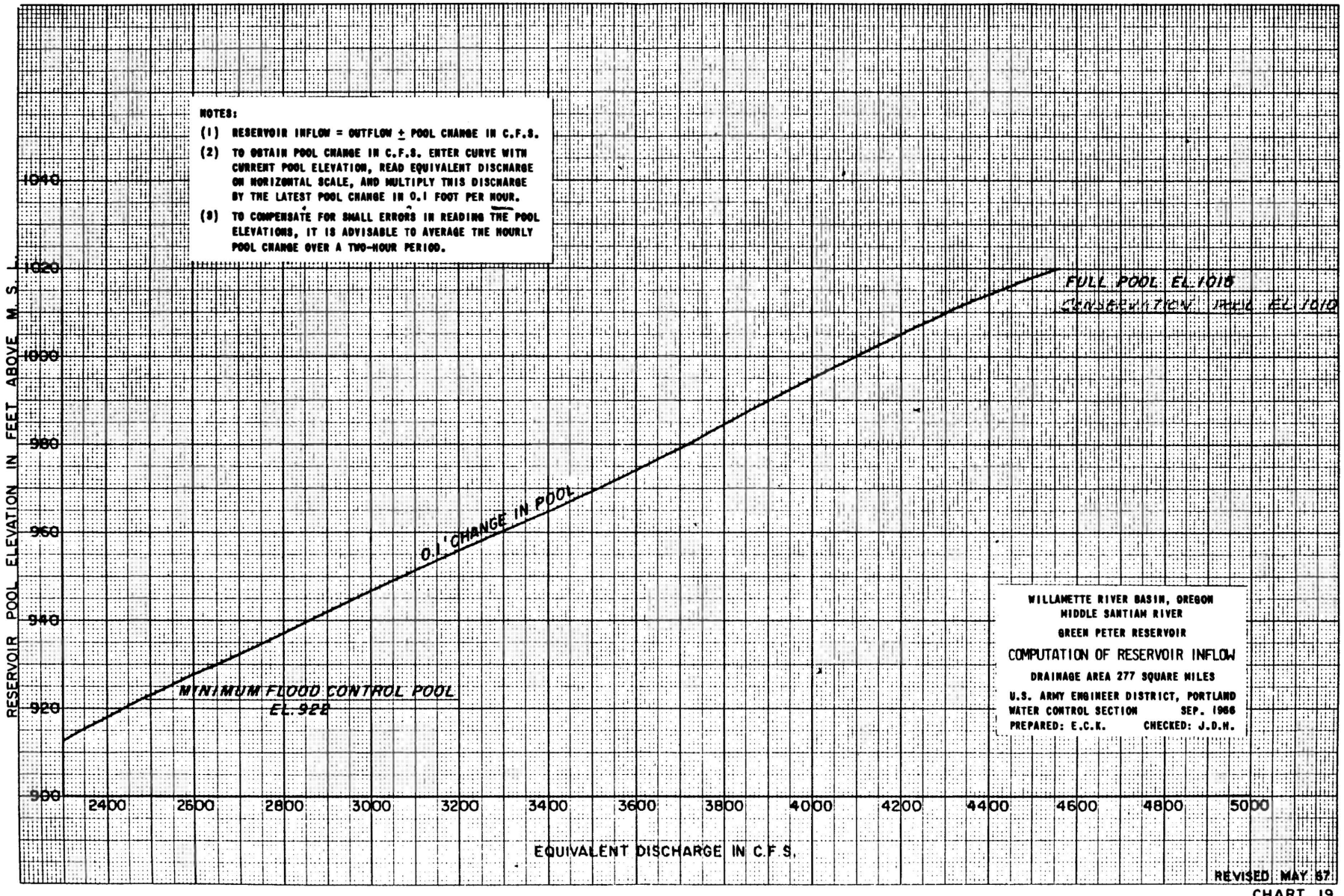
WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER RESERVOIR

SPECIAL RESERVOIR REGULATION CURVES

U.S. ARMY ENGINEER DISTRICT, PORTLAND
WATER CONTROL SECTION AUGUST 1966
PREPARED: JWH, BJT CHECKED: GEG

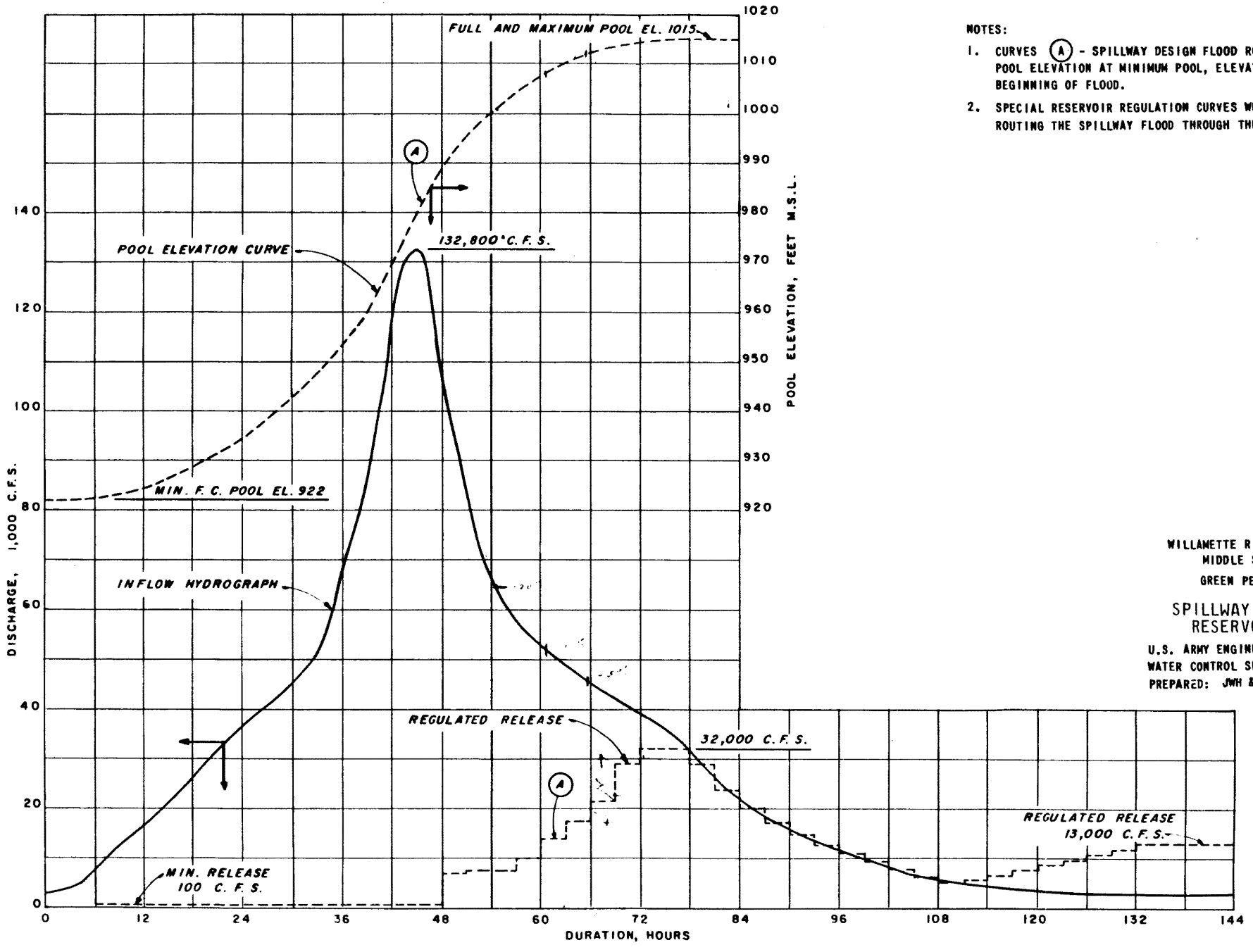
GP-20-24/18

CHART 18



GP-20-24/19

CHART 19



NOTES:

1. CURVES (A) - SPILLWAY DESIGN FLOOD ROUTING ASSUMING POOL ELEVATION AT MINIMUM POOL, ELEVATION 922, AT BEGINNING OF FLOOD.
2. SPECIAL RESERVOIR REGULATION CURVES WERE USED IN ROUTING THE SPILLWAY FLOOD THROUGH THE RESERVOIR.

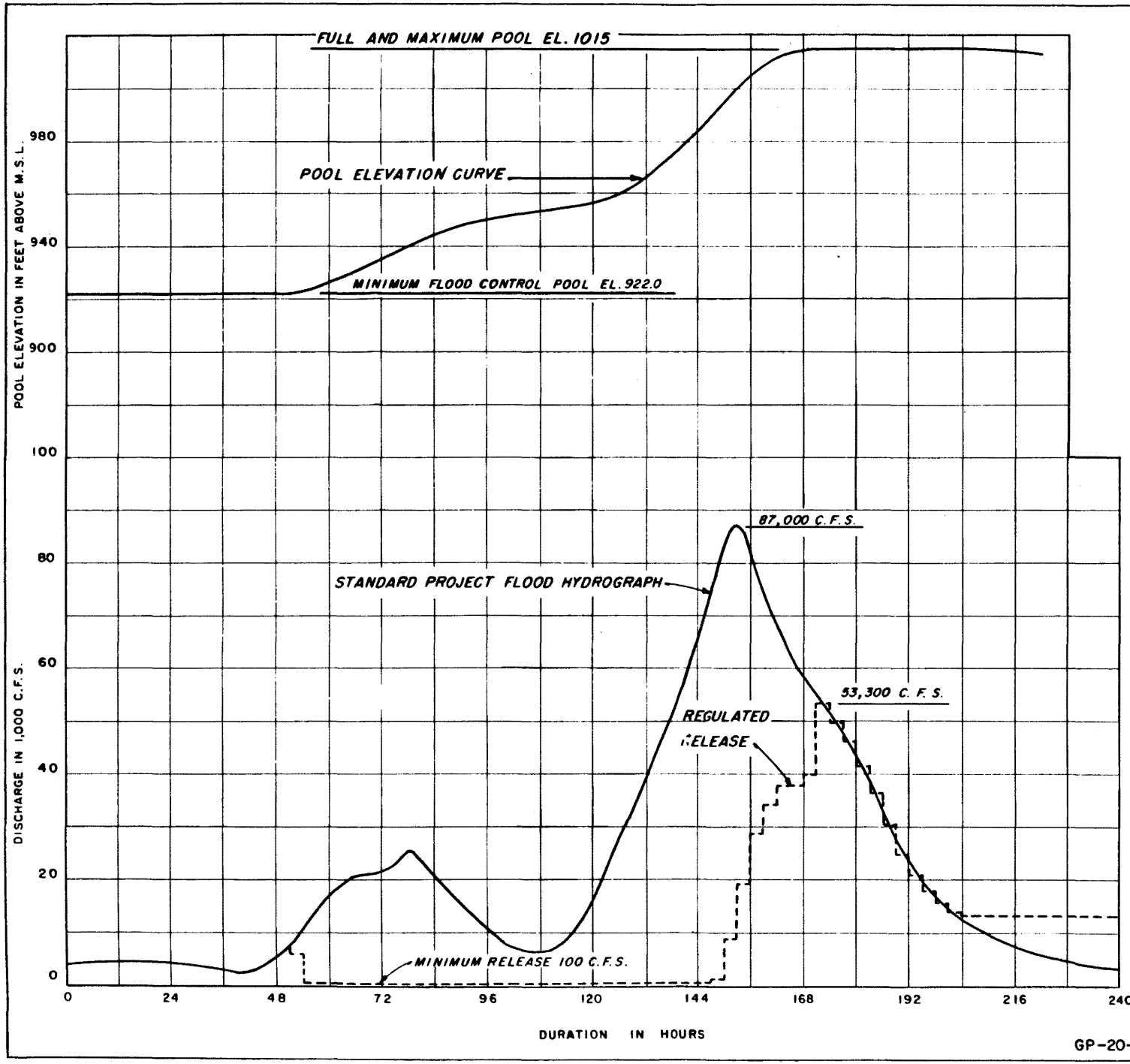
WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER RESERVOIR

SPILLWAY DESIGN FLOOD RESERVOIR ROUTING

U.S. ARMY ENGINEER DISTRICT, PORTLAND
WATER CONTROL SECTION AUGUST 1966
PREPARED: JWH & GEG CHECKED: GEG

GP-20-24/20

CHART 20



NOTES:

1. THE STANDARD PROJECT FLOOD RESERVOIR ROUTING WAS BEGUN ASSUMING MINIMUM POOL ELEVATION 922, AT THE BEGINNING OF FLOOD.
2. SPECIAL RESERVOIR REGULATION CURVES WERE USED IN ROUTING THE STANDARD PROJECT FLOOD THROUGH THE RESERVOIR.

GP-20-24/21

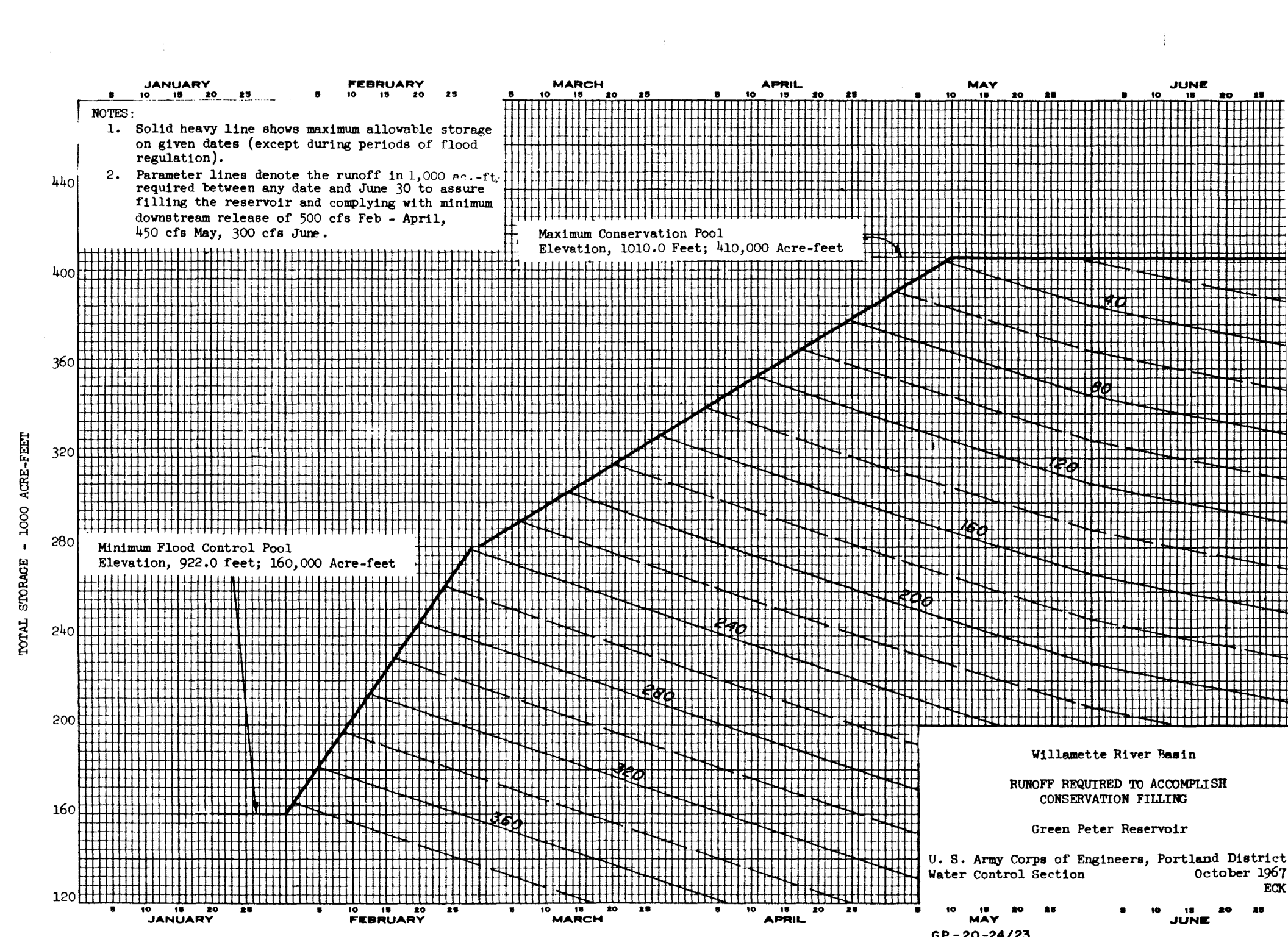
WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER RESERVOIR

STANDARD PROJECT FLOOD
RESERVOIR ROUTING

DRAINAGE AREA 277 SQUARE MILES

U.S. ARMY ENGINEER DISTRICT, PORTLAND
WATER CONTROL SECTION AUGUST 1966
PREPARED: B.J.T. CHECKED: G.E.G.

CHART 21

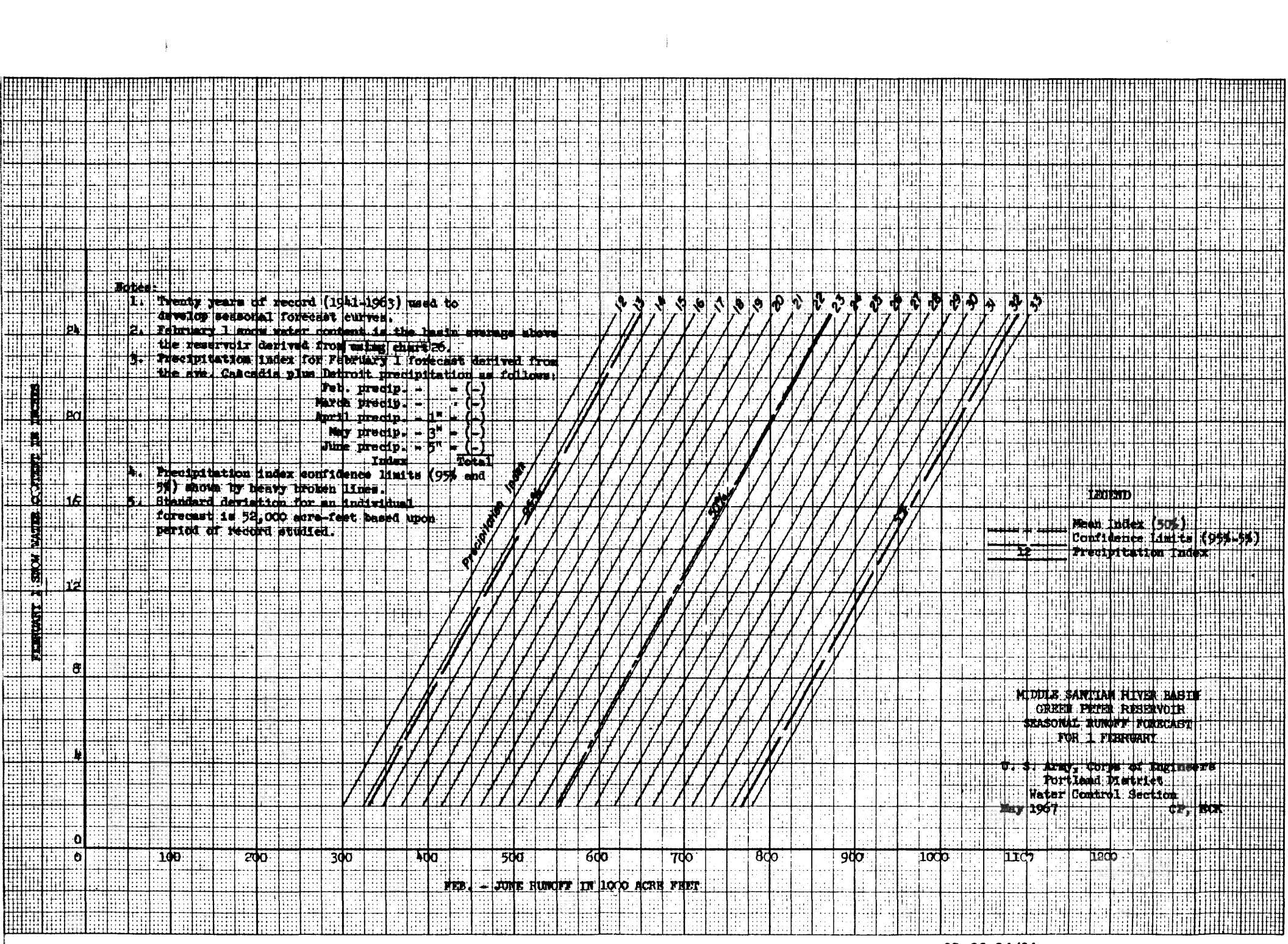

JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
5 10 15 20 25
NOTES:
1. Solid heavy line shows maximum allowable storage on given dates (except during periods of flood regulation).
2. Parameter lines denote the runoff in 1,000 ac.-ft. required between any date and June 30 to assure filling the reservoir and complying with minimum downstream release of 500 cfs Feb - April, 450 cfs May, 300 cfs June.
Maximum Conservation Pool
Elevation, 1010.0 Feet; 410,000 Acre-feet
Minimum Flood Control Pool
Elevation, 922.0 feet; 160,000 Acre-feet
TOTAL STORAGE - 1000 ACRE-FEET
440
400
360
320
280
240
200
160
120
40
80
120
160
200
240
280
320
360
Willamette River Basin
RUNOFF REQUIRED TO ACCOMPLISH CONSERVATION FILLING
Green Peter Reservoir
U. S. Army Corps of Engineers, Portland District
Water Control Section
October 1967
ECK
GP-20-24/23
CHART 22

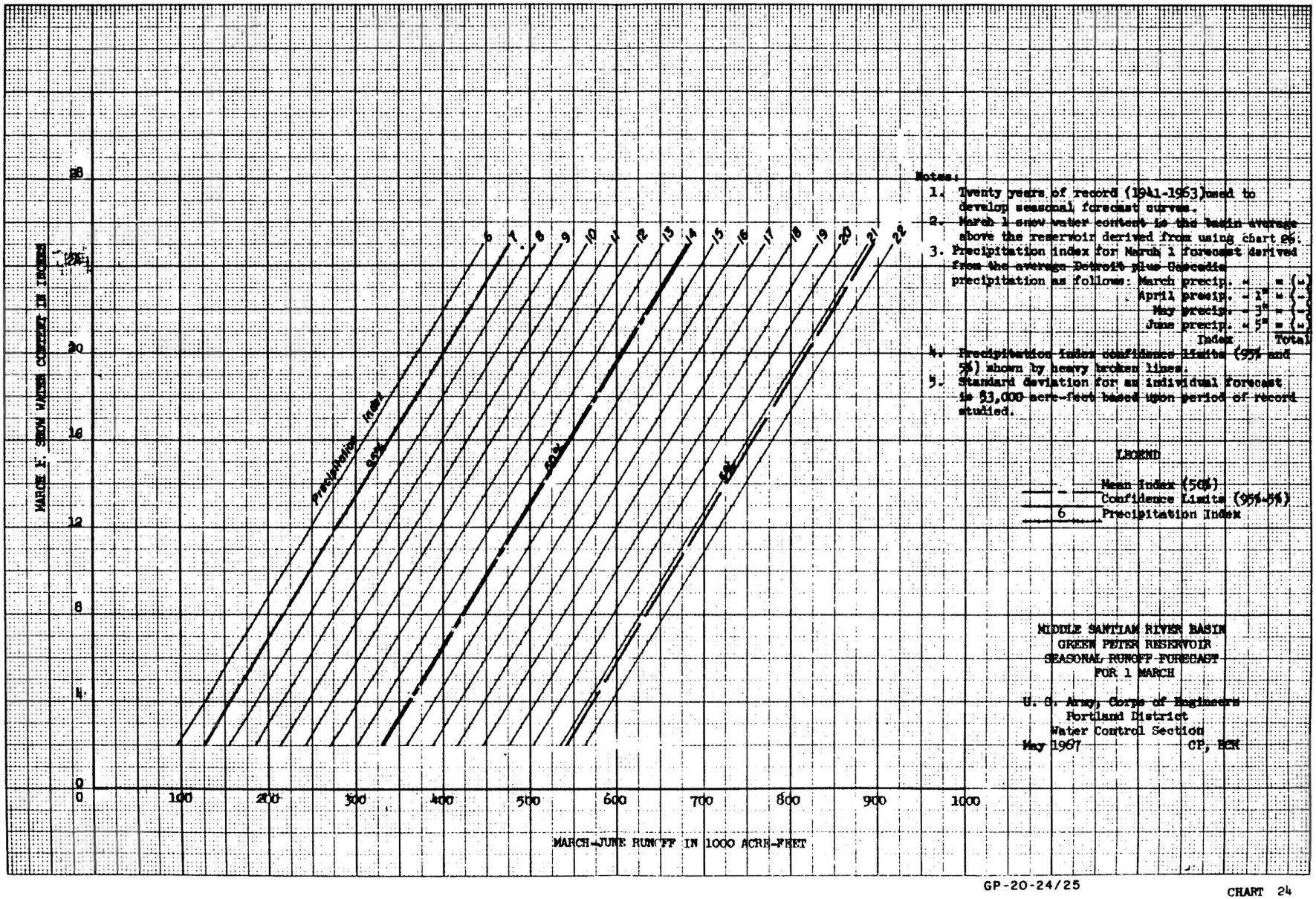
Notes:

1. Twenty years of record (1941-1963) used to develop seasonal forecast curves.
2. February 1 snow water content is the basin average above the reservoir derived from [illegible] chart 26.
3. Precipitation index for February 1 forecast derived from the ave. Cascadia plus Detroit precipitation as follows:

Feb. precip.	-	= (-)
March precip.	-	= (-)
April precip.	- 1"	= (-)
May precip.	- 3"	= (-)
June precip.	- 5"	= (-)
	Index	Total

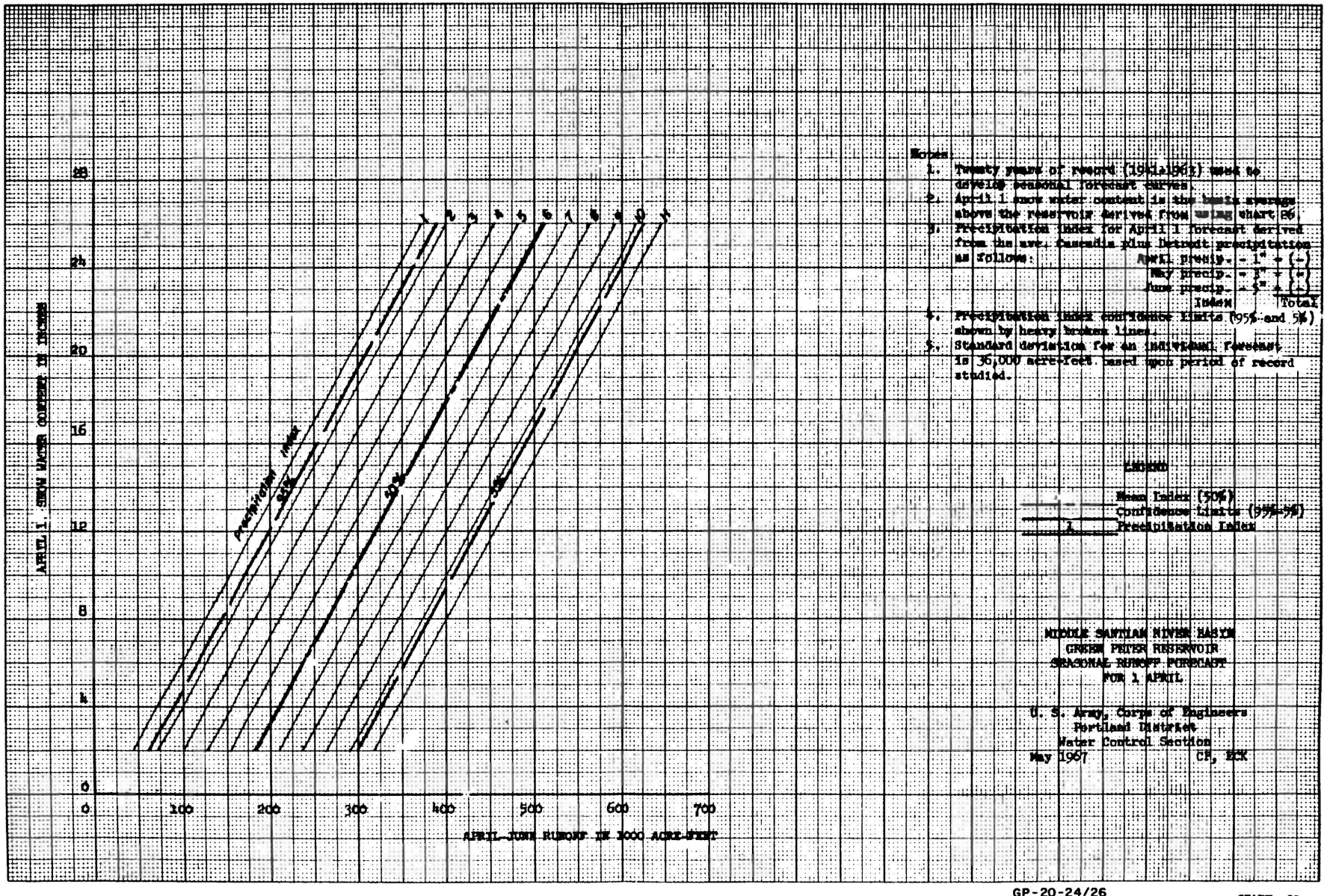
4. Precipitation index confidence limits (95% and 5%) shown by heavy broken lines.
5. Standard deviation for an individual forecast is 52,000 acre-feet based upon period of record studied.





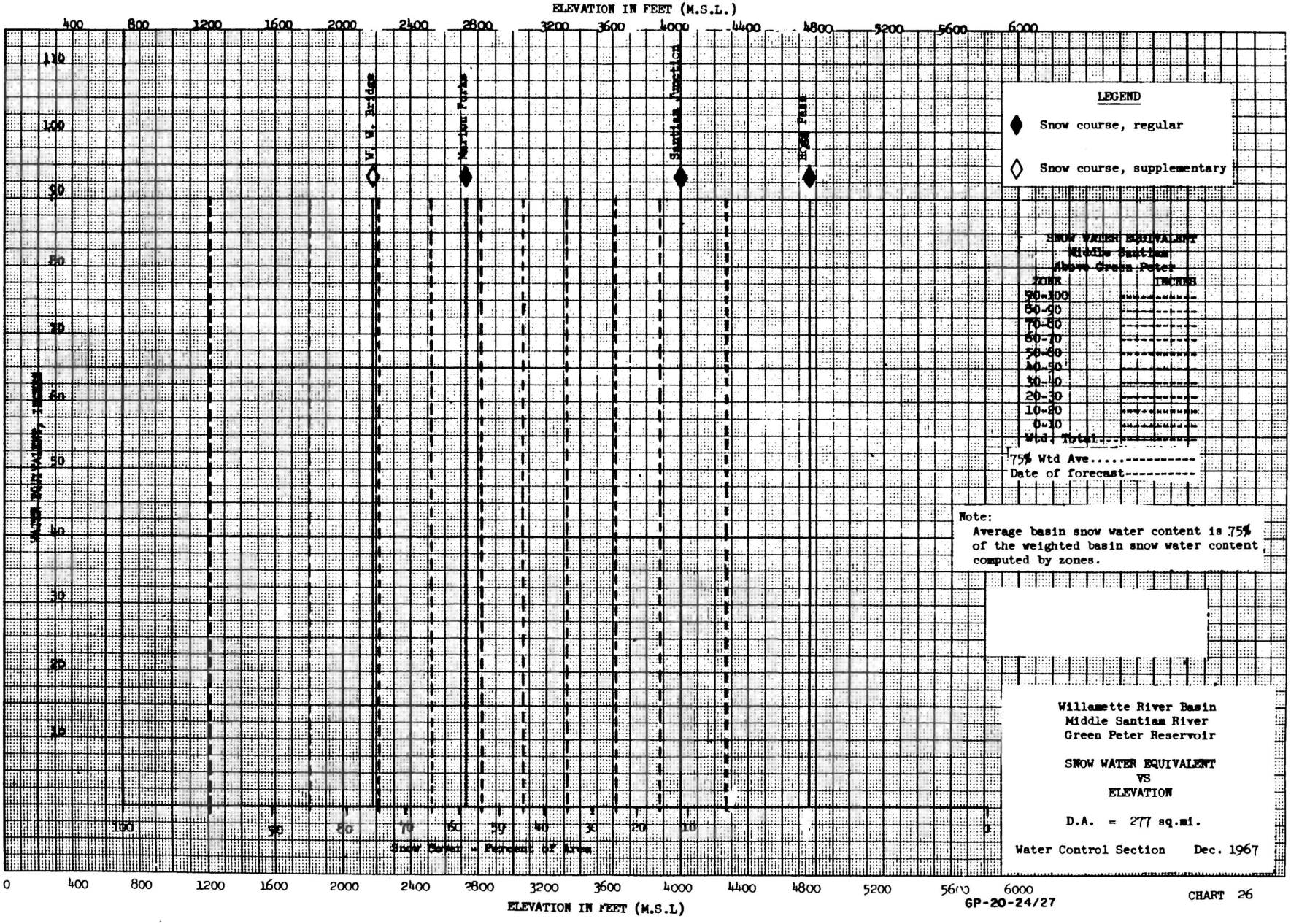
GP-20-24/25

CHART 24



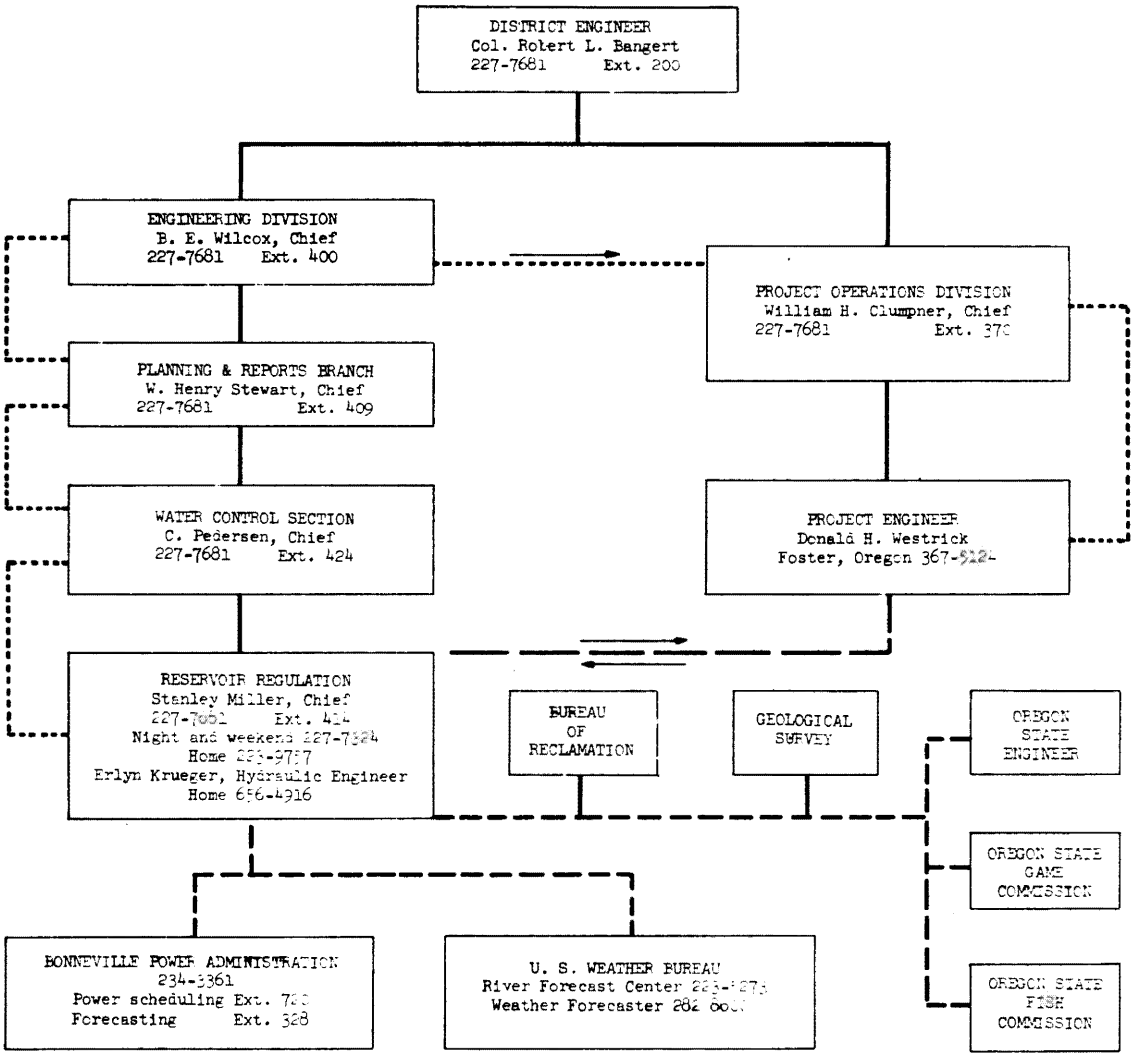
GP-20-24/26

CHART 25


ELEVATION IN FEET (M.S.L.)
400 800 1200 1600 2000 2400 2800 3200 3600 4000 4400 4800 5200 5600 6000
W. W. Bridge
Marion Forks
Santiam Junction
Hoover Pass
LEGEND
Snow course, regular
Snow course, supplementary
SNOW WATER EQUIVALENT
Middle Santiam
Above Green Peter
ZONE INCHES
90-100
80-90
70-80
60-70
50-60
40-50
30-40
20-30
10-20
0-10
Wtd. Total
75% Wtd Ave.
Date of forecast
Note:
Average basin snow water content is 75% of the weighted basin snow water content computed by zones.
Snow Cover - Percent of Area
100 90 80 70 60 50 40 30 20 10 0
0 400 800 1200 1600 2000 2400 2800 3200 3600 4000 4400 4800 5200 5600 6000
ELEVATION IN FEET (M.S.L)
Willamette River Basin
Middle Santiam River
Green Peter Reservoir
SNOW WATER EQUIVALENT
VS
ELEVATION
D.A. = 277 sq.mi.
Water Control Section Dec. 1967
GP-20-24/27
CHART 26

GREEN PETER - FOSTER
PROJECT

Functional Organization Chart



LEGEND

SUPERVISORY AND ADMINISTRATIVE

RESERVOIR REGULATION INSTRUCTIONS AND PROJECT HYDROLOGIC DATA

COORDINATION AND LIAISON

CONFIRMATION-RESERVOIR REGULATION INSTRUCTIONS

Water Control Section Jan 1968
Prepared: S. M. Checked: CP

FS-20-22/11 CHART 27

NPPEN-PP-6

No. _____

SUBJECT: Confirmation of Reservoir Regulation Power Operation instructions.

TO: Project Engineer, Foster Project
Corps of Engineers, U. S. Army
Star Route, Foster, Oregon 97345

THROUGH: Project Operations Division

1. This is to confirm oral instructions from _____

to _____; Foster Operator at _____ PST

_____, regarding operation of the reservoir(s)

indicated below:

( ) Green Peter ( ) Foster

2. The following instructions were issued: Generation schedule for

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

NPP FL
AUG 66 54

Chief, Engineering Division

CHART 28

(Letter of transmittal unnecessary)

GREEN PETER PROJECT DAILY HYDROMETEOROLOGICAL & POWER DATA

RCS NPPEN-PR-42(R2)

To: Reservoir Regulation Subsection
Project Operations Division

Called in by: _____ Received by: _____ Time: _____ Date: _____

TIME	GREEN PETER							STREAM & PRECIPITATION DATA						TIME
	GENERATION M.W.			DISCHARGE		ELEVATION		MIDDLE SANTIAM NEAR CASCADIA		QUARTZVILLE CREEK NEAR CASCADIA		GREEN PETER OUTFLOW	POWER-HOUSE	
	UNIT 1	UNIT 2	TOTAL	TURBINES C. F. S.	GATES C. F. S.	POOL FT.	T. W. FT.	GAGE FT.	DISCHARGE C.F.S.	GAGE FT.	DISCHARGE C.F.S.	DISCHARGE C.F.S.	Precip. Inches	
01														01
02														02
03														03
04														04
05														05
06														06
07														07
08														08
09														09
10														10
11														11
12														12
13														13
14														14
15														15
16														16
17														17
18														18
19														19
20														20
21														21
22														22
23														23
24														24
Totals														Totals
Means														Means
Sta. Sv.														

OBSERVED STREAM DATA

STATION	TIME	TAPE	CHART	STAFF	P. H.	PEAK & TIME
QUARTZVILLE CREEK NEAR CASCADIA						
MIDDLE SANTIAM NEAR CASCADIA						

NET HEAD	

GREEN PETER GATE SETTINGS

TIME	Gate	Feet	TIME	Gate	Feet	TIME	Gate	Feet

O - OUTLET S - SPILLWAY

MID TO MID. DATA

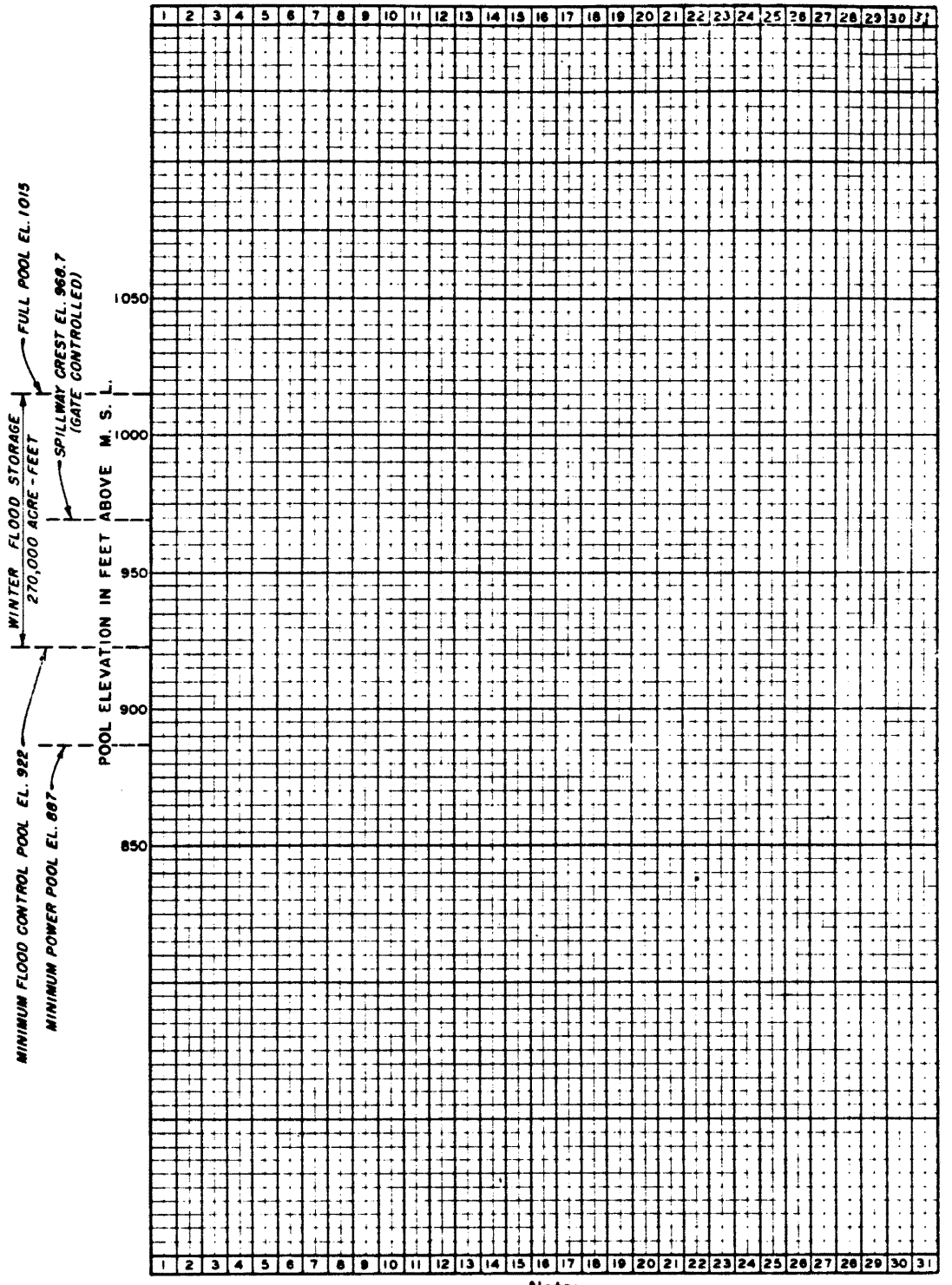
POOL FT.	STORAGE AC. FT.	INFLOW C.F.S.	WIND
1/2 Diff.			

DATE: _____

CHART 29

NPP Form 34G (Translucent)
Sept. 1966

Reports Control Symbol ENGCW-E



MONTH OF 19

Note:
% of outflow for the month was utilized for generation.

	EL. IN FEET ABOVE M. S. L.	GROSS STORAGE AC. FT.
MINIMUM POWER POOL	887	97,000
MINIMUM FLOOD CONTROL POOL	922	160,000
MAXIMUM CONSERVATION POOL	1,010	410,000

MAXIMUM PLANNED RELEASE 13,000 C.F.S.

MONTHLY RESERVOIR REGULATION

GREEN PETER RESERVOIR

WILLAMETTE RIVER BASIN

DRAINAGE AREA ABOVE GREEN PETER DAM 277 SQ. MI.

U.S. ARMY ENGINEER DISTRICT, PORTLAND

NPP Form 315(GP) Jan. 62

CHART 30

NPP Form
Mar. 1961 252(Rev.)

TO: Multiple Purpose Projects Branch
Operations Division

POWER PRODUCTION REPORT

Month & Year

Reports Control Symbol
NPPVK - 57

District: PORTLAND, OREGON

Project & Location:

GENERATION

GENERATOR NUMBER	MWH	GENERATOR NUMBER	MWH
1		12	
2		13	
3		14	
4		15	
5		16	
6			
7			
8			
9			
10			
11			
TOTAL GENERATION			

DISPOSITION

LOCATION	LOCAL USE MWH	TO BPA MWH
STATION		
PROJECT		
NAVIGATION LOCK		
SPILLWAY		
FISHWAY		
BUILDINGS AND GROUNDS		
TO OTHERS		
UNACCOUNTED AND LOSSES		
TOTALS		

CONDENSER POWER

UNIT	MWH
1	
2	
3	

OTHER DATA

SUBJECT	MWH	TIME	DATE
5 Minute Peak		M.	
Clock Hour Peak		M.	

PLANT FACTOR:
TOTAL GENERATION / (N.P. Rating X Total Hours in the Month) %

TOTAL IN-SERVICE HOURS (All Units Except House Units)

NET GENERATION REPORTED ON FPC FORM 4 -

Remarks:

Distribution:

Project Engineer:

CHART 31

F.P.C. Form No. 4 — Budget Bureau No. 54-R014.4

FEDERAL POWER COMMISSION
MONTHLY POWER PLANT REPORT

INSTALLED CAPACITY - The kilowatt capacity of each plant listed should represent total name-plate rating of generators exclusive of auxiliary or house units. Revise to include any additions, retirements, or re-ratings. State below or on reverse side, the kilowatt amount, nature and approximate date of each change. New plants should be added. If plant has been sold give name and address of purchaser.

GENERATION - Report net generation (gross less use by power plant for auxiliary equipment) by water power and by Each Kind of Fuel — anthracite, bituminous or lignite coal, coke, fuel oil, natural gas or other (Specify). Please give estimates if exact figures are not available.

FUEL CONSUMED - Report actual or estimated amount of fuel used in generating electric energy including fuel for maintenance of standby service. Report to nearest whole unit - short ton, 42 gal. bbl., or Mcf.

FUEL STOCKS - Enter coal and fuel oil held for electric energy generation including regular stocks at plant and in cars or barges at plant site. Amounts held in central storage yards should be included with appropriate note. Report to nearest whole unit.

UNITED STATES ARMY ENGINEERS

241

BONNEVILLE, OREGON

36-640

REPORT FOR

OCTOBER 1960

→ PLEASE RETURN ONE COPY BEFORE THE 10TH OF THE MONTH

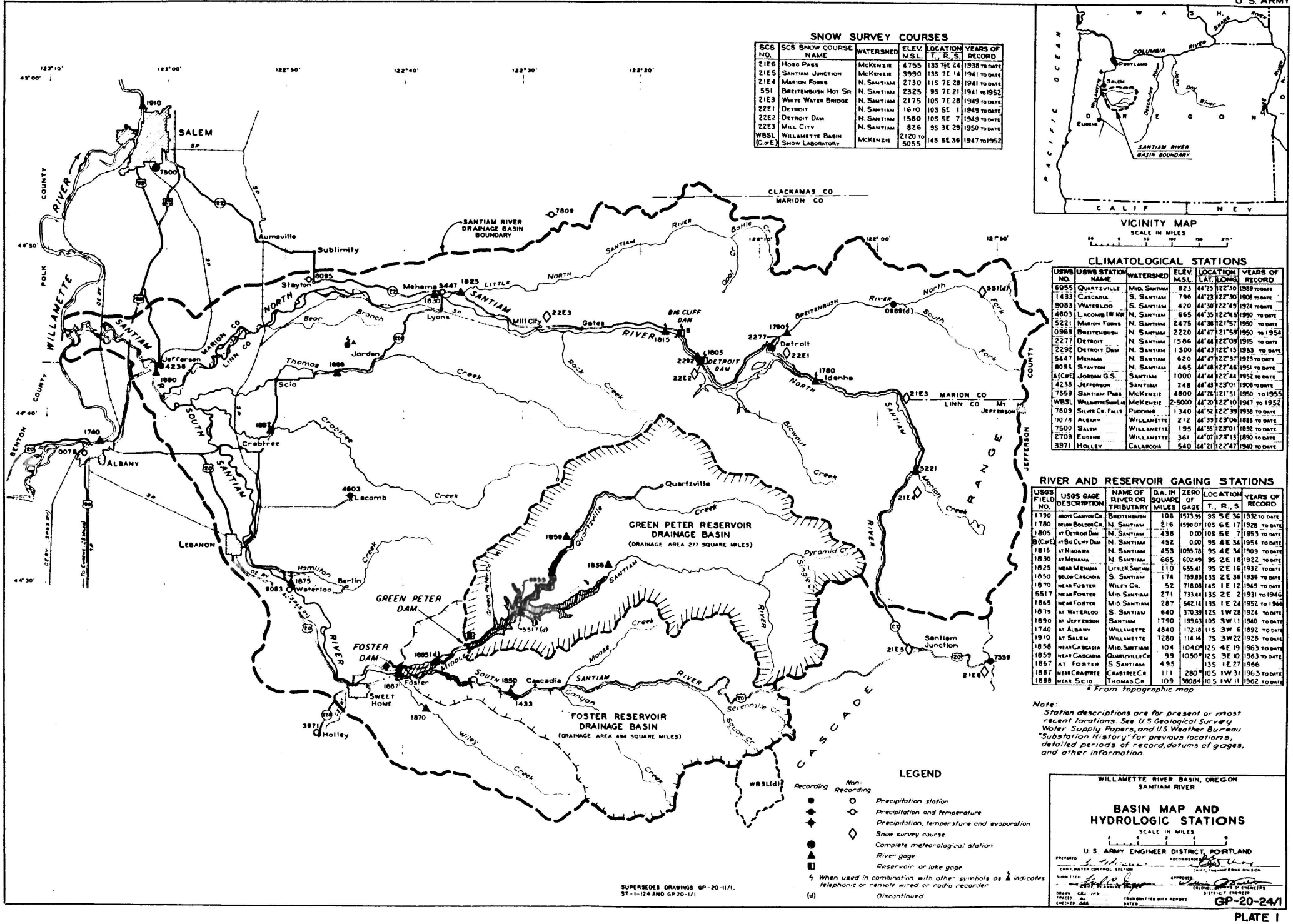
PLANT NAME AND CODE NUMBERS	PRIME MOVER TYPE AND KIND OF FUEL	INSTALLED CAPACITY (Name-Plate Rating) KILOWATTS	NET GENERATION KILOWATT-HOURS	FUEL FOR GENERATION INCLUDING STANDBY SERVICE Nearest Short Ton; 42 Gal. Bbl.; Mcf.	
				Consumed During Month	Stocks End of Month
BONNEVILLE 92 36 7 1 640*001	WATER PWR	518,400	297,073,561		

→ PLEASE REPORT CAPACITY CHANGES - SEE INSTRUCTIONS

CHART 32

CORPS OF ENGINEERS

U. S. ARMY



SNOW SURVEY COURSES

SCS NO.	SCS SNOW COURSE NAME	WATERSHED	ELEV. M.S.L.	LOCATION T., R., S.	YEARS OF RECORD
21E6	Hogg Pass	McKenzie	4755	13S 7E 24	1938 TO DATE
21E5	Santiam Junction	McKenzie	3990	13S 7E 14	1941 TO DATE
21E4	Marion Forks	N. Santiam	2730	11S 7E 28	1941 TO DATE
551	Breitenbush Hot Sp.	N. Santiam	2325	9S 7E 21	1941 TO 1952
21E3	White Water Bridge	N. Santiam	2175	10S 7E 28	1949 TO DATE
22E1	Detroit	N. Santiam	1610	10S 5E 1	1949 TO DATE
22E2	Detroit Dam	N. Santiam	1580	10S 5E 7	1949 TO DATE
22E3	Mill City	N. Santiam	826	9S 3E 25	1950 TO DATE
WBSL (C. of E.)	Willamette Basin Snow Laboratory	McKenzie	2120 TO 5055	14S 5E 36	1947 TO 1952

VICINITY MAP

SCALE IN MILES

CLIMATOLOGICAL STATIONS

USWB NO.	USWB STATION NAME	WATERSHED	ELEV. M.S.L.	LOCATION LAT.	LOCATION LONG.	YEARS OF RECORD
6955	Quartzville	Mid. Santiam	823	44°25'	122°30'	1939 TO DATE
1433	Cascadia	S. Santiam	796	44°23'	122°30'	1908 TO DATE
9083	Waterloo	S. Santiam	420	44°30'	122°49'	1924 TO DATE
4803	Lacomb 1W NW	N. Santiam	665	44°35'	122°45'	1950 TO DATE
5221	Marion Forks	N. Santiam	2475	44°36'	121°57'	1950 TO DATE
0969	Breitenbush	N. Santiam	2220	44°47'	121°59'	1950 TO 1954
2277	Detroit	N. Santiam	1586	44°44'	122°09'	1915 TO DATE
2292	Detroit Dam	N. Santiam	1300	44°43'	122°15'	1953 TO DATE
5447	Mehama	N. Santiam	620	44°47'	122°37'	1923 TO DATE
8095	Stayton	N. Santiam	465	44°48'	122°46'	1951 TO DATE
A (Cor.)	Jordan G.S.	Santiam	1000	44°44'	122°44'	1952 TO DATE
4238	Jefferson	Santiam	248	44°43'	123°01'	1908 TO DATE
7559	Santiam Pass	McKenzie	4800	44°26'	121°51'	1950 TO 1955
WBSL	Willamette Snow Lab	McKenzie	2-5000	44°20'	122°10'	1947 TO 1952
7809	Silver Cr. Falls	Pudding	1340	44°52'	122°39'	1938 TO DATE
0078	Albany	Willamette	212	44°39'	123°06'	1883 TO DATE
7500	Salem	Willamette	195	44°55'	123°01'	1892 TO DATE
2709	Eugene	Willamette	361	44°07'	123°13'	1890 TO DATE
3971	Holley	Calapooia	540	44°21'	122°47'	1940 TO DATE

RIVER AND RESERVOIR GAGING STATIONS

USGS FIELD NO.	USGS GAGE DESCRIPTION	NAME OF RIVER OR TRIBUTARY	D.A. IN SQUARE MILES	ZERO OF GAGE	LOCATION T., R., S.	YEARS OF RECORD
1790	above Canyon Cr.	Breitenbush	106	1573.95	9S 5E 36	1932 TO DATE
1780	below Boulder Cr.	N. Santiam	216	1590.07	10S 6E 17	1928 TO DATE
1805	at Detroit Dam	N. Santiam	438	0.00	10S 5E 7	1953 TO DATE
B (Cor.)	at Big Cliff Dam	N. Santiam	452	0.00	9S 4E 34	1954 TO DATE
1815	at Niagara	N. Santiam	453	1093.78	9S 4E 34	1909 TO DATE
1830	at Mehama	N. Santiam	665	602.49	9S 2E 18	1922 TO DATE
1825	near Mehama	Little N. Santiam	110	655.41	9S 2E 16	1932 TO DATE
1650	below Cascadia	S. Santiam	174	759.88	13S 2E 36	1936 TO DATE
1870	near Foster	Wiley Cr.	52	718.08	14S 1E 12	1949 TO DATE
5517	near Foster	Mid. Santiam	271	733.44	13S 2E 2	1931 TO 1946
1865	near Foster	Mid. Santiam	287	562.14	13S 1E 24	1952 TO 1966
1875	at Waterloo	S. Santiam	640	370.39	12S 1W 28	1924 TO DATE
1690	at Jefferson	Santiam	1790	199.63	10S 3W 11	1940 TO DATE
1740	at Albany	Willamette	4840	172.18	11S 3W 6	1892 TO DATE
1910	at Salem	Willamette	7280	114.14	7S 3W 22	1928 TO DATE
1858	near Cascadia	Mid. Santiam	104	1040*	12S 4E 19	1963 TO DATE
1859	near Cascadia	Quartzville Cr.	99	1050*	12S 3E 10	1963 TO DATE
1867	at Foster	S. Santiam	495		13S 1E 27	1966
1887	near Crabtree	Crabtree Cr.	111	280*	10S 1W 31	1963 TO DATE
1888	near Scio	Thomas Cr.	109	38084	10S 1W 11	1962 TO DATE

* From topographic map

Note:
Station descriptions are for present or most recent locations. See U.S. Geological Survey Water Supply Papers, and U.S. Weather Bureau "Substation History" for previous locations, detailed periods of record, datums of gages, and other information.

LEGEND

Recording	Non-Recording	
●	○	Precipitation station
●	-○-	Precipitation and temperature
✦	◇	Precipitation, temperature and evaporation
	◇	Snow survey course
●		Complete meteorological station
▲		River gage
◧		Reservoir or lake gage

4 When used in combination with other symbols as ✦ indicates telephonic or remote wired or radio recorder

(d) Discontinued

SUPERSEDES DRAWINGS GP-20-11/1, ST-1-124 AND GP 20-1/1

WILLAMETTE RIVER BASIN, OREGON
SANTIAM RIVER

BASIN MAP AND HYDROLOGIC STATIONS

SCALE IN MILES

U. S. ARMY ENGINEER DISTRICT, PORTLAND

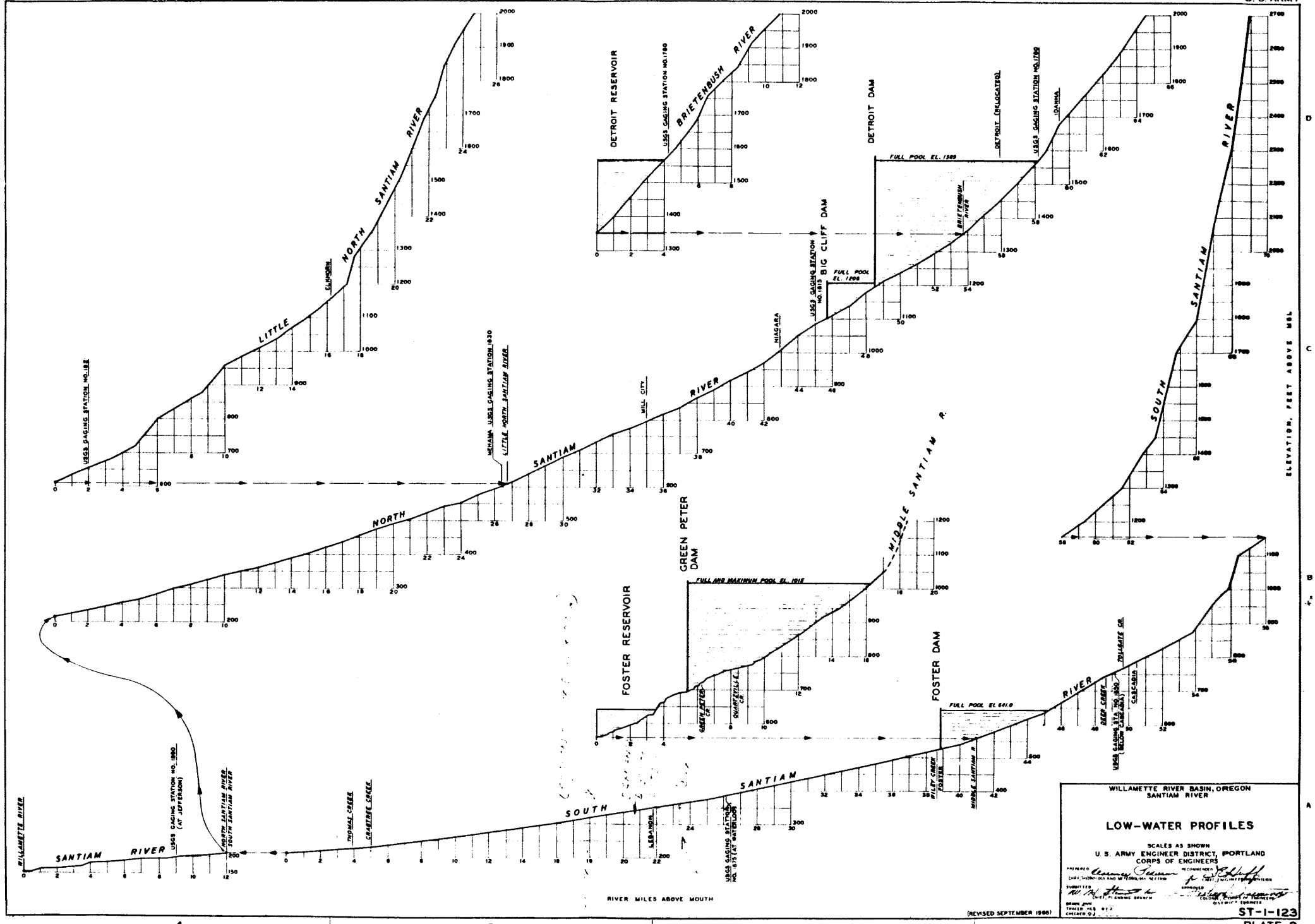
PREPARED — CHIEF, WATER CONTROL SECTION
RECOMMENDED — CHIEF, ENGINEERING DIVISION
SUBMITTED — CHIEF, PLANNING BRANCH
APPROVED — COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER
DRAWN: C.E.L. DPS.
TRACED: A.
CHECKED: ARS
TRANSMITTED WITH REPORT DATED

GP-20-24/1

PLATE I

CORPS OF ENGINEERS

U. S. ARMY



WILLAMETTE RIVER BASIN, OREGON
SANTIAM RIVER

LOW-WATER PROFILES

SCALES AS SHOWN

U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

PREPARED
CHIEF, HYDROLOGY AND METEOROLOGY SECTION

RECOMMENDED
CHIEF, ENGINEERING DIVISION

SUBMITTED
CHIEF, PLANNING BRANCH

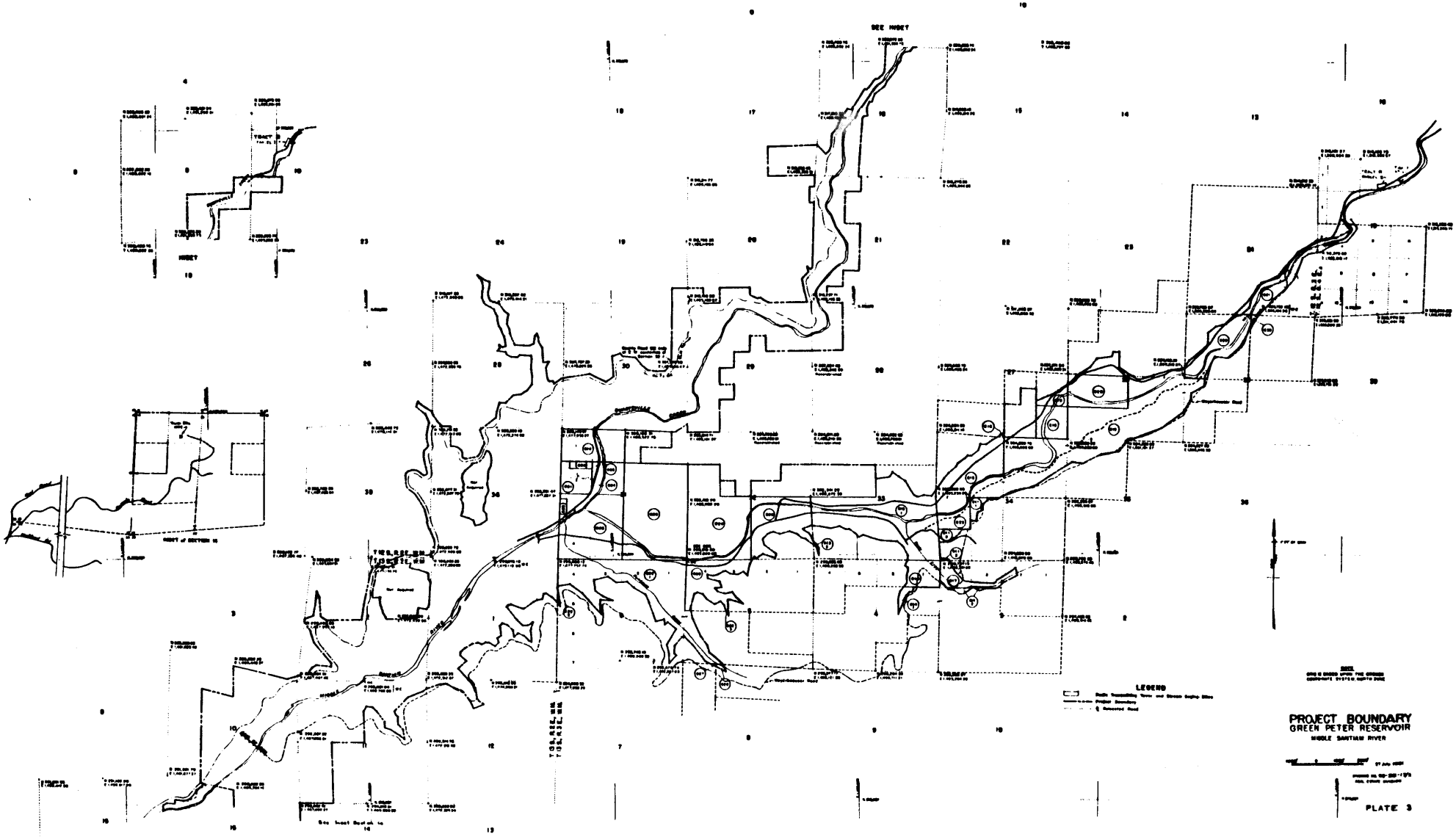
APPROVED
COLONEL, CORPS OF ENGINEERS
DISTRICT ENGINEER

DRAWN JDVE
TRACED HLS 8-72
CHECKED DJ

(REVISED SEPTEMBER 1986)

ST-1-123

PLATE 2



PROJECT BOUNDARY
GREEN PETER RESERVOIR
MIDDLE SANTIAM RIVER

PLATE 3

CBT	USGS SITE NUMBER	STATION NAME
GPR	14186100	Green Peter Lake Nr Foster
QCCO	14185900	Quartzville Cr. Nr Cascadia

Bald Peter

Thistle Cr.

Beaman Cr.

Green Peter Cr.

Big Alder Cr.

Hall Rd.

Billings Park

GREEN PETER DAM

GPR

Powerhouse

Thistle Creek Access

Whitcomb Creek Park

Whitcomb Island

Green Peter Peninsula

Foots Canyon

Rocky Top Rd.

Rocky Top

QCCO

Trout Cr.

Plat I Hee Cr.

Moose Cr.

West Fork

East Fork

Little Bottom Cr.

Rumble Cr.

Straight Cr.

MIDDLE SANTIAM RIVER

Forest Boundary

National

Fally Creek

T. 12 S., R. 2 E., W.M.
T. 13 S., R. 2 E., W.M.

R. 2 E.

R. 3 E.

T. 12 S., R. 3 E., W.M.

T. 12 S., R. 4 E., W.M.

SCALE IN FEET

3300 0 3300 6600

CONTOUR INTERVAL 200 FEET

STREAM GAGES

GREENPETER LAKE
Lane County, Oregon

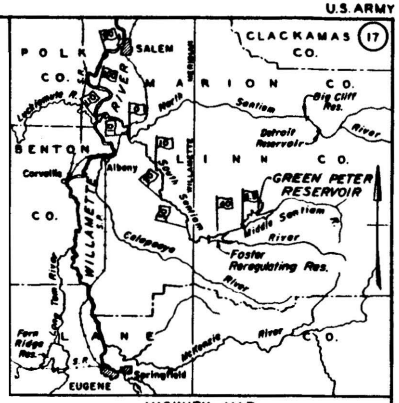
SIGNIFICANT PROJECT FEATURES

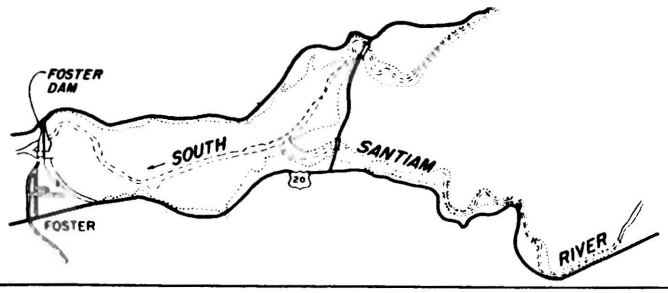
- Project Boundary
- Green Peter Dam
- Maximum Pool (Elev. 1,015.0 Ft.)
- Minimum Flood Control Pool (Elev. 922.0 Ft.)
- Stream gage (point of triangle at location)
- Precipitation Station
- Telemetered
- Mountain Peak

Produced by GIS, Survey and Mapping Section, Geotechnical Engineering Branch

U.S. Army Engineer District, Portland

CENPP-PE-HR





SCALE IN FEET
200 0 200 400 600

FLOOD CONTROL
WILLAMETTE RIVER BASIN, OREGON
GREEN PETER RESERVOIR
MIDDLE SANTIAM RIVER

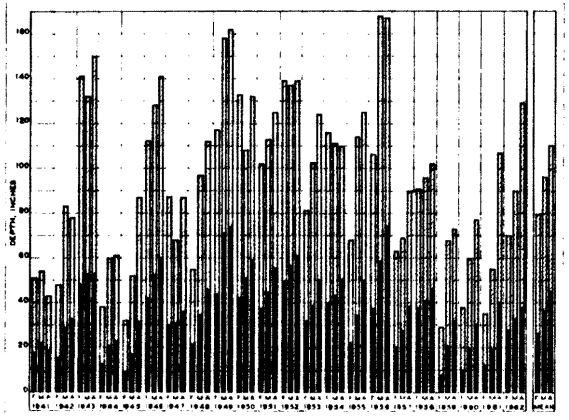
SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, PORTLAND

DRAWN BY H.E.B.-F.G.B. REVISED SEP 1967

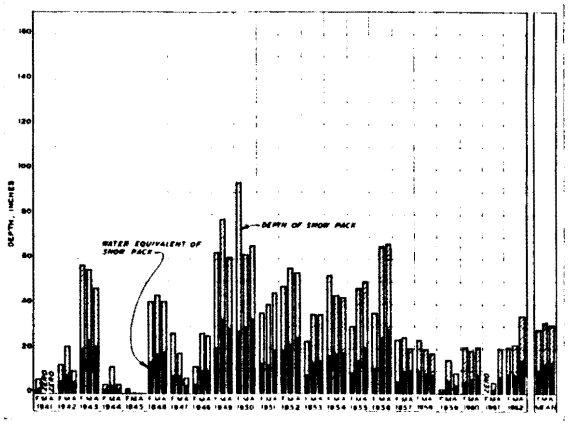
PLATE 4

CORPS OF ENGINEERS

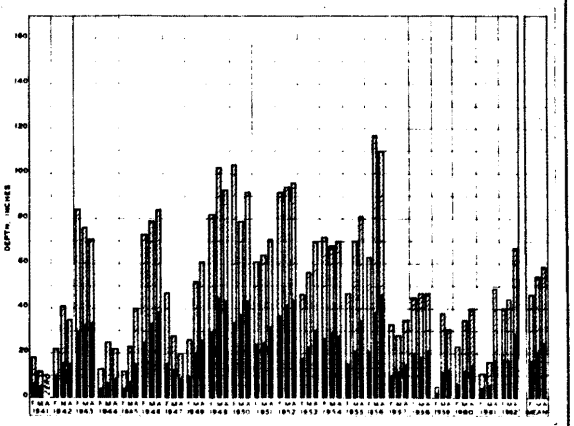
U.S. ARMY



HOGG PASS
ELEVATION 4755

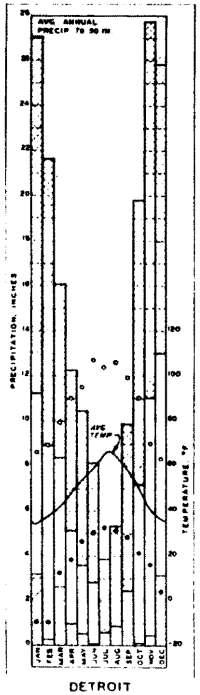


MARION FORKS
ELEVATION 2730

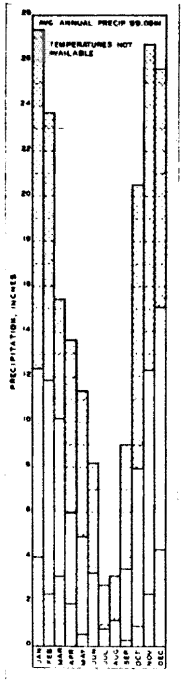


SANTIAM JUNCTION
ELEVATION 3080

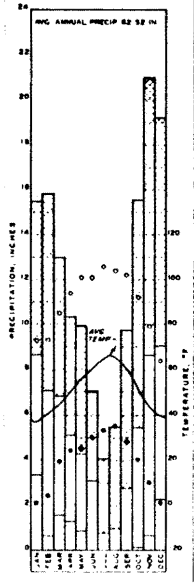
SNOW COURSES - DEPTH AND WATER EQUIVALENT OF SNOW PACK



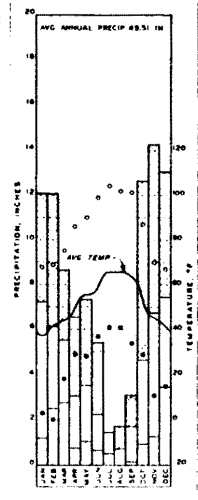
DETROIT
ELEVATION 1565
PERIOD OF RECORD 1904-1981



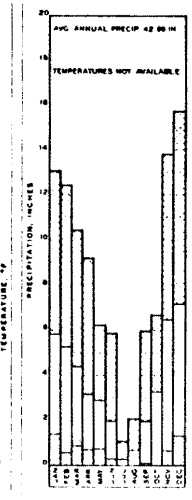
QUARTZVILLE
ELEVATION 861
PERIOD OF RECORD 1939-1981



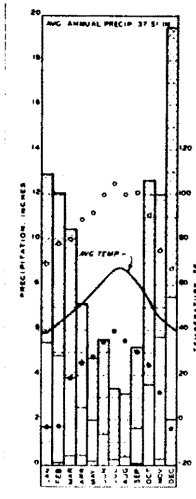
CASCADIA R S
ELEVATION 188
PERIOD OF RECORD 1914-1981



LACOMB
ELEVATION 885
PERIOD OF RECORD 1942-1981

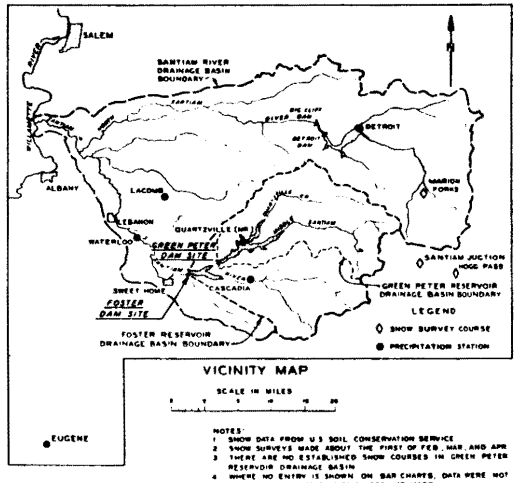


WATERLOO
ELEVATION 410
PERIOD OF RECORD 1924-1981



EUGENE
ELEVATION 364
PERIOD OF RECORD 1891-1981

MONTHLY PRECIPITATION AND TEMPERATURE



VICINITY MAP

SCALE IN MILES

LEGEND

MAXIMUM PRECIPITATION
AVERAGE PRECIPITATION
MINIMUM PRECIPITATION
ABSOLUTE MAXIMUM TEMPERATURE
ABSOLUTE MINIMUM TEMPERATURE

NOTES:
1. SNOW DATA FROM U.S. SOIL CONSERVATION SERVICE.
2. SNOW SURVEYS MADE ABOUT THE FIRST OF FEB., MAR. AND APR.
3. THERE ARE NO ESTABLISHED SNOW COURSES IN GREEN PETER RESERVOIR DRAINAGE BASIN.
4. WHERE NO ENTRY IS SHOWN ON BAR CHARTS, DATA WERE NOT AVAILABLE OR OBSERVATIONS WERE NOT MADE.
5. PRECIPITATION AND TEMPERATURE DATA FROM RECORDS OF U.S. WEATHER BUREAU

WILLAMETTE RIVER BASIN, OREGON
SANTIAM RIVER

CLIMATIC CHARACTERISTICS

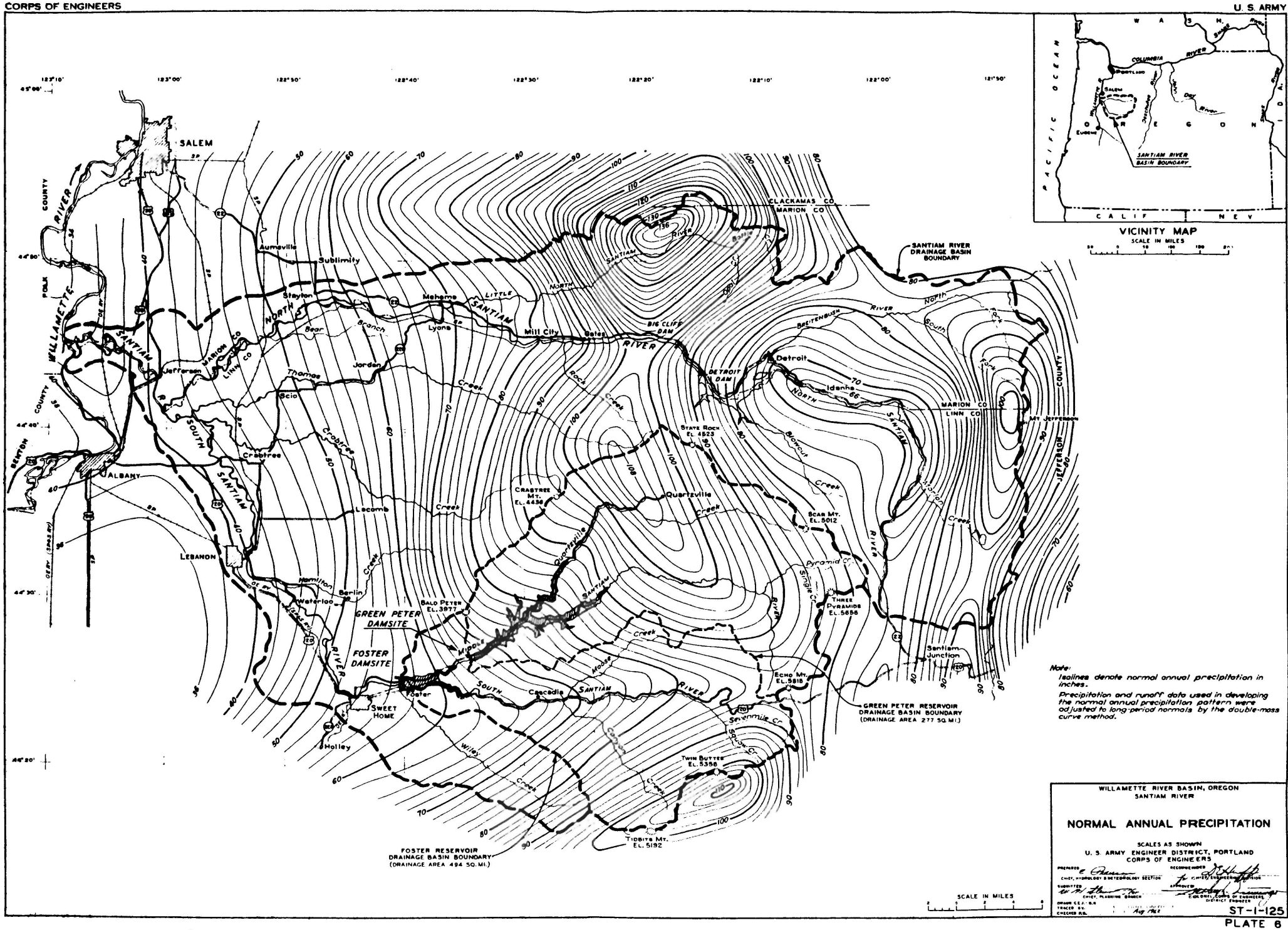
SCALES AS SHOWN
U.S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

ST-1-121

PLATE 5

CORPS OF ENGINEERS

U. S. ARMY



VICINITY MAP

SCALE IN MILES

Note:

Isolines denote normal annual precipitation in inches.

Precipitation and runoff data used in developing the normal annual precipitation pattern were adjusted to long-period normals by the double-mass curve method.

WILLAMETTE RIVER BASIN, OREGON
SANTIAM RIVER

NORMAL ANNUAL PRECIPITATION

SCALES AS SHOWN
U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

PREPARED — CHIEF, HYDROLOGY & METEOROLOGY SECTION
RECOMMENDED — CHIEF, ENGINEERING DIVISION
SUBMITTED — CHIEF, PLANNING BRANCH
APPROVED — COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER
DRAWN CEA; BR
TRACED BY
CHECKED AA

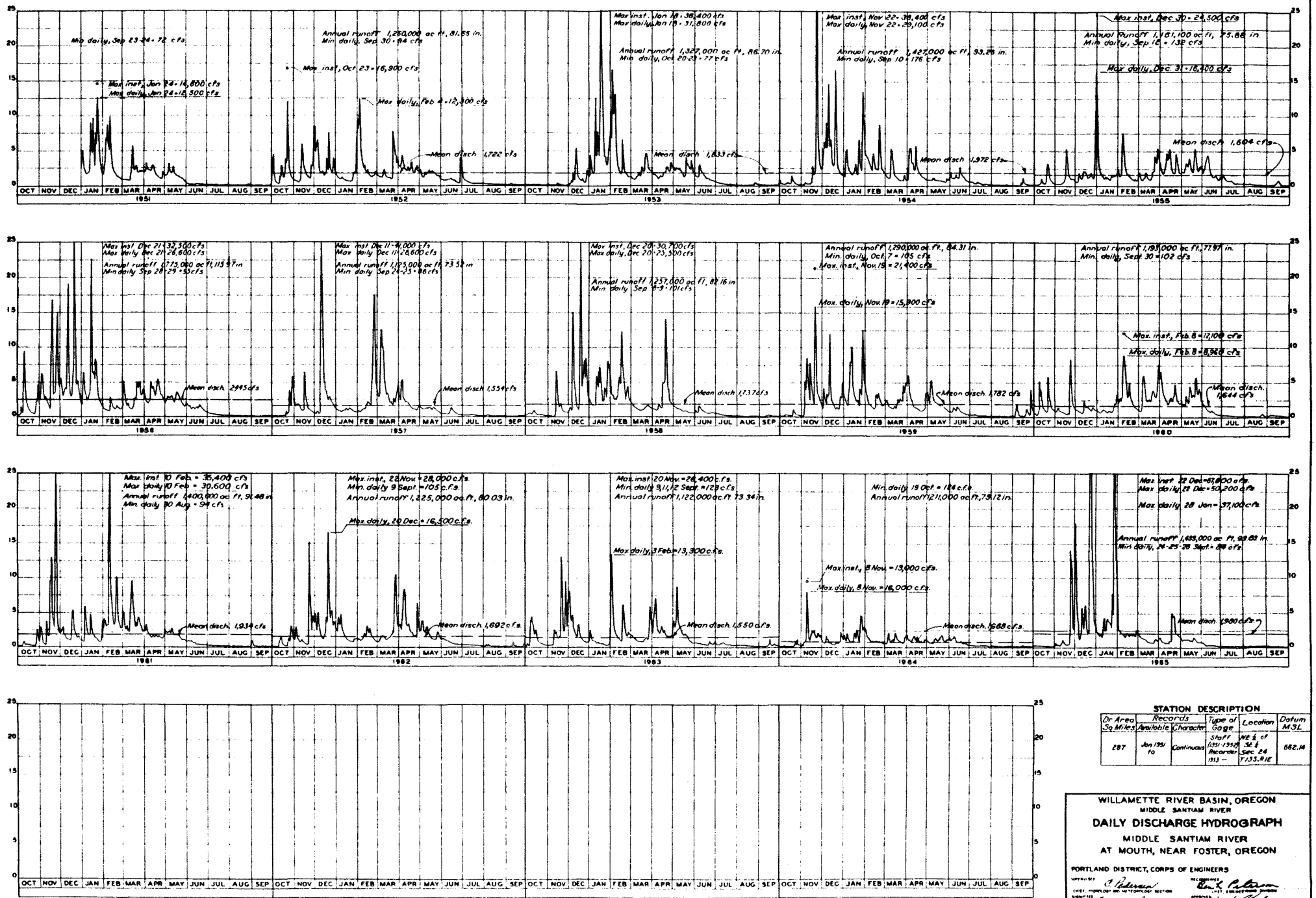
Aug 1962

ST-1-125

PLATE 6

CORPS OF ENGINEERS

U. S. ARMY



STATION DESCRIPTION

Dr Area Sq Miles	Records Available	Records Character	Type of Gage	Location	Datum MSL
287	Jan 1951 to	Continuous	Staff (1951-1952) Recorder 1953 –	NE ¼ of SE ¼ Sec 24 T.13S.R.1E	552.14

WILLAMETTE RIVER BASIN, OREGON

MIDDLE SANTIAM RIVER

DAILY DISCHARGE HYDROGRAPH

MIDDLE SANTIAM RIVER

AT MOUTH, NEAR FOSTER, OREGON

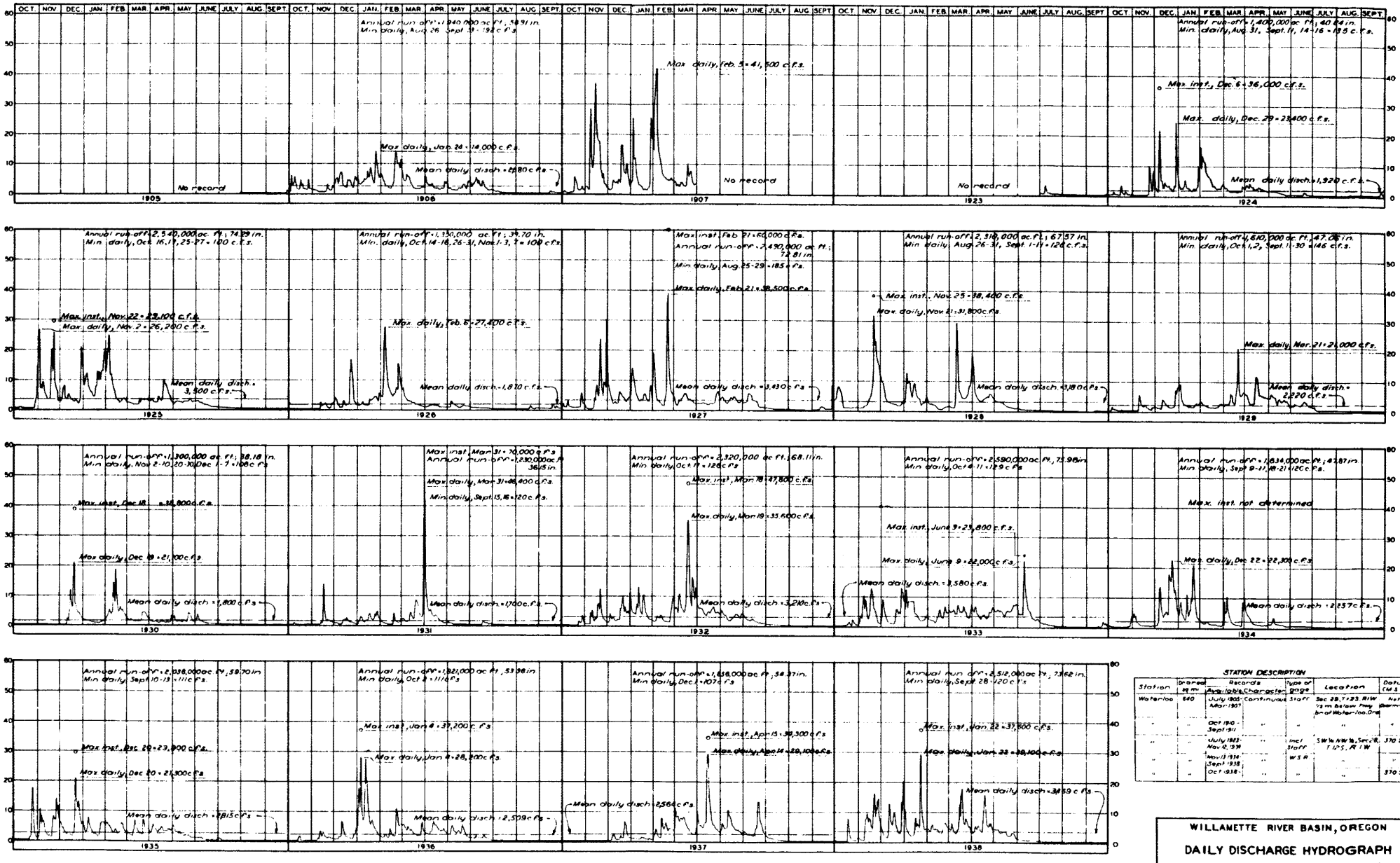
PORTLAND DISTRICT, CORPS OF ENGINEERS

PD-25-11/2

PLATE 8

CORPS OF ENGINEERS

U.S. ARMY



STATION DESCRIPTION

Station	Drainage Area sq mi	Records Available: Character	Type of gage	Location	Datum (M.S.L.)
Waterloo	640	July 1905 - Mar 1907 : Continuous	Staff	Sec 28, T 13 S, R 1 W, 12 mi Below Foot Bridge at Waterloo, Ore.	Not Observed
"	"	Oct 1910 - Sept 1911	"	"	"
"	"	July 1913 - Nov. 4, 1914	Incl Staff	SW¼ NW¼, Sec. 28, T 12 S, R 1 W	370.2
"	"	Nov. 13 1914 - Sept 1918	W.S.R.	"	"
"	"	Sept 1918 - Oct 1918	"	"	370.38

WILLAMETTE RIVER BASIN, OREGON

DAILY DISCHARGE HYDROGRAPH

SOUTH SANTIAM RIVER AT WATERLOO, OREGON

IN 3 SHEETS — SHEET NO. 1

U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

DRAWN O.J. — TRACED R.V.M. — CHECKED O.J.

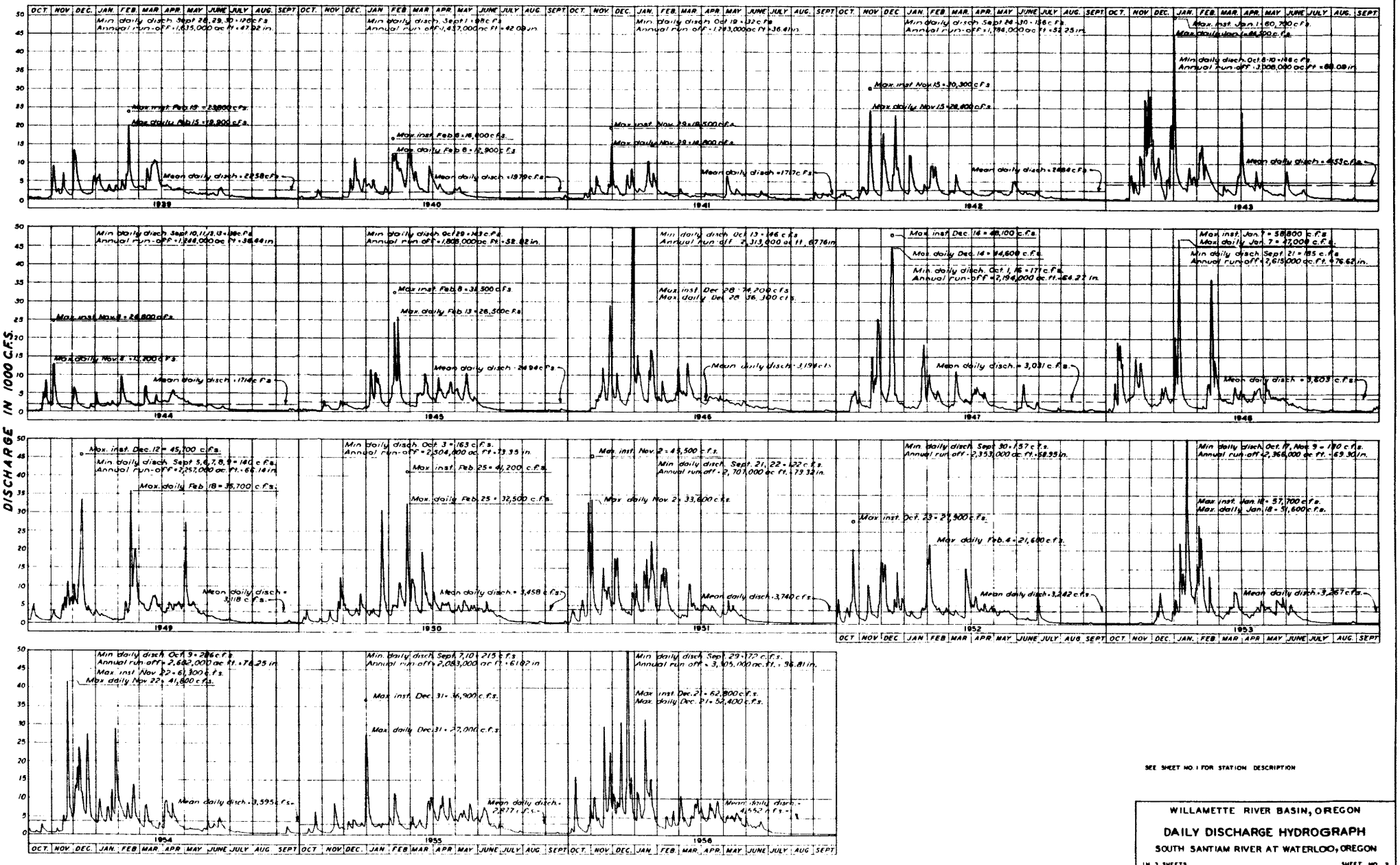
WB-05-3/29

PD-25-35/1

PLATE 9

CORPS OF ENGINEERS

U. S. ARMY



SEE SHEET NO. 1 FOR STATION DESCRIPTION

WILLAMETTE RIVER BASIN, OREGON

DAILY DISCHARGE HYDROGRAPH

SOUTH SANTIAM RIVER AT WATERLOO, OREGON

IN 3 SHEETS — SHEET NO. 2

U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

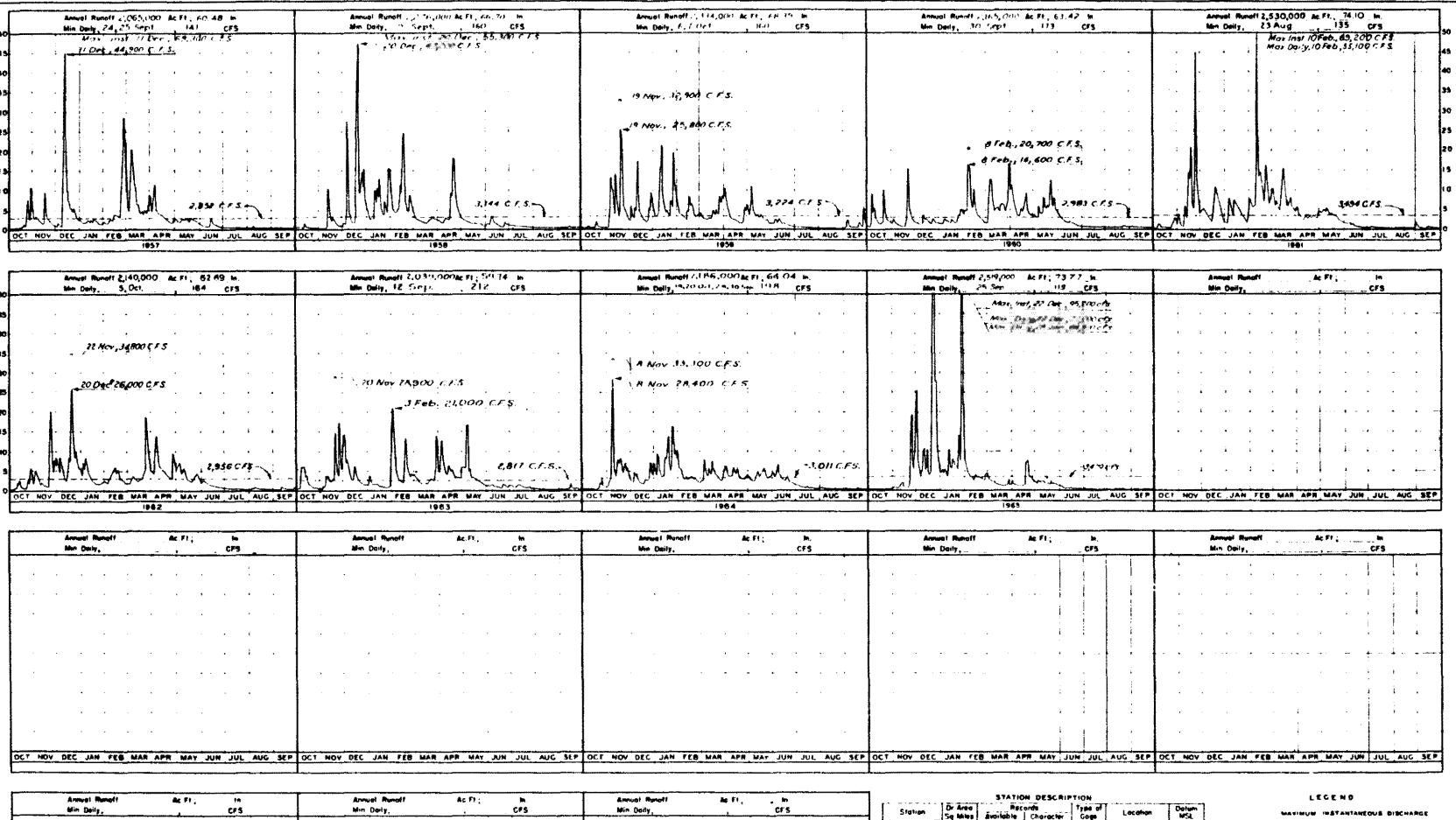
WB-05-3/30

PD-25-35/2

PLATE 10

CORPS OF ENGINEERS

U. S. ARMY



STATION DESCRIPTION

Station	Dr. Area Sq. Miles	Records Available	Records Character	Type of Gage	Location	Datum MSL

SEE SHEET NO. 1 FOR STATION DESCRIPTION

LEGEND

MAXIMUM INSTANTANEOUS DISCHARGE

MAXIMUM DAILY DISCHARGE

MEAN DISCHARGE

WILLAMETTE RIVER BASIN, OREGON

DAILY DISCHARGE HYDROGRAPH

SOUTH SANTIAM RIVER AT WATERLOO, OREGON

IN 3 SHEETS SHEET NO. 3

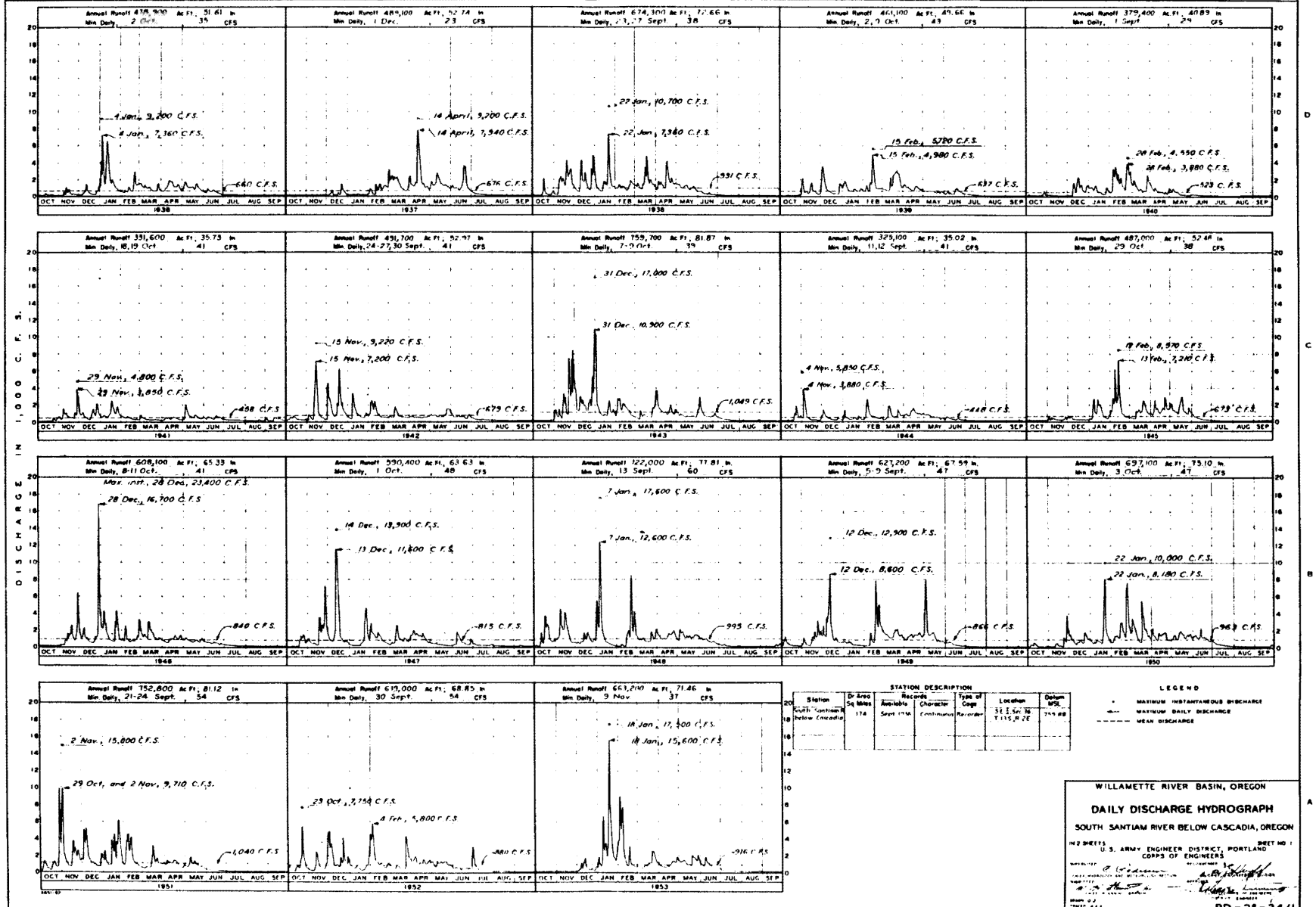
U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

PD-25-35/3

PLATE II

CORPS OF ENGINEERS

U S ARMY



STATION DESCRIPTION

Station	Dr Area Sq Miles	Records Available	Records Character	Type of Gage	Location	Datum MSL
South Santiam R Below Cascadia	174	Sept 1936	Continuous	Recorder	16 E Sec 36 T 11S, R 2E	749.88

LEGEND

- MAXIMUM INSTANTANEOUS DISCHARGE
- MAXIMUM DAILY DISCHARGE
- MEAN DISCHARGE

WILLAMETTE RIVER BASIN, OREGON

DAILY DISCHARGE HYDROGRAPH

SOUTH SANTIAM RIVER BELOW CASCADIA, OREGON

IN 2 SHEETS — SHEET NO 1

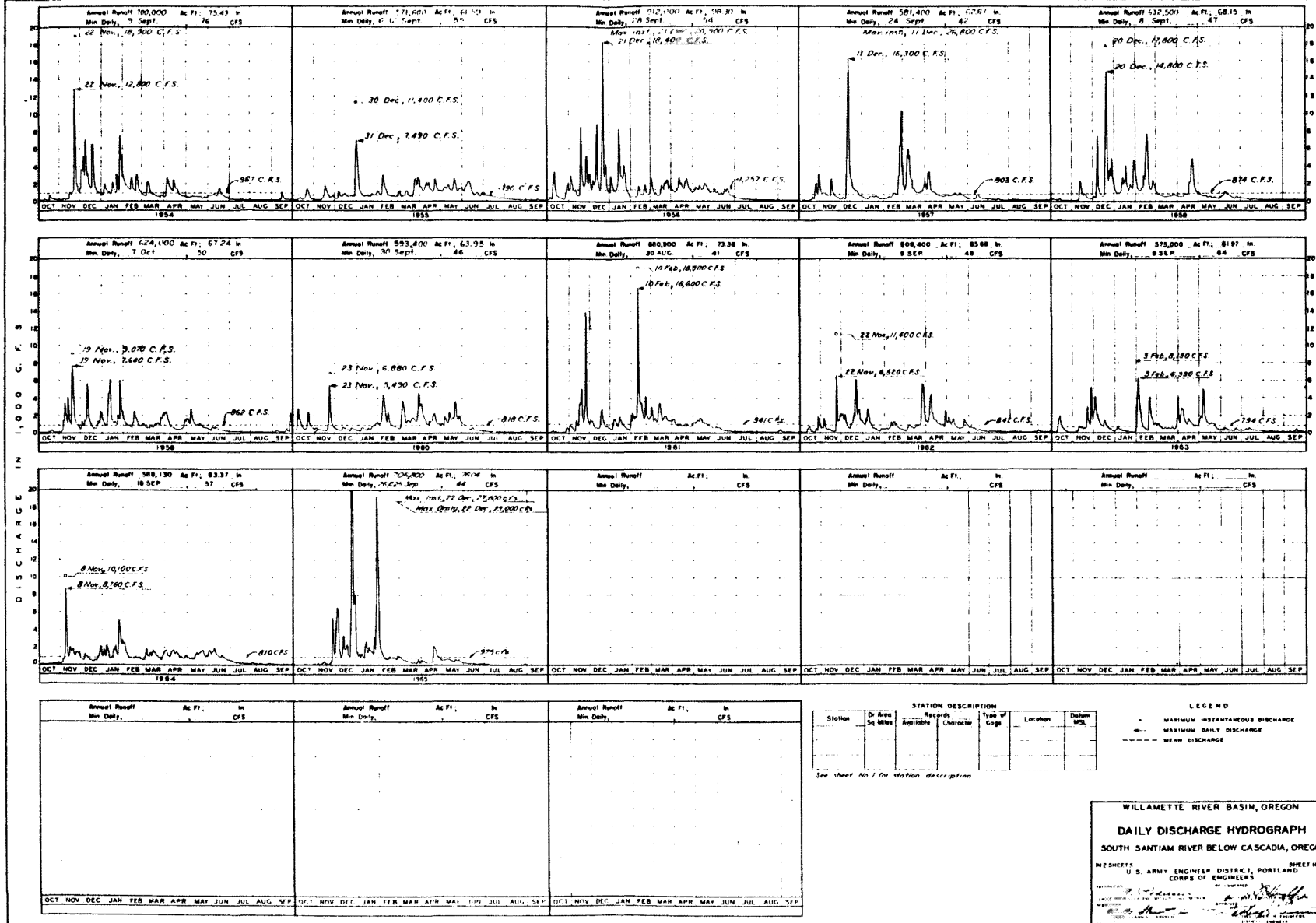
U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

RD-25-3471

PLATE 12

CORPS OF ENGINEERS

U. S. ARMY



STATION DESCRIPTION

Station	Dr Area Sq Miles	Records Available	Records Character	Type of Gage	Location	Datum MSL

See sheet No 1 for station description

LEGEND

- MAXIMUM INSTANTANEOUS DISCHARGE
- MAXIMUM DAILY DISCHARGE
- MEAN DISCHARGE

WILLAMETTE RIVER BASIN, OREGON

DAILY DISCHARGE HYDROGRAPH

SOUTH SANTIAM RIVER BELOW CASCADIA, OREGON

IN 2 SHEETS — SHEET NO. 2

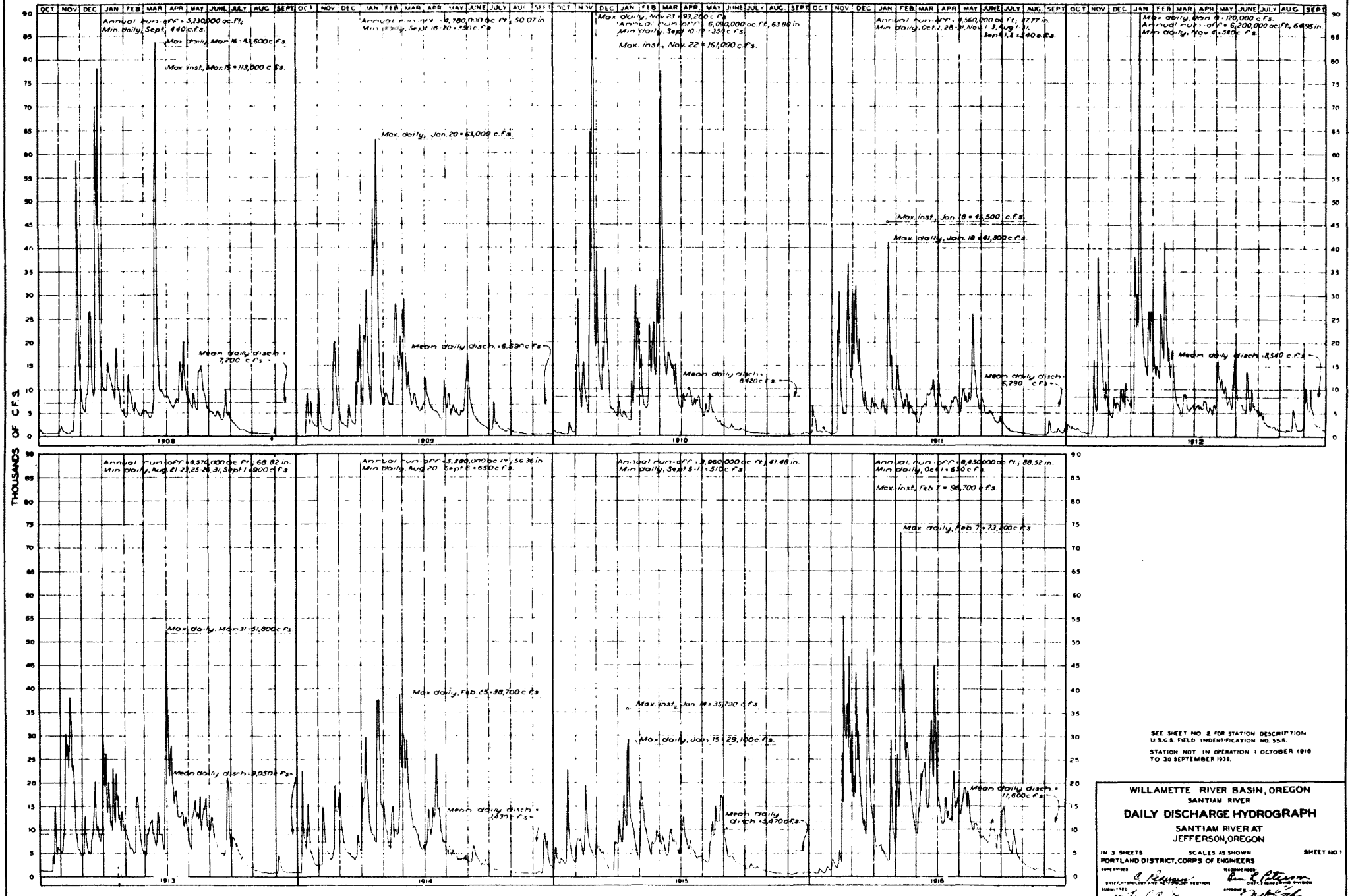
U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

RD-25-34/2

PLATE 13

CORPS OF ENGINEERS

U.S. ARMY



SEE SHEET NO. 2 FOR STATION DESCRIPTION
U.S.G.S. FIELD IDENTIFICATION NO. 555.

STATION NOT IN OPERATION 1 OCTOBER 1918 TO 30 SEPTEMBER 1939.

DE-20-45/18

WILLAMETTE RIVER BASIN, OREGON

SANTIAM RIVER

DAILY DISCHARGE HYDROGRAPH

SANTIAM RIVER AT JEFFERSON, OREGON

IN 3 SHEETS | SCALES AS SHOWN | SHEET NO. 1

PORTLAND DISTRICT, CORPS OF ENGINEERS

SUPERVISED C. Rasmussen CHIEF, HYDROLOGY AND METEOROLOGY SECTION

RECOMMENDED Ben E. Peterson CHIEF, ENGINEERING DIVISION

SUBMITTED CHIEF, PLANNING BRANCH

APPROVED COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

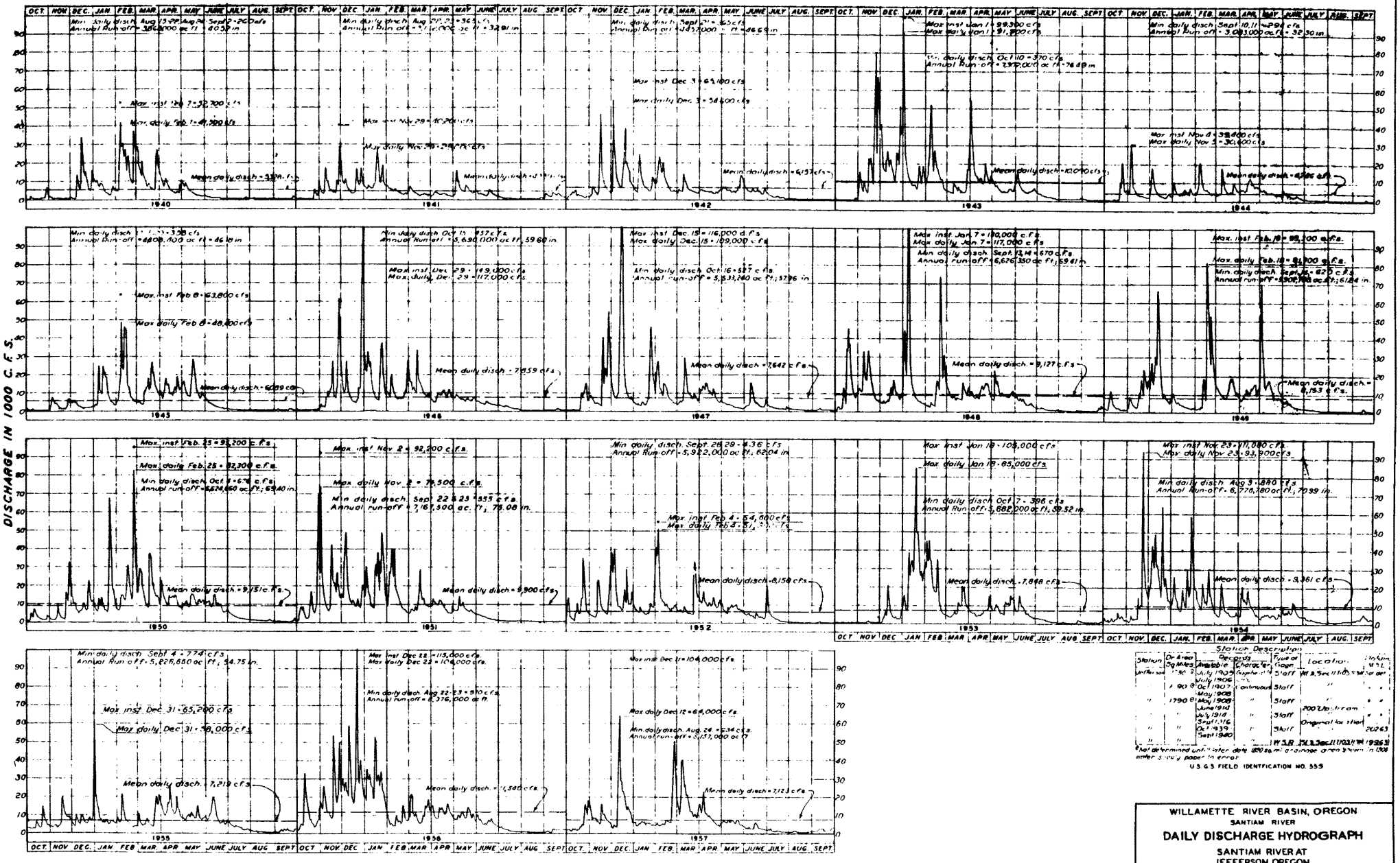
DRAWN BY JMH
TRACED BY VWH
CHECKED BY RYO

PD-25-10/1

PLATE 14

CORPS OF ENGINEERS

U. S. ARMY



Station	Drainage Area Sq Miles	Records Available	Records Character	Type of Gage	Location	Station No. U.S.G.S.
Jefferson	1390	July 1903	Graphic	Staff	Mi. 8.5 on U.S. Highway 20	
"	"	July 1906	"	"	"	"
"	1390	Oct 1907	continuous	Staff	"	"
"	"	May 1908	"	"	"	"
"	1390	May 1908	"	Staff	"	"
"	"	June 1914	"	"	200' Upstream	"
"	"	July 1914	"	Staff	"	"
"	"	Sept 1916	"	"	Original location	"
"	"	Oct 1939	"	Staff	"	20263
"	"	Sept 1940	"	"	"	"

What determined unit water data (1390 sq mi drainage area shown in 1908 under steady paper in error

U.S.G.S. FIELD IDENTIFICATION NO. 555

WILLAMETTE RIVER BASIN, OREGON

SANTIAM RIVER

DAILY DISCHARGE HYDROGRAPH

SANTIAM RIVER AT JEFFERSON, OREGON

IN 3 SHEETS | SCALES AS SHOWN | SHEET NO. 2

PORTLAND DISTRICT, CORPS OF ENGINEERS

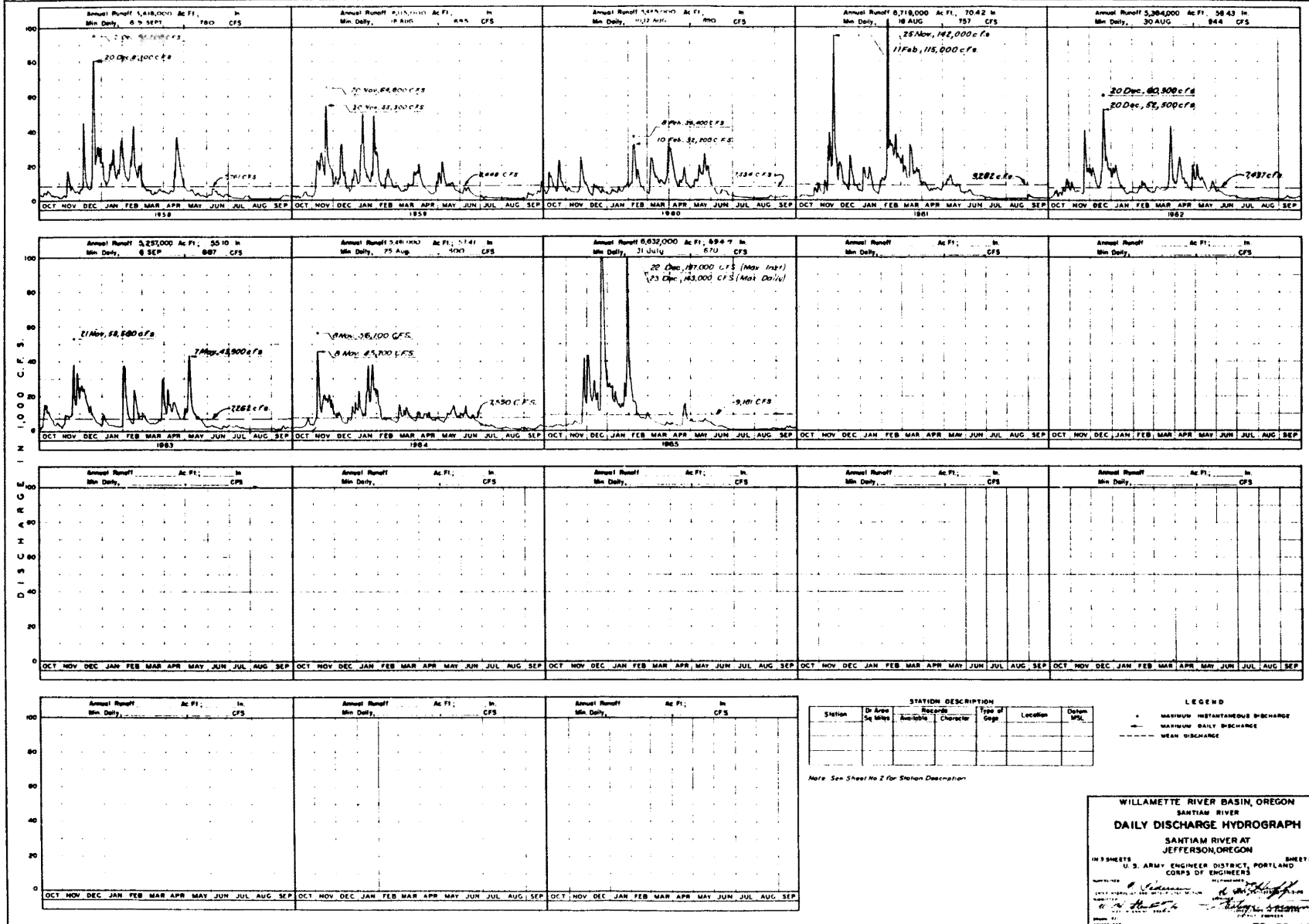
DE-20-45/17

PD-25-10/2

PLATE 15

CORPS OF ENGINEERS

U. S. ARMY



STATION DESCRIPTION

Station	Dr Area Sq Miles	Records Available	Records Character	Type of Gage	Location	Datum MSL

Note See Sheet No 2 for Station Description

LEGEND

- MAXIMUM INSTANTANEOUS DISCHARGE
- MAXIMUM DAILY DISCHARGE
- MEAN DISCHARGE

WILLAMETTE RIVER BASIN, OREGON

SANTIAM RIVER

DAILY DISCHARGE HYDROGRAPH

SANTIAM RIVER AT JEFFERSON, OREGON

IN 3 SHEETS — SHEET NO 3

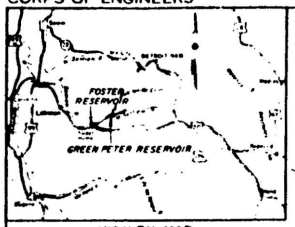
U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

PD-25-10/3

PLATE 16

CORPS OF ENGINEERS

U. S. ARMY



VICINITY MAP
SCALE IN MILES

PUBLIC ACCESS SITE

PROPOSED QUARTZVILLE ROAD RELOCATION

PROPOSED QUARTZVILLE ROAD RELOCATION

6-B(INDEX)

5-A(INDEX)

PROPOSED PROJECT BOUNDARY

GREEN PETER DAM (UNDER CONSTRUCTION)

PROPOSED PROJECT BOUNDARY

MIDDLE SANTIAM

MAX. POOL EL. 1015

MIN. F.C. POOL EL. 922

SANTIAM RIVER

1-A(INDEX)

2-A(INDEX)

3-A(INDEX)

PROPOSED PROJECT BOUNDARY

R2E.W.M.
R3E.W.M.

PROPOSED WEYERHAEUSER TIMBER ACCESS ROAD

LEGEND

- MAXIMUM POOL EL. 1018
- MINIMUM FLOOD CONTROL POOL EL. 922
- PROPOSED ROAD RELOCATION
- EXISTING PAVED ROAD
- EXISTING ALL WEATHER HAUL ROAD
- EXISTING SECONDARY ROAD
- PROPOSED PROJECT BOUNDARY
- 1-A(INDEX) PROPOSED SEDIMENTATION RANGE
- PROPOSED PRIVATE ROAD

SCALE IN FEET

WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER
GREEN PETER RESERVOIR

SEDIMENTATION RANGE LAYOUT

IN 2 SHEETS SHEET NO 1

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

SUPERVISED ... CHIEF, WATER CONTROL SECTION
RECOMMENDED ... CHIEF, ENGINEERING DIVISION
SUBMITTED ... CHIEF, PLANNING BRANCH
APPROVED ... DIVISION ENGINEER, CORPS OF ENGINEERS, DISTRICT ENGINEER

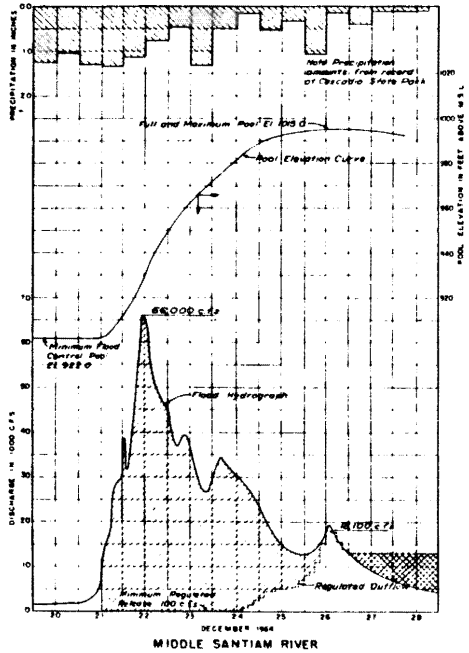
DRAWN BY P.S.E. - A.S.S.
TRACED BY
CHECKED BY L.M.S - A.S.S.

GP-20-18/1

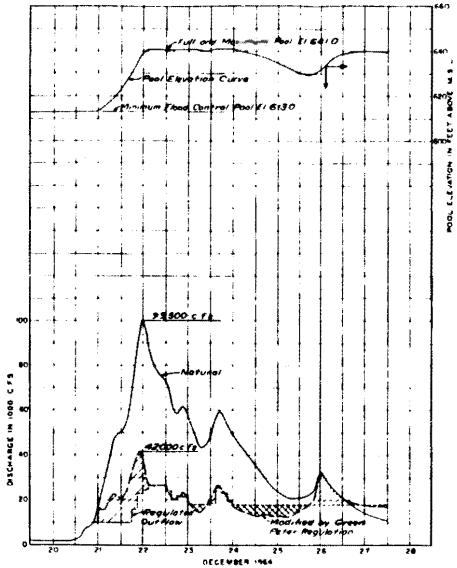
PLATE 17

CORPS OF ENGINEERS

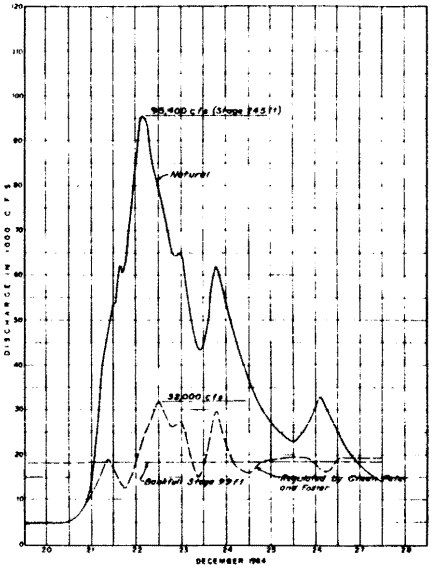
U. S. ARMY



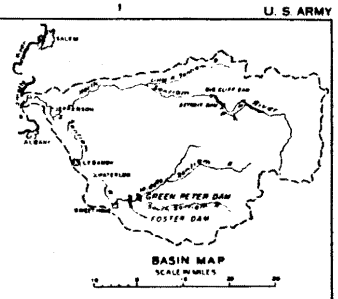
MIDDLE SANTIAM RIVER
AT GREEN PETER DAM
DRAINAGE AREA 277 SQ MI



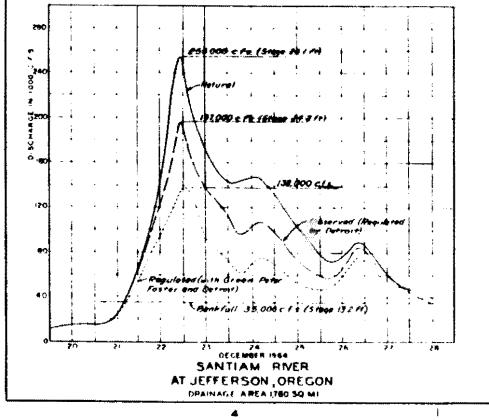
SOUTH SANTIAM RIVER
AT FOSTER DAM
DRAINAGE AREA 494 SQ MI



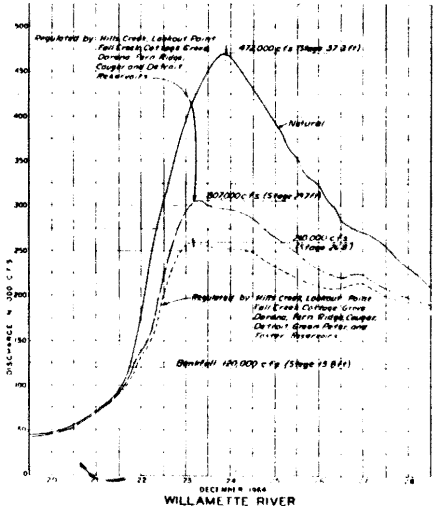
SOUTH SANTIAM RIVER
AT WATERLOO, OREGON
DRAINAGE AREA 840 SQ MI



BASIN MAP
SCALE IN MILES



SANTIAM RIVER
AT JEFFERSON, OREGON
DRAINAGE AREA 1780 SQ MI



WILLAMETTE RIVER
AT SALEM, OREGON
DRAINAGE AREA 7280 SQ MI

FLOOD CONTROL STORAGE RESERVOIRS ABOVE SALEM

RESERVOIR	FLOOD CONTROL STORAGE AC-FT FEET	REMARKS
COTTAGE GROVE	30,000	EXISTING
DORENA	70,000	"
LOOKOUT POINT	337,000	"
FERN RIDGE	94,700	"
DETROIT	300,000	"
HILLS CREEK	200,000	"
COUGAR	155,000	"
GREEN PETER	270,000	"
FOSTER	30,000	"
FALL CREEK	[illegible]	"

LEGEND

PRECIPITATION

WATER STORED IN RESERVOIR

WATER IN EXCESS OF INFLOW RELEASED FROM RESERVOIR

WILLAMETTE RIVER BASIN, OREGON
SANTIAM RIVER

NATURAL AND REGULATED HYDROGRAPHS

FLOOD OF DECEMBER 1964

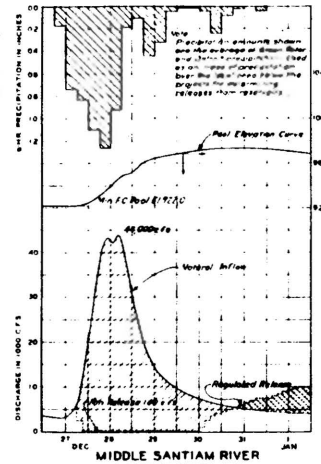
U S ARMY ENGINEER DISTRICT PORTLAND

GP-20-24/2

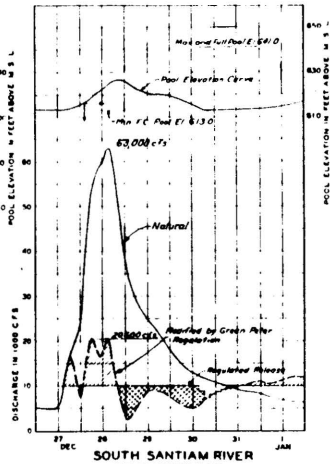
PLATE 18

CORPS OF ENGINEERS

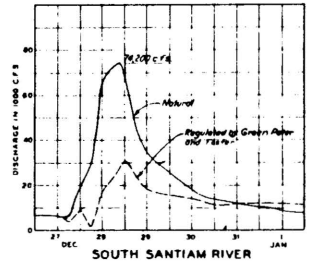
U. S. ARMY



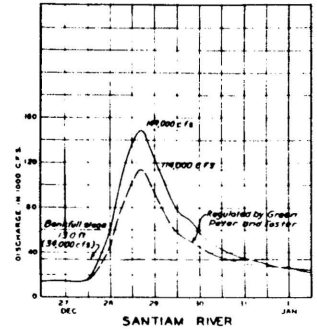
MIDDLE SANTIAM RIVER
AT GREEN PETER DAM
DRAINAGE AREA 277 SQ MI



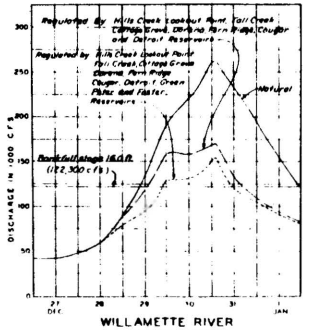
SOUTH SANTIAM RIVER
AT FOSTER DAM
DRAINAGE AREA 494 SQ MI



SOUTH SANTIAM RIVER
AT WATERLOO, OREGON
DRAINAGE AREA 840 SQ MI

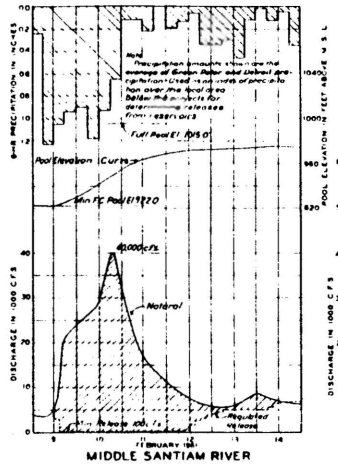


SANTIAM RIVER
AT JEFFERSON, OREGON
DRAINAGE AREA 1190 SQ MI

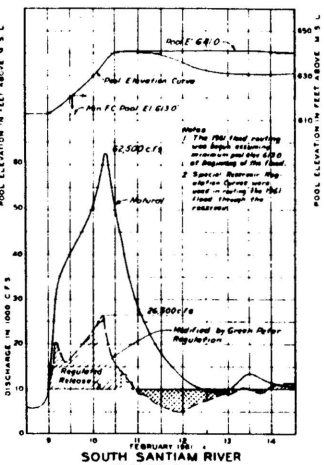


WILLAMETTE RIVER
AT SALEM, OREGON
DRAINAGE AREA 7280 SQ MI

FLOOD OF DECEMBER 1945 - JANUARY 1946



MIDDLE SANTIAM RIVER
AT GREEN PETER DAM
DRAINAGE AREA 277 SQ MI.

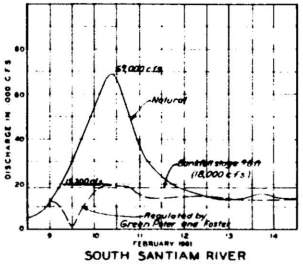


SOUTH SANTIAM RIVER
AT FOSTER DAM
DRAINAGE AREA 494 SQ MI

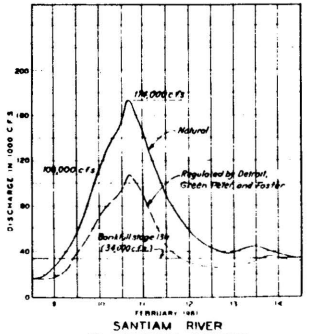


BASIN MAP
SCALE IN MILES

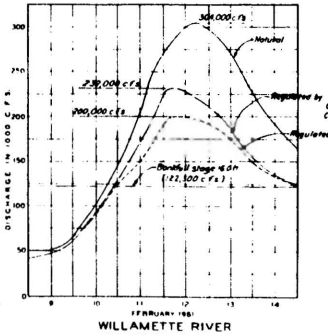
FLOOD CONTROL STORAGE RESERVOIRS ABOVE SALEM		
RESERVOIR	FLOOD CONTROL STORAGE ACRE-FEET	REMARKS
COTTAGE GROVE	30,000	EXISTING
DORENA	70,000	"
LOOKOUT POINT	337,000	"
FERN RIDGE	94,200	"
DETROIT	300,000	"
HILLS CREEK	200,000	"
COUGAR	195,000	"
GREEN PETER	270,000	"
FOSTER	30,000	"
FALL CREEK	115,000	"



SOUTH SANTIAM RIVER
AT WATERLOO, OREGON
DRAINAGE AREA 840 SQ MI



SANTIAM RIVER
AT JEFFERSON, OREGON
DRAINAGE AREA 1190 SQ MI



WILLAMETTE RIVER
AT SALEM, OREGON
DRAINAGE AREA 7280 SQ MI

FLOOD OF FEBRUARY 1961

LEGEND

PRECIPITATION

WATER STORED IN RESERVOIR

WATER IN EXCESS OF INFLOW RELEASED FROM RESERVOIR

WILLAMETTE RIVER BASIN, OREGON
SANTIAM RIVER

NATURAL AND REGULATED HYDROGRAPHS
FLOODS OF 1945 AND 1961

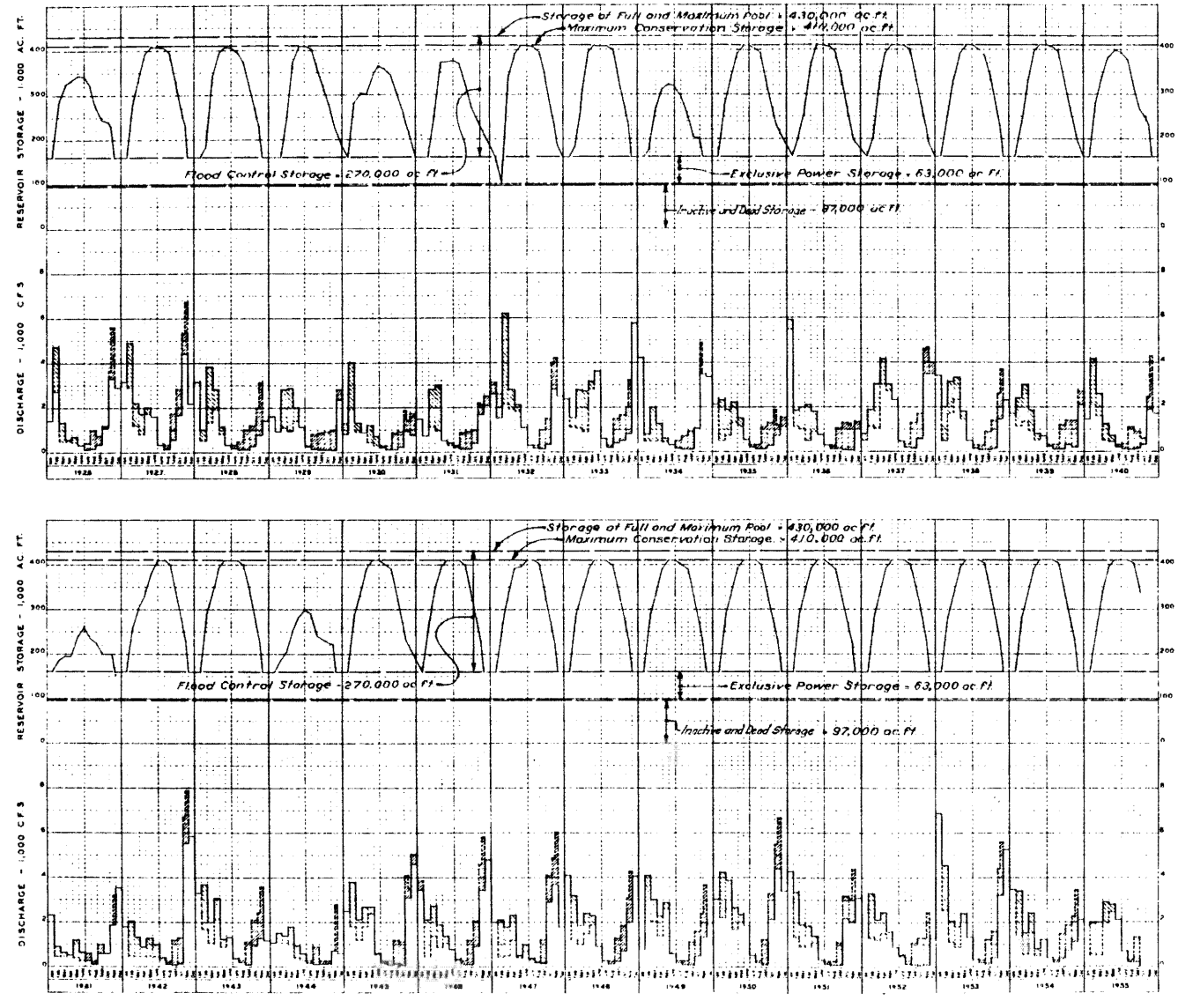
U. S. ARMY ENGINEER DISTRICT, PORTLAND

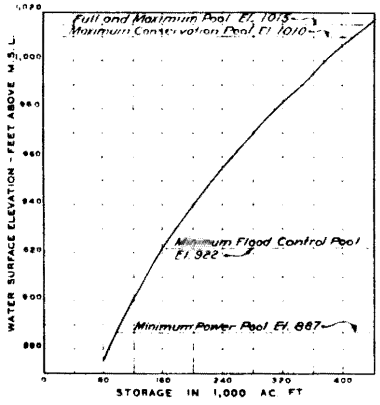
GP-20-24/3

PLATE 19

CORPS OF ENGINEERS

U.S. ARMY





STORAGE CAPACITY

LEGEND

- NATURAL INFLOW
- REGULATED OUTFLOW
- WATER STORED IN RESERVOIR
- WATER RELEASED FROM RESERVOIR

NOTES

1. THIS CHART ILLUSTRATES, AT THE GREEN PETER RESERVOIR SITE FOR THE PERIOD 1928-1955, THE INFLOW, OUTFLOW, AND RESERVOIR CONTENTS AS AFFECTED BY A PLAN TO DEVELOP THE ULTIMATE WATER RESOURCES OF THE WILLAMETTE BASIN.
2. GREEN PETER IS ONE UNIT OF A SYSTEM OF FOURTEEN MULTI-PURPOSE RESERVOIRS RECOMMENDED FOR THE WILLAMETTE BASIN.
3. FLOOD CONTROL REGULATION IS ILLUSTRATED ON PLATES 18 AND 19.
4. SEE TEXT FOR DETAILED EXPLANATION OF SEASONAL RESERVOIR REGULATION.

WILLAMETTE RIVER BASIN, OREGON
MIDDLE SANTIAM RIVER

GREEN PETER RESERVOIR

SEASONAL RESERVOIR REGULATION

SCALES AS SHOWN

U.S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

GP-20-11/4

PLATE 20

US Army Corps
of Engineers®
Portland District

EXHIBIT A

DROUGHT CONTINGENCY PLAN FOR THE WILLAMETTE VALLEY PROJECT



Detroit reservoir at minimum power pool, after the 2015 Drought (Oct 17, 2015)

Drought Contingency Plan for the Willamette Valley Project

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1.0 Introduction.

1-01. Purpose. The purpose of this document is to provide a drought contingency plan (DCP) for USACE reservoirs in the Willamette Valley Project.

1-02. Requirements. This DCP for the Willamette Valley Project meets the requirements of ER 1110-2-1941, *Development of Drought Contingency Plans*, dated 15 September, 1981. Engineering Regulation (ER) 1110-2-240, *Water Control Management*, dated 30 May 2016, Section 2-3.i, states that water control management policies and procedures, including project regulation, shall be evaluated for adaptation to climate change. A vulnerability assessment by the USACE, summarized in two reports, the 2011 and 2012 *USACE Climate Change Adaptation Plans and Report*, dated September 2011, and June 2012, respectively, identified drought as a source of continuing vulnerability in the future. Updated policy and guidance regarding DCP updates to account for climate change is planned as stated in the CWTS[1] Report 15-15, *USACE Drought Contingency Planning in the Context of Climate Change, U.S. Army Corps of Engineers: Washington DC*, dated September 2015 (Pinson et al., 2015).

1-03. Background. This 2017 DCP update provides a description of historical droughts, drought signals and indicators, drought trends in the context of climate change, water uses and availability, flow and drought management for the Willamette Valley Project, and addresses coordination and communications to take place during a drought situation. This DCP will be included as an exhibit to the Willamette Master Manual and the individual water control manuals upon approval. As of 2017, the Willamette Master Manual draft, dated March 2015, is awaiting the updated NEPA documentation on the operations and maintenance of the Willamette Valley Project.

1-04. Responsibilities. The Portland District Reservoir Regulation & Water Quality Section (CENWP-EC-HR) is responsible for preparation, revision, and implementation of the DCP. The Northwestern Division Water Management, Columbia Basin (CENWD-PDW) is responsible for oversight and approval of this DCP.

2.0 Authorities

The following list of authorities is pertinent to the preparation of drought contingency plans and drought related activities:

- Section 6 of the Flood Control Act of 1944, 33 U.S.C. § 708, provides authority for the Secretary of the Army to enter into agreements for surplus water with states, municipalities, private concerns, or individuals at such prices and on such terms as he may deem reasonable for domestic, municipal, and industrial uses (but not for crop irrigation), for surface water that may be available at any reservoir under the control of the Department of the Army, and provides adequate authority to permit temporary withdrawal of water from USACE projects to supplement normal supplies.

[1] "CWTS" is Civil Works Technical Series

- Flood Control Act of 1941, Pub. L. No. 84-99, 33 U.S.C. § 701n, as amended by Section 82 of the Water Resources Development Act of 1974, Pub. L. No. 93-251, grants the Chief of Engineers discretionary authority to provide emergency supplies of clean water. Work under this authority requires a request from the governor of the affected state. This law authorizes an emergency fund to be expended in preparation for emergency response to natural disasters, including drought, and authorizes the Chief of Engineers to perform emergency work and to provide emergency supplies of clean water on such terms as he determines to be advisable as a result of drought.
- Pub. L. No. 95-51, Disaster Relief Act of 1974 Appropriations Act, amended the Flood Control Act of 1941 to provide for disaster relief, and authorized the Secretary of the Army to construct wells and transport water to farmers, ranchers, and political subdivisions within areas determined to be drought distressed.
- The National Drought Policy Act of 1998, Pub. L. No. 105-199, established the National Drought Policy Commission to provide advice and recommendations on creation of an integrated coordinated Federal policy designed to prepare for and respond to serious drought emergencies.
- ER 1110-2-1941, *Development of Drought Contingency Plans*, dated 15 September 1981, provides policy and guidance for the preparation of drought contingency plans as part of the USACE over-all water management activities.
- ER 1110-2-240, *Water Control Management*, dated 30 May 2016, describes the policies and procedures to be followed in water management activities, including special regulations to be conducted during droughts. It also sets the responsibility and approval authority in development of water control plans.
- ER 500-1-1, *Emergency Employment of Army and Other Resources*, dated 30 September 2001, prescribes policies for the Civil Emergency Management Program of the USACE under the Flood Control Act of 1941. Section II of this ER describes the policy for the USACE to provide assistance during drought, the level of assistance authorized in providing emergency water, and funding procedures for emergency water activities.
- ER 405-1-12, *Real Estate Handbook,* dated 20 November 1985, provides guidance for issuing an appropriate real estate instrument for water withdrawal users who will be installing water lines or other facilities or equipment.
- EM 1110-2-3600, *Management of Water Control Systems*, 30 November 1987 requires that the drought management plan be incorporated into the project water control manuals and master water control manuals. It also provides guidance in formulating strategies for project regulation during droughts.

The USACE Institute for Water Resources, *Water Supply Handbook*, *Report 96-PS-4*, dated December 1998, Chapter 2, provides the authorities, policies and procedures for the different types of water during a drought. This includes storage costs, restrictions, disaster relief, emergency water supply planning and other water uses during a state of emergency, including drought conditions.

3.0 Droughts

3-01. Definition of Drought. The CWTS report 15-15 (referred to in Section 1-02), classifies three types of drought: meteorological, agricultural, and hydrologic. Socioeconomic and ecological droughts are other types described by the National Drought Mitigation Center. These types of droughts are described follows:

- **Meteorological** drought is a period of months to years in which precipitation is below normal. It can be accompanied by above-normal temperatures and other factors. It can precede and cause the other types of drought.
- **Agricultural or soil-moisture** drought is a period with dry soils which can reduce crop production and plant growth. Soil-moisture drought can result from below-normal precipitation, above-normal evaporation, or intense but less-frequent precipitation events. Susceptibility to soil-moisture drought can depend on crop or vegetation type.
- **Hydrologic** drought refers to a period when river streamflow and water storages in aquifers, lakes and reservoirs fall below long-term mean levels. It can develop slowly as stored water is used but not replenished.
- **Socioeconomic** droughts occur when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply. The supply of economic goods, such as water, forage, food grains, fish and hydropower depends on weather. Because of the natural variability of climate, water supply is ample in some years, but not able to meet human and environmental needs in other years.
- **Ecological** drought is a prolonged and widespread deficit in naturally available water supplies, which include changes in natural and managed hydrology and create multiple stresses across ecosystems.

3-02. Historical Oregon Droughts. Droughts in Oregon occur in all parts of the state and in both winter and summer months. The region east of the Cascade Mountain Range is the most vulnerable to drought with localized risks statewide where climate is influenced by local topographical features. Water is often in short supply in much of Oregon during the low flow months of July through September. Figure 3-1 is reproduced from the draft Willamette Master Manual, dated March 2015, which shows the low precipitation during the summer months compared to the rest of the year. This condition has been described as Oregon's seasonal "drought". Droughts appear to be cyclic and can have an effect on the economy, particularly on the hydropower and agricultural sectors. Environmental consequences include insect infestations in forests and reduced water availability for endangered fish. Severe drought conditions have preceded major forest fires. Water allocation continues to be controversial.

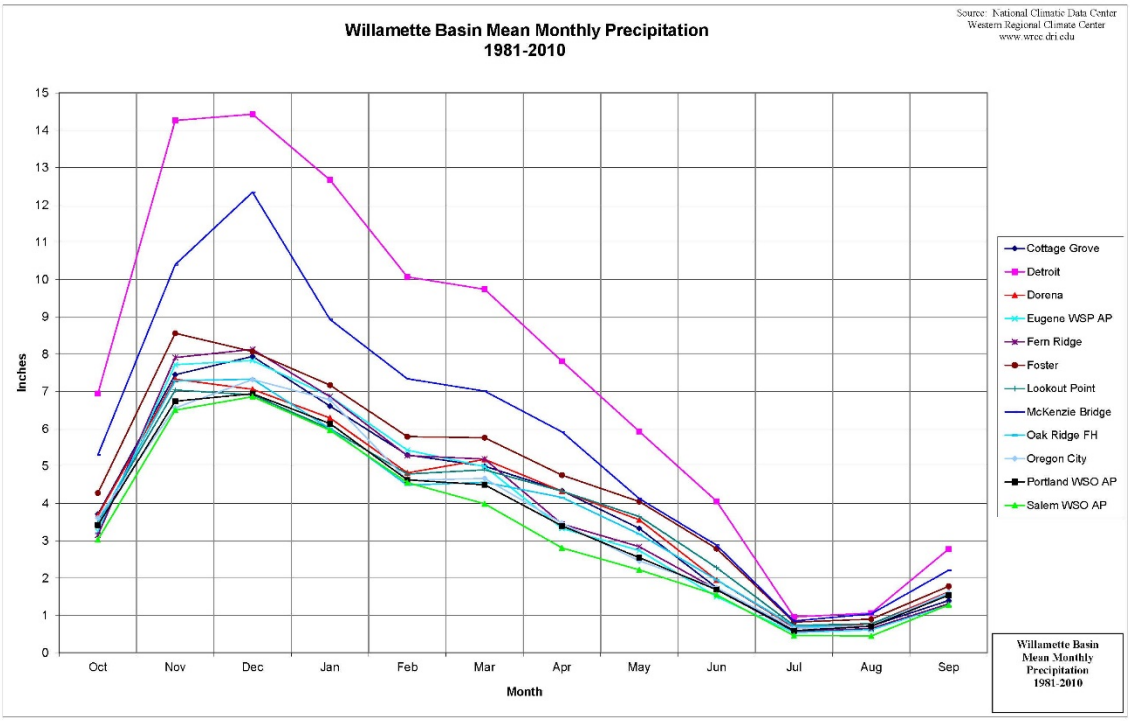


Figure 3-1. Willamette Basin Monthly Precipitation

Eight significant hydrologic drought periods have occurred in Oregon since 1900 (*Oregon Emergency Management Plan, Natural Hazards Mitigation Plan, Drought Chapter*, February 2012, and the *2015 Drought After Action Report for Portland District Reservoir Operations*.).

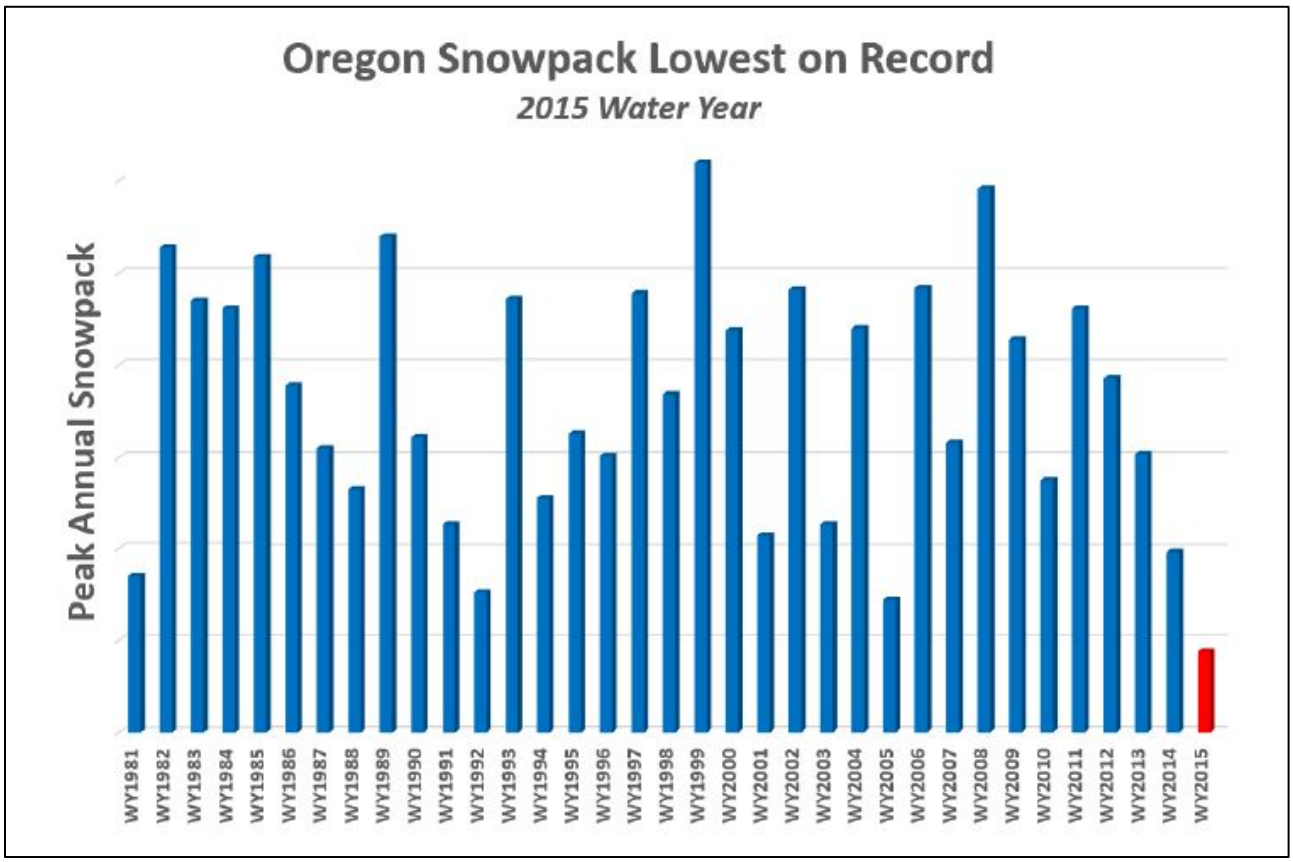
1904-1905: Drought period of about 18 months
1917-1931: Very dry period punctuated by brief wet spells (1920-21, 1927)
1939-1941: Three year intense drought
1976-1977: Brief, but intense statewide drought
1985-1994: Generally dry period, with statewide droughts in 1992 and 1994
2001-2002: Second most intense drought in Oregon's history
2005: Drought affected at least eleven of Oregon's thirty-six counties
2015: El Niño brought dry and very warm conditions from February thru October

The most recent drought year occurred in water year 2015, and was a low water year for the history books with record low snowpack and streamflows along with record high temperatures that combined to create drought conditions across Oregon.

Based on the Oregon Surface Water Supply Index (SWSI) (see section 3-04.c), water year 2014 began quite dry, became normal in June and July, and then became dry again in September, resulting in an extremely dry start to water year 2015. The 2015 statewide snowpack set new record lows, replacing the previous low-snow years of 1977, 1981, 1992 and 2005. Many snow sites set records for the lowest peak snowpack and earliest melt-out date since measurements

began. Figure 3-2 shows the relative, state-wide peak annual snowpack for each water year, 1981 through 2015, showing that 2015 was the lowest for this period.

For the period May 2015 through July 2015, Oregon recorded the warmest average temperatures since 1895 when record keeping began. By 1 September 2015, the SWSI for the entire state ranged from -1.65 to -3.78 (recalibrated as of September 2016), with the Willamette Basin at 3.78. By the end of September, the U.S. Drought Monitor showed the Willamette Basin to be in a D2 Severe Drought condition and 25 of Oregon's 36 counties had requested and received drought declarations from the Governor. Reservoirs fell to unprecedented levels, irrigators stopped irrigation early in the season, and some cities implemented water restrictions.



Source: Drought Annex, State of Oregon Emergency Operations Plan, January 2016

Figure 3-2. Peak Annual Oregon Snowpack 1981-2015

3-03. Drought Signals and Indicators. A key to understanding the impacts of a drought is to evaluate the specific components of the hydrologic cycle. Precipitation and snow can be considered the carrier of the drought signal, while hydrologic processes such as snowpack accumulation and melt, runoff, evaporation rates, soil moisture, streamflow magnitudes, and groundwater content and flow can be viewed as the indicators revealing the drought presence.

The El Niño Southern Oscillation Index (ENSO) refers to the cyclical conditions that occur across the equatorial Pacific Ocean due to natural interactions between the ocean and atmosphere. El Niño is the warm phase of the ENSO cycle and the La Niña, is the cool phase. A major El Niño event generally occurs every 3 to 7 years and tends to bring drier winters to the Pacific Northwest which could signal a potential drought. La Niña conditions in the Pacific Northwest are often, but not always, characterized by cold air temperatures starting in November and December, high snowpack conditions in the mountains and low elevation snowfall in the valleys, and reduced snowmelt in the mountains until late spring.

There does not appear to be a viable connection with ENSO for short term or sustained drought for Western Oregon. The overall warm signal for the Pacific Northwest during ENSO is marginal for Western Oregon at best. El Niño warmth may suggest higher snow levels, producing a less reliable snowmelt in the spring, which could be a factor for refill of the reservoirs. The La Niña (ENSO) phase, does lean wetter for the Willamette and might be considered to not produce a drought situation; however, caution should be used when considering the use of ENSO, as the resolution in climate models is low, there are lots of uncertainty, and the opposite of what might be expected in a La Niña or El Niño year does occur.

A discussion of the up-to-date ENSO status is issued monthly by NOAA's Climate Prediction Center and the International Research Institute for Climate and Society. The discussions and data can be accessed at the Climate Prediction Center's website provided in the Weblinks section of this document.

3-04. Drought Monitoring and Climate Forecasts. The United States Department of Agriculture (USDA) and the Natural Resources Conservation Service (NRCS) provide climate forecasts that include indicators of drought. Regulators monitor and use these to aid in making water management decisions.

a. USDA Drought Monitor. The USDA provide maps, data, and forecasts related to drought through the Drought Monitor website. The U.S. Drought Monitor is a weekly product that provides a general summary of current drought conditions. Various indices, outlooks, field reports, and news accounts are reviewed and synthesized. Policymakers and the media use the information in discussions of drought and in allocating drought relief. The Drought Monitor provides a color coded map of the U.S. that shows levels of drought intensities by region. The Drought Monitor Update Report for Oregon can be accessed at the weblink provided in the Weblinks section of this document.

b. Natural Resources Conservation Service Oregon. The NRCS Oregon provides snow and precipitation data for current water year, water supply outlook reports, climate, and soil moisture/temperature data for their SNOTEL sites. Snow survey products and water supply outlook reports for Oregon are provided through maps and graphs, and can be accessed at the weblink provided in the Weblinks section of this document.

The water supply outlook reports include the Oregon Basin Outlook Report, streamflow forecast tables and maps, daily water supply forecasts, reservoir reports, and the Surface Water Supply Index. The Oregon Basin Outlook Report provides a monthly update (January through June) of

the water supply for select basins across Oregon and includes the current status of the snowpack and long term water supply forecasts.

c. Drought Severity. Drought is typically measured in terms of water availability in a defined geographical area. It is common to express drought with a numerical index that ranks severity. NOAA uses the Palmer Drought Severity Index that provides data back to 1900. Most federal agencies use the Palmer Method. This method uses precipitation, runoff, evaporation, and soil moisture as variables. Because the method does not use snowpack as a variable, the Palmer index does not provide an accurate indication of drought in the Pacific Northwest and Oregon; however, it can be useful because of its long term historical record of wet and dry conditions back to 1900.

The Oregon Water Resources Department uses the Surface Water Supply Index (SWSI) to help assess drought conditions. The SWSI is developed by the NRCS. The SWSI is calculated using mountain snowpack, precipitation, reservoir storage, and streamflow data to predict the anticipated water availability for the upcoming year. The SWSI scale measures anticipated water supply by drainage basin, ranging from a +4.1 representing extremely wet conditions to -4.1, representing extremely dry conditions. The SWSI calculations use different equations for each month, all available data, an objective method to determine coefficients, and a 5-month running average to smooth the effects between months. Figure 3-3 shows the 14 river basins within Oregon used to evaluate state-wide drought conditions. The up-to-date and historic SWSI values can be accessed at the weblink provided in the Weblinks section of this document.

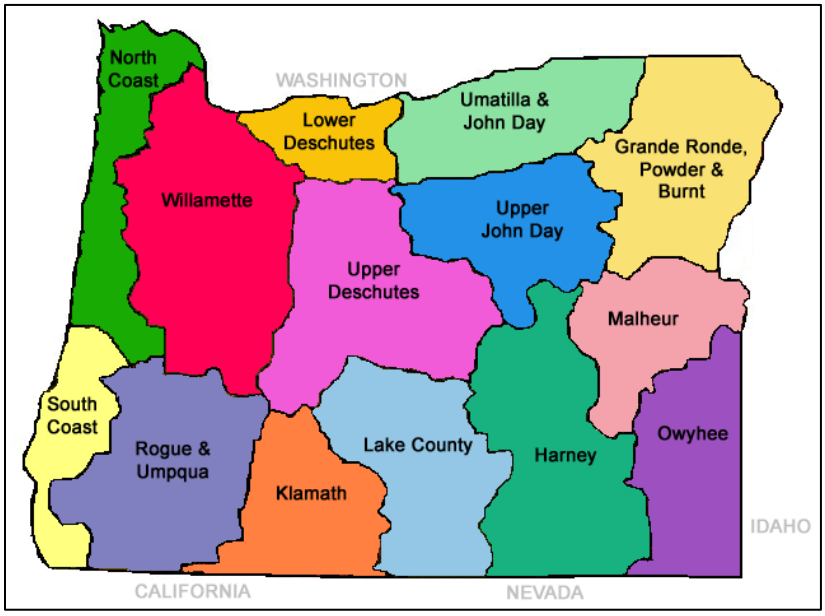


Figure 3-3. Oregon River Basins to Evaluate Drought Conditions

3-05. Drought in the Context of Climate Change. Drought contingency plans are a critical element of flexible water management when combined with water control manuals and the

operation deviation process. The following describes efforts to include climate change in DCPs, climate and streamflow projections in Oregon, and implications to future operations of the Willamette Valley Project.

a. Drought Contingency Planning for Climate Change. The CTWS Report 15-15, contains an overview of climate change and drought in the U.S. to aid in planning for current and future droughts at USACE projects. As of 2017, the report may be accessed at the weblink provided in the Weblinks section of this document. Table 1 of the CTWS Report 15-15, shows that the prediction for the Northwest is for a possible increase in summer drought conditions, and increased hydrologic drought due to changes in mountain snowpack. Appendix B of the report provides a summary of the climate change impacts for six regions in the U.S., including the Northwest.

b. Climate and Streamflow Projections. The report prepared for the CENWP by the Oregon Climate Change Research Institute, *Historical Trends and Future Projections of Climate and Streamflow in the Willamette Valley and Rogue River Basins*, dated June 2015 and revised March 3, 2016, examines observed changes in temperature, precipitation, snowpack, and streamflow in the Willamette and Rogue River Basins, provides projections of the future changes of these variables based on global climate model (GCM) simulations, and addresses implications to water management. The following is a summary of the findings of this study. Refer to the report for details.

1) Temperature. The temperature trend analysis shows, that the minimum and maximum temperatures are projected to increase year-round with greater warming in June through August periods. There is a high degree of confidence in the temperature increases because all models agree with the trend.

2) Precipitation. Some model predictions show an increase and some show a decrease in precipitation. The average multi-model projection change is small in each season, with slightly more precipitation in the winter and less in the summer. While the average multi-model projection change is small, the range of plausible outcomes should be considered.

3) Snowpack. Snow water equivalent as a portion of cumulative precipitation is expected to decline across the region. The North Santiam sub-basins which historically receive the most snow, show a projected December through February decline. The Middle Willamette sub-basin generally receives less snow compared to the other basins and future trend is to receive even less snow. In addition, the small increases in total winter precipitation are projected to potentially equate to very little snow in the future due to the increase in winter temperatures.

4) Streamflow. Changes in streamflow are primarily driven by decreases in snow accumulation, and secondarily by seasonal variation in precipitation change. Models show that mean winter flows will increase and summer flows will decrease, with the magnitude of change mainly determined by the basin's sensitivity to a decline in snow accumulation. The North Santiam is considered sensitive to the snowpack. In this basin, the mean flow is projected to increase significantly during the winter and decrease in the spring and summer, whereas, in the

Middle Fork, the winter flows are projected to increase slightly with small changes during the rest of the year.

Annual peak flows are projected to increase in the future with the peak flows with lower return periods to increase more than those with higher return periods. For rain driven basins, annual peak flows of are of short duration (1 to 5 days), and are projected to occur up to 5 days earlier in the water year. For basins with a larger snowmelt component such as in the North Santiam, peaks are expected to occur up to 2 weeks earlier.

c. Implications for Water Management. The probability of drought is projected to increase under future climate change if drought were defined as prolonged periods of demand exceeding supply. As of 2017, it is not clear if current operations provide enough flexibility to manage hydrological changes.

4.0 Basin Description

4-01. Willamette Basin Description. The Willamette Basin is an 11,200 square mile watershed that is a major tributary to the Columbia River and is located entirely within the state of Oregon. The basin has a maximum north-south length of about 150 miles, averages about 75 miles in width, and encompasses 12 percent of the state. The basin is bound by three mountain ranges: the Cascade Range to the east, the Coast Range to the west, and the Calapooya Mountains to the south. Maximum elevations exceed 10,000 feet in the Cascade Range, 4,000 feet in the Coast Range, and 6,000 feet in the Calapooya Mountains. Thirteen of Oregon's thirty-six counties intersect or lie within the boundary of the basin and nearly seventy percent of Oregon's population lives within the basin.

Principal tributaries of the Willamette River originate in the Cascade Range and have headwater elevations generally around 6,000 feet (see figure 4-1). In the upper reaches, these tributaries flow in narrow valleys with steep gradients. The major Cascade Range tributaries include the Santiam, McKenzie, Middle Fork of the Willamette, Molalla, and Clackamas Rivers. The Willamette River is also fed by major tributaries from the Coast Range, including the Long Tom, Marys, Luckiamute, Yamhill, and Tualatin rivers. At the south end of the basin, the Coast Fork of the Willamette River emerges from the Calapooya Mountains and joins the mainstem Willamette River near the City of Springfield (near Eugene).

Precipitation ranges from 40 to 200 inches in the Willamette Basin. Based on computations from USGS data, the average annual flow at Salem (river mile 84, drainage area of 7,280 square miles) for the water years 1910-2015 is 23,300 cfs, or about 16.9 million acre-feet per year. The minimum daily flow at Salem was 2,480 cfs on 27 August 1940. This flow occurred before the USACE dams were completed and operational. The minimum regulated flow for the period 1970-2016 after all of the USACE dams in the Willamette Basin became operational, was 4,140 cfs which occurred on February 20th, 1977.

4-02. Willamette Reservoir System. The USACE operates 13 dams in the Willamette Basin. The system of 13 dams is referred to as the Willamette Valley Project. Eleven of the USACE dams are operated as multiple purpose storage projects and two are strictly reregulating dams for

hydropower production. The locations of the individual dams are shown on figure 4-1. The USACE' reservoirs in the Willamette Valley Project can store up to approximately 1.6 million acre-feet of usable water. This represents about 9 percent of the average annual runoff of the Willamette River at Salem. The 13 USACE dams manage about 27 percent of the entire drainage area above Portland and 42 percent of the drainage area above Salem.

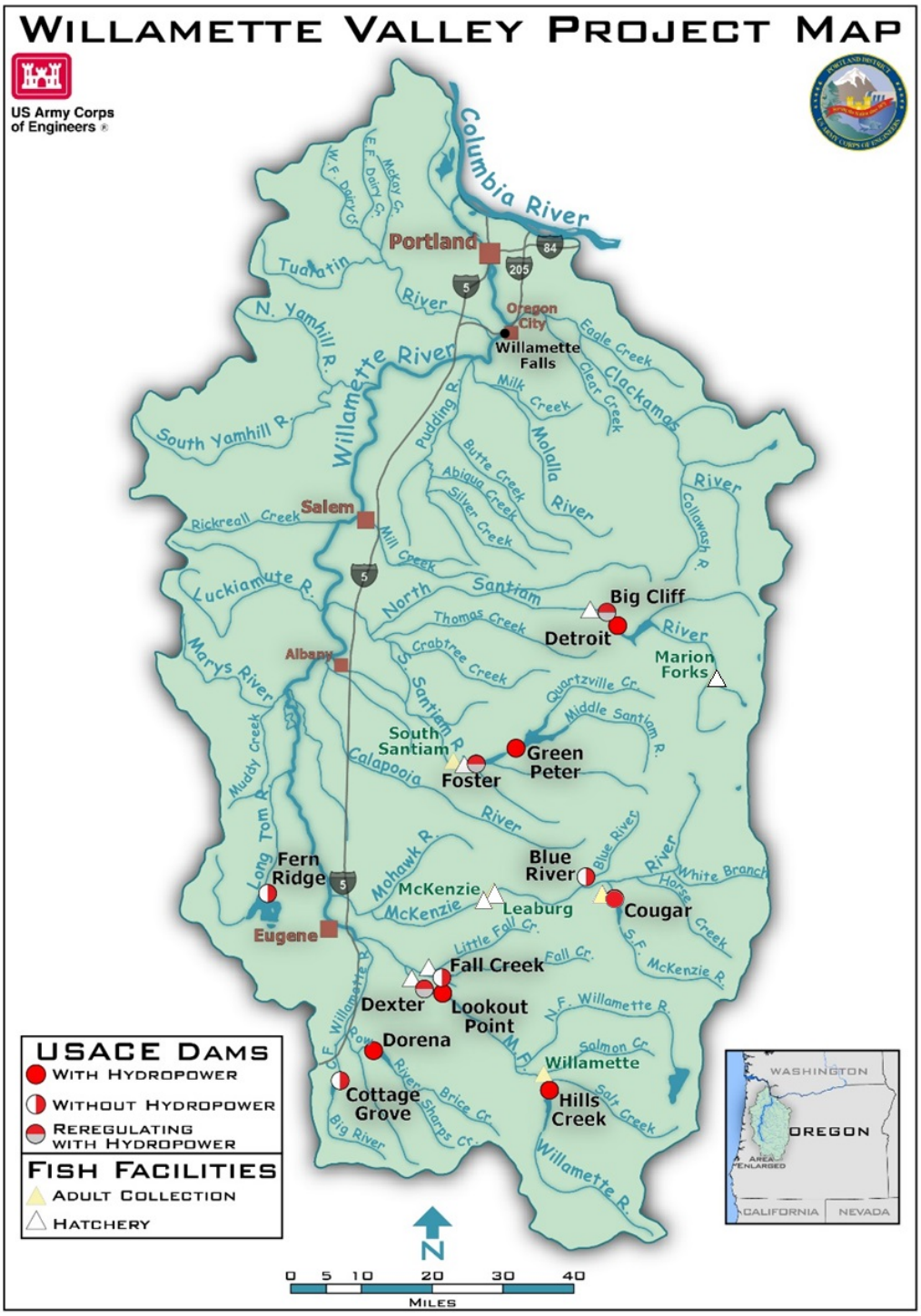


Figure 4-1. Willamette Valley Project Map

4-03. USACE Projects in the Willamette Valley Project. The list of 13 USACE projects in the Willamette Basin are shown on table 4-1. Each water control manual is an appendix to the draft

Willamette Master Manual. As of 2017, the Willamette Master Manual is in draft form while awaiting updated NEPA documentation on the operations and maintenance of the Willamette Valley Project, which is required for approval of the Master Manual. The location of each project is shown on Figure 4-1. A description of each project can be found in their respective water control manuals. Three projects have reregulation dams downstream of them; Big Cliff is the reregulation dam for Detroit; Dexter is the reregulation dam for Lookout Point; and Foster is the reregulation dam for Green Peter, but also has storage capability.

Table 4-1. List of Willamette Valley Project Water Control Manuals

Appendix	Project
--	Willamette Master Manual
1-A	Blue River Lake
1-B	Cottage Grove Lake
1-C	Cougar Lake
1-D	Detroit and Big Cliff Lakes
1-E	Dorena Lake
1-F	Fall Creek lake
1-G	Fern Ridge Lake
1-H	Foster Lake
1-I	Green Peter Lake
1-J	Hills Creek Lake
1-K	Lookout Point and Dexter Project

5.0 Water Uses and Availability

5-01. Water Uses. Water that is stored in the Willamette Valley Project is currently (2017) used for irrigation, fishery enhancement, recreation, hydropower, and environmental flows. Future water storage allocations may include municipal and industrial water supply. It is increasingly important to plan for providing adequate flows for multiple water uses. Informed decision making is accomplished through coordination of the Willamette Conservation Plan (see Section 7-02). The following is a brief description of water use in the Willamette Basin. In addition the effect on cultural resources as a result of low pool levels is provided.

a. Irrigation. According to House Document (HD) 531 that provides authorization for the Willamette Valley Project, irrigation was anticipated to be a significant use of water stored in the Project reservoirs. The U.S. Bureau of Reclamation (Reclamation) administers water service contracts for irrigators within 15 water service contract reaches. Irrigation use in the Willamette Basin has not occurred as initially projected and is not expected to occur in the future at levels near the scope and scale originally envisioned. As of February 2017, nearly 75,000 acre-feet of water (less than 5% of the conservation storage) is contracted for irrigation. Table 5-1 shows the

number of contracts within each reach, volume of water contracted, and the acres served for each reach in the Willamette Basin. Figure 5-1 shows the reach locations.

Table 5-1. Willamette System Irrigation Contract Data

	Reach	Reservoirs Providing Water	Number of Contracts	Acre-Feet Contracted	Acres Served
1	Willamette River	All Reservoirs	45	22,825	11,289
2	Santiam River	All Reservoirs on North and South Santiam Rivers	3	242	323
3	North Santiam River	Big Cliff, Detroit	29	11,375	6,584
4	South Santiam River	Foster, Green Peter	13	914	492
5	Willamette River	All Reservoirs Except Santiam Reservoirs	28	15,603	11,015
6	Long Tom River	Fern Ridge	55	19,715	8,379
7	Willamette River	All Reservoirs Except Santiam and Fern Ridge	9	749	458
8	McKenzie River	Blue River, Cougar	31	1,772	911
10	Middle Fork Willamette River	Fall Creek, Dexter, Lookout Point, Hills Creek	2	911	472
11	Middle Fork Willamette River	Dexter, Lookout Point, Hills Creek	2	92	37
12	Fall Creek	Fall Creek	3	11	5
13	Coast Fork Willamette River and Row River	Dorena, Cottage Grove	6	581	233
14	Row River	Dorena	1	51	20
15	Coast Fork Willamette River	Cottage Grove	1	56	45
	Total		**228**	**74,899**	**40,262**

Source: Reclamation, as of February, 2017

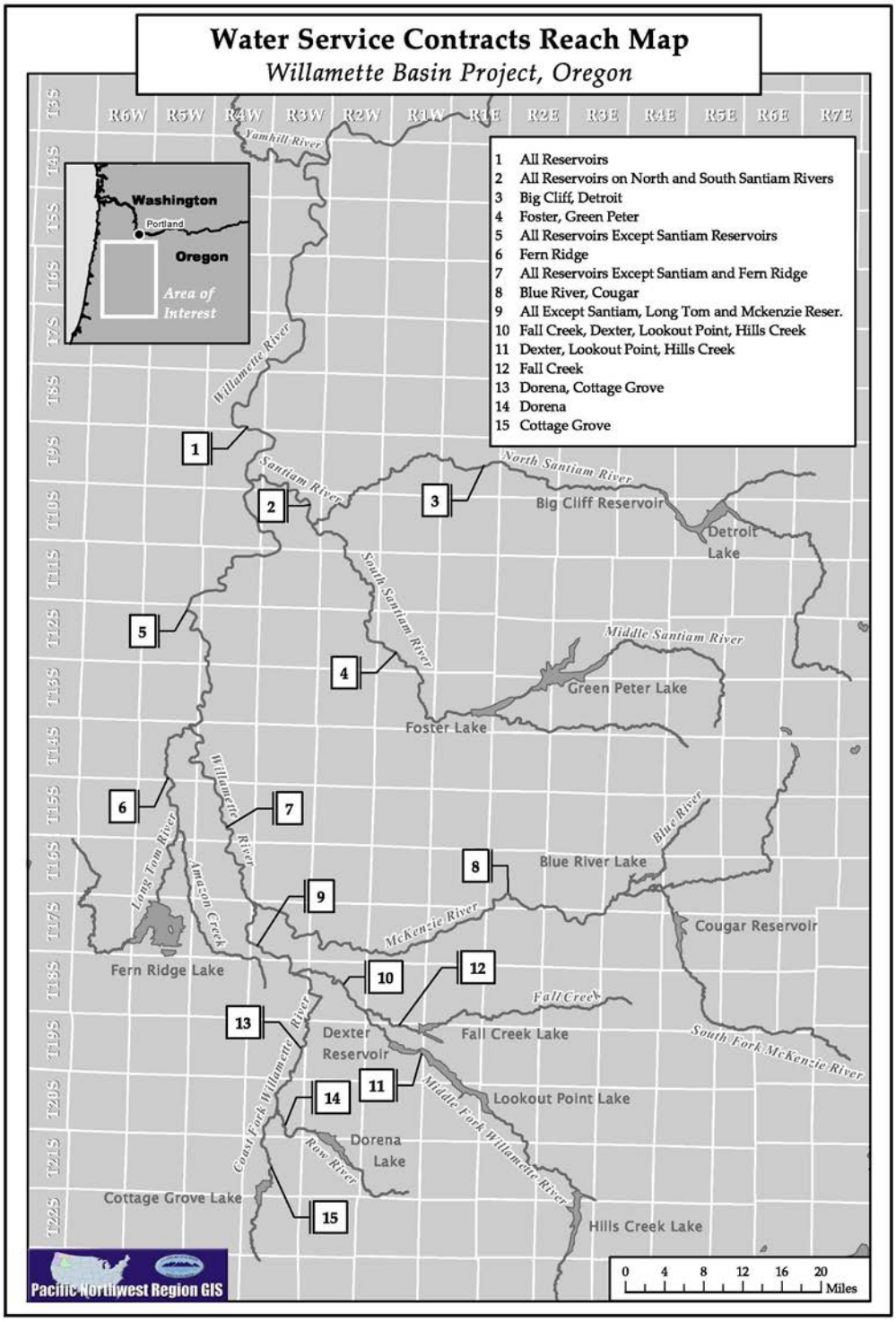


Figure 5-1. Water Service Contracts Reach Map

b. Fishery Enhancement. State and federal fishery resource agencies have identified a number of fish species in the Willamette Basin that are of regional or national significance. Upper Willamette River (UWR) winter steelhead, UWR Spring Chinook salmon, and bull trout are listed as "threatened" under the national Endangered Species Act. Oregon chub was listed as threatened but was delisted in 2015. As habitat degradation and water quality problems, including temperature, affect fish populations, it will be increasingly important to provide for adequate flows in the Willamette Basin.

c. Recreation. Reservoir recreation such as boating and water skiing are major revenue sources for many basin communities. Peak demand for these activities often coincides with the driest point of the summer season, when water for irrigation and in-stream needs is most critical. In some years as early as July, some reservoirs may be drawn down to levels too low to allow use of boat ramps; however, these same summer releases may provide flows for fishing, kayaking, and other recreation on rivers like the McKenzie and North Santiam. The reservoirs are not operated to meet recreation needs during a drought.

d. Hydropower. Eight of the Willamette Valley Project dams have a federal hydropower facility. These dams provide enough power to service 300,000 homes. Generation from the peaking projects are often based upon load throughout the day or week and are subject to frequent fluctuations. The reregulation reservoirs are used to absorb the fluctuations in flows from their upstream peaking projects and release flows at a more uniform level. The generation at the baseload projects provides uniform generation supply. Monthly generation can change drastically from year to year depending on the amount of runoff which occurs in the basin. A non-federal hydropower facility was added to Dorena Dam in 2014. The Dorena water control plan has not been altered due to installation of the hydropower facility. All flow releases from Dorena Dam are as determined by CENWP-EC-HR and reservoir regulations are documented in the Dorena Water Control Manual.

e. Environmental. A set of environmental flow recommendations (e-flows) were developed through the Sustainable Rivers Project, a USACE and The Nature Conservancy partnership. The purpose and benefits of the e-flows are to improve habitats on the flood plain margins, re-establish some river dynamism such as increasing river sediment transport, thereby encouraging re-formation of pools and riffles, re-establishing extant flood plain connection and smoothing the flow transitions after winter high flow events to facilitate lateral movement between refugia, seed dispersal, and birdnesting, etc. These operations are targeted for winter and spring months and use water that would need to be released to stay within the rule curve elevations. The e- flow operations provide ecological benefits while affecting minimal change to flood risk reduction, water quality, hydropower and meeting biological opinion flow objectives. E-flow targets are for the Middle Fork Willamette River at Jasper (outflows from Fall Creek and Dexter), South Fork McKenzie outflows from Cougar, and the North Santiam at Mehama (outflows from Big Cliff) and have been incorporated into the respective water control manuals.

f. Municipal and Industrial Water Supply. Some of the largest cities in the Willamette Basin rely on the Willamette River and its tributaries for drinking water. As population increases throughout the valley, and as environmental and financing issues reduce the likelihood that

municipalities will build new reservoirs for drinking water, river flow and existing reservoirs will continue to be an important water source.

Throughout the basin, employers such as pulp and paper mills use river water directly without purchasing through a municipal provider. In addition, high-tech industries have grown and have a significant demand for water. Although most of the high-tech industries receive their water through a municipal system, it is important to include all industry needs when planning for dry season uses of reservoir water.

As of 2017, the Willamette River Basin Review Feasibility Study is assessing the feasibility of reallocating storage in the Willamette Valley Project reservoirs from general joint-use to specific originally authorized purposes, including municipal and industrial (M&I) water supply, irrigation, and fish and wildlife. Any reallocation plan will require approval from Congress as the volume of storage exceeds the limits for local approval. Once the storage is reallocated and state issued water rights are modified, storage will be available for M&I use. The amount of storage and water expected to be needed for M&I is higher than listed in HD 531, but still much less than irrigation.

g. Navigation. Navigation is an authorized purpose of the Willamette Valley Project, but the project flows are no longer regulated for navigation use above the Willamette Falls Lock at Oregon City. Project authorizing documents (HD 544, 75th Congress, third session, March 16, 1938) stipulated a minimum flow of 5,000 cfs between Albany and the Santiam River, and 6,500 cfs downstream to Salem to provide navigation depths of 6 feet and 5 feet, respectively, above Willamette Falls. These minimum flows have been adopted for water quality purposes (see section 5-01.h). Over the years, the ODEQ has issued wastewater discharge permits based on a 7Q10 flow (the EPA definition: the lowest 7-day regulated average flow that occurs on average once every 10 years), which is approximately 5,500 cfs near Salem. The USACE continues to attempt to meet these flows to aid in water quality and fisheries enhancement in compliance with the 2008 Biological Opinion.

h. Water Quality. The minimum congressional flows of 5,000 cfs at Albany and 6,500 cfs at Salem were established for the purposes of navigation, but have become base flows used to maintain water quality standards in the mainstem Willamette. Both water quantity and quality were of great concern, particularly in watersheds with salmon and other fish species listed as endangered or threatened under the Endangered Species Act. Many streams in Oregon do not meet water quality standards during the summer due to high water temperatures, but release of water from reservoirs provide some aid in reducing water temperatures downstream of the dams. Water quality standards are also limited due to inadequate riparian zones and increasing problems associated with agriculture and forestry chemicals.

i. Effects on Cultural Resources. The USACE Willamette Valley Projects Dams lies within the traditional lands for four federally recognized Native American Tribes, the Confederated Tribes of the Grand Ronde Community of Oregon, the Confederated Tribes of the Siletz Indians, the Cow Creek Tribes of Umpqua Indians, and the Confederated Tribes of the Warm Springs Reservation of Oregon. The tributaries that the dams block are used traditionally by these tribes (historically and today) for the gathering of plants for food and fiber, fish, and

other wildlife associated with the watershed. The projects also have inundated hundreds of historic and Native American archaeological sites. Drought situations where water levels are altered, such as being lower for longer periods of time, might affect the archaeological resources due to exposure, wave action, recreational uses, and vandalism / looting. It also has the potential to have an additional negative effect on subsistence fishing utilized by the Tribes. The USACE has a responsibility to the protection of these resources, archaeological and historic under the National Historic Preservation Act. Tribal traditional cultural properties are included under the NHPA, as well as the consultation and coordination under the Executive Order 13175, Department of Defense (DoD) American Indian and Alaska Native Policy, 2004; Department of the Army American Indian and Alaska Native Policy, 24 Oct 2012; Tribal Consultation, Presidential Memorandum, 5 Nov 2009: USACE Memorandum, Sovereignty and Government-to-Government Relations with American Indian and Alaska Native Tribal Governments: USACE Tribal Policy Principles, 10 May 2010; and USACE Tribal Consultation Policy, 1 Nov 2012.

5-02. Available Storage. The storage of water in the Willamette Valley Project is based on seasonal regulation schedules established according to each project's rule curve. The Willamette Valley Project can store up to approximately 1.6 million acre-feet of water within the conservation pool. The ability to use water from inactive storage, power pool storage, and uncontracted stored water is described below.

a. Quantity of Inactive Storage. For projects with hydropower that have regulating outlets (Hills Creek, Lookout Point, Cougar, Green Peter, and Detroit), the inactive storage is the reservoir capacity between the minimum power pool and the lowest regulating outlet invert elevation. For projects without USACE operated hydropower (Fall Creek, Cottage Grove, Dorena, Fern Ridge, and Blue River), the inactive storage is the reservoir capacity between the minimum flood pool and lowest regulating outlet invert elevations. For reregulation projects (Dexter, Foster, and Big Cliff), the inactive storage is the reservoir capacity between the minimum power pool and the spillway crest. The total inactive storage for the Willamette Valley Project reservoirs is approximately 359,999 acre-feet. Table 5-2 shows the percent of inactive storage by project.

b. Ability to Use Inactive Storage. Under no circumstances should the inactive storage be used for power generation, as operating to the low heads could cause damage to the turbines. In 2015, most of the Willamette Valley Project reservoirs dipped into inactive storage to meet minimum flow with little impact. The impact of drafting into the inactive storage is an increased risk of not refilling the reservoir. Fall Creek Project uses 9,505 acre-feet of inactive storage in winter for a maximum of two weeks to pass predatory fish in order to reduce predation on salmonids in the reservoir.

Table 5-2. Inactive Storage Volume by Project[1]

Project	Inactive Storage Volume (Acre-Feet)	Inactive Storage (Percent)
Hills Creek	6,600	1.8%
Lookout Point	19,194	5.3%
Dexter	97,644	27.1%
Fall Creek	9,505	2.6%
Cottage Grove	3,139	0.9%
Dorena	7,355	2.0%
Fern Ridge	2,802	0.8%
Cougar	16,700	4.6%
Blue River	3,430	1.0%
Green Peter	71,220	19.8%
Foster	10,980	3.1%
Detroit	109,700	30.5%
Big Cliff	1,730	0.5%
Total	**359,999**	100.0%

[1]Volumes derived based on reservoir storage capacity tables located on the CENWP-EC-HR weblink, as of June 2017.

c. Ability to Use Power Pool Storage. The power pool is the reservoir capacity between the minimum flood pool and the minimum power pool. Table 5-3 shows the powerpool storage by project (Dexter and Big Cliff do not have flood pools, therefore they are not shown). Under project authorities, the power pool is reserved exclusively for power generation. Infrequent, limited (or modest) drafting into the power pool on a case-by-case basis may be accomplished pursuant to project authorities. This decision must be coordinated with the Bonneville Power Administration to ensure that any decision to use the power pool has taken into consideration power requirements. The decision should also consider how critical the need is to draft (e.g., biological need to provide minimum flows at the time).

If reservoirs draft to the minimum power pool level, generation will be stopped to avoid damage to the generating units. Station service will be supplied to the plants from the transmission grid. Regulating outlets will be used to maintain streamflow.

Table 5-3. Powerpool Storage Volume by Project[1]

Project	Powerpool Storage Volume (Acre-Feet)	Powerpool Storage (Percent)
Hills Creek	48,800	28.5%
Lookout Point	11,377	6.6%
Cougar	8,700	5.1%
Green Peter	62,600	36.5%
Foster	3,600	2.1%
Detroit	36,375	21.2%
Total	**171,452**	**100.0%**

[1]Volumes derived based on reservoir storage capacity tables located on the CENWP-EC-HR weblink, as of June 2017.

d. Quantity of Uncontracted Water Supply Storage. The Reclamation holds two water rights with the State of Oregon to store 1.64 million acre-ft (applications filed in 1954 and 1968) of water in the Willamette Valley Project reservoirs for irrigation use only. As of February 2017, there are only 74,899 acre-feet of water actually contracted, therefore the uncontracted storage is about 95% of the water rights storage. It is important to note that the entirety of the conservation storage volume remains is in the joint-use purpose. As of 2017, the conservation storage volume in the Willamette Valley Project is 1.6 million acre-ft. See section 6-03 for more information on irrigation contracts.

e. Ability to Use Uncontracted Water and Procedures to Obtain Water. The withdrawal of water from streams, lakes, and reservoirs, is regulated by the OWRD under the state water law. An applicant must file for a water right with the OWRD. Any withdrawal permit for stored water will be issued subject to a contract or agreement with the owner/operator of the facility (such as the USACE).

f. Use of Surplus Water. Section 6 of the Flood Control Act of 1944 (Public Law 78-534) authorized the Secretary of the Army to enter into agreements for use of surplus water for temporary drought relief, and for purposes other than crop irrigation. Surplus water will only be declared available when the use would not significantly affect other authorized purposes. When stored water is in excess of meeting the authorized project purposes it can be identified as surplus water available for use on a temporary (5 years, with the ability for one 5-year extension). Surplus water withdrawn from the streams below USACE projects will require a signed agreement accompanied by a brief letter report documenting how and why stored water is determined to be available as surplus. The level of detail will be commensurate with the amount of water to be used, time of use, and economic and environmental effects. Authority to sign these agreements by the District Commander requires approval from USACE Headquarters. As of December 2016, the price of the available water is based on the updated cost of storage (highest of four cost methods for the Willamette Valley Project), as required for reallocated storage, though draft rule making issued in December 2016 may change this methodology. A template for a surplus water agreement for use of water from USACE reservoirs is provided in Attachment 1.

6.0 Oregon Water Rights

6-01. Appropriation Doctrine. Water rights in Oregon are managed by the OWRD. Refer to the *Water Rights in Oregon, An Introduction to Oregon's Water Laws*, by the OWRD, dated November 2013. In Oregon, the prior appropriation doctrine has been law since February 24, 1909 when the first unified water code introduced state control over the right to use water. The principle of prior appropriation means the first person to obtain a water right on a stream is the last to be shut off in times of low streamflows. Before 1909, water users had to depend on themselves or local courts to defend their rights to water. The appropriation doctrine holds that a water right is limited to the quantity of water which is beneficially used, without waste. In 1935, an Oregon Revised Statute (ORS 537.1 0) concerning public ownership of water was established. The statute stated that "All water within the state from all sources belongs to the public." During times of low streamflows, the appropriator with the oldest date of priority can demand water specified in their water right permit obtained from the Department, regardless of the needs of other users. The date of priority, determined by the date of application for the permit, determines

the seniority of the appropriators' right. The more senior the water right, the longer water is available during periods of low streamflow.

6-02. Instream Water Rights. An instream water right law was enacted in Oregon via Senate Bill 140 during 1987. The Oregon legislation recognized that public uses are beneficial uses, as defined by the appropriation doctrine. The act allows the Departments of Fish and Wildlife, Environmental Quality, and Parks and Recreation to request instream water rights from the Department. The law gives instream water rights the same status as other water rights, except that municipal uses may have priority over these rights. In a Governor declared drought, Oregon law allows the Department to give preference to human consumption and livestock watering over other uses. Unlike minimum perennial streamflows, the commission cannot waive the instream right in favor of later water rights during the periods of low streamflow. Instream water rights have a priority date, and are regulated in the same way as other water rights. An instream water right cannot affect a use of water with a senior priority date. In the Willamette Basin, the majority of the minimum perennial streamflows established in 1964 have not been converted to instream water rights. Once converted the instream water rights will have a priority date of 1964.

Instream water rights do not guarantee that a specified quantity of water will be maintained in a stream or is available for use. When the water level in a stream is below the instream water right level, holders of junior water rights are required to stop using the water. A holder of a water right to the natural flow of the stream has no right to stored water in a reservoir without an additional water right for use of stored water.

6-03. Irrigation Contracts. The Reclamation implements and manages the sale of irrigation water for the Federal government. The Reclamation filed applications for water rights in 1954 and 1968 on behalf of the federal government. Subsequent state water right certificates have been issued to the Reclamation authorizing all of the 1.64 million acre-feet of system conservation pool storage for irrigation uses (Certificates 72755 and 72756). Currently, irrigators have contracted for less than five percent of the 1.64 million acre-feet; however, agricultural needs may increase in the future. To use the stored water, a contract holder with the Reclamation must obtain a state permit to withdraw the water from an Oregon stream, referred to as a secondary water right.

The storage of water in the Willamette Valley Project is based on the seasonal regulation schedules established according to the rule curve for each dam. The USACE coordinates with the multiple federal and state agencies when releasing stored water at projects to meet secondary project purposes.

7.0 Flow Management

7-01. Reservoir Regulation Seasons. Reservoir regulation activities occur over three regulation seasons; major flood, conservation storage, and conservation release. The major flood season is from mid-November through January. During the major flood season, reservoirs are kept at their minimum flood pool to capture high inflows in order to reduce the risk of downstream flooding. The conservation storage season is from February through about mid-May. During this period, the reservoirs fill to their maximum conservation pool level to store

water for the conservation release season. During the conservation release season from mid-May through mid-November, water stored within the conservation pool is released for multiple uses, including hydropower, fisheries enhancement, water quality, environmental purposes, recreation, and consumptive use for irrigation.

7-02. Willamette Conservation Plan. The Willamette Conservation Plan (WCP) is the annual water management plan for the Willamette Valley Project and identifies flow and storage needs for each tributary and reservoir in the Willamette Valley Project. Forecasts in April, of runoff volume and system-wide volume storage in the Willamette Valley Project by mid-May are used to set minimum flow objectives for April through October on the mainstem Willamette River, which is central to the WCP. The WCP includes estimates of mainstem flows and reservoir storage volumes likely to occur over the conservation season based on forecasts, system operational alternatives, and constraints through modeling. Reservoir modeling considers the likelihood of meeting the tributary flow objectives in table 7-1 and the mainstem flow objectives in table 7-3. Adaptive management (see section 7-07) may be used to adjust operations within authorized project purposes due to changing conditions and with new knowledge that is gained from ongoing operating experience or studies. Refer to the most recent WCP for the up-to-date minimum flow objectives, as they vary from year-to-year depending on water availability. The WCP may be obtained from the CENWP-EC-HR.

The WCP is coordinated to meet the ESA and all other purposes of the Willamette Valley Project. The Willamette Action Team for Ecosystem Restoration (WATER) is a forum of the Action Agencies (USACE, Reclamation, and BPA), Services (USFWS and NOAA Fisheries), state agencies, and tribes, responsible for planning and implementing flow management in the Willamette Basin. The Flow Management Committee is the technical committee under WATER to coordinate the development of and implement the WCP. The WCP is updated annually during the conservation storage season based on the April forecast made in early April, and anticipated total system storage in mid-May. The plan is fine-tuned in early June after spring refill.

7-03. Forecasts. Forecasts are required during the conservation storage period to assess the timing and capability of refilling to the desired maximum conservation storage elevation of individual projects. The benefits of an accurate forecast are twofold: (1) minimum flow requirements less than normal minimum releases can be requested through the OWRD if insufficient inflows are forecasted and (2) probability of lake refill and timing can be estimated in order to inform lake users. Projections of lake levels during the summer and fall periods are also useful for the same reasons. Adaptive management (see section 7-07) allows for adjustments in reservoir operations if unexpected hydrologic changes were to occur.

NOAA's Climate Prediction Center Seasonal Drought Outlook or the Department of Agriculture's drought indices can be used as an indicator of a short-term drought in consideration of planning for operations in meeting minimum flow objectives without much base-flow or rain. If rainfall and runoff forecasts show that the Willamette Valley Project reservoirs may not fill to the maximum conservation pool levels, a potential drought

situation may be indicated. Drought forecasting in the Willamette Basin is most useful in preparing for and during the conservation release season.

Beginning in January, the USACE uses NRCS's April-September water supply volume forecasts issued monthly, and may use Ensemble Streamflow Prediction (ESP) forecasts issued by the Northwest River Forecast Center of the National Weather Service, as input in modeling of the reservoir system. The ESP forecasts use historical meteorological data to represent possible future conditions for probabilistic analyses. These forecasts help estimate how full the reservoirs may be in May and June and how much stored water may be available for release during the conservation season.

7-04. Methods and Tools. Methods and tools are discussed in individual project water control manuals or as described in the *Standard Procedures for Regulation of the Willamette Basin Projects* (contact CENWP-EC-HR for the most up-to-date version). The tools assist in developing estimates of reservoir refill during the conservation filling period.

For long-term planning (greater than 6 months) and for use in the Willamette Conservation Plan, the CENWP-EC-HR runs the USACE's Hydrologic Engineering Center (HEC), reservoir simulation model, HEC-ResSim, to evaluate the water supply forecasts. Water supply volumes are input to the ResSim model to estimate how full the reservoirs may be in May and how much stored water will be available for the release season.

For shorter-term planning, as of 2017, the USACE and Northwest River Forecast Center (NWRFC) use the Community Hydrologic Prediction System (CHPS) reservoir system simulation model, a product of the NWRFC. The USACE provides reservoir regulation information as input to the model while the NWRFC provides weather sequences of given probabilities, soil moisture and ground water conditions. Model runs are made with these parameters and assumptions, and the output are forecasts of lake inflows, streamflows, and lake elevations. The model is used to inform project operational decisions.

During the summer and during drought situations, the CHPS model is run twice a week to ensure the summer flow objectives are met. In addition, the water travel time during the summer is longer due to lower flows, and the CHPS forecast model runs help ensure the flow objectives are met with proper timing.

7-05. Project Minimum Flows. Throughout the year, water is passed through the dams to meet or exceed the congressionally authorized minimum flows. Due to developments in the basin to meet Endangered Species Act needs, a set of minimum flow objectives were recommended by the NOAA's National Marine Fisheries Service Biological Opinion, *Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation, Consultation on the "Willamette River Basin Flood Control Project,"* dated 11 July 2008. The Congressional minimum flows as stated in House Document 531, Volume V (Appendix J) and the biological opinion objective flows are provided in table 7-1.

The operational flow objectives and the associated flow management guidelines are intended to balance the risks to listed fish species under low water year conditions with the risks to other uses authorized by Congress for the Willamette Valley Project. Key among these authorized uses are those significant to human health and safety, including flood risk management, hydropower production, and summer and fall low flow augmentation for maintenance of water quality.

7-06. System Minimum Flow Objectives. In addition to the project minimum flows discussed in section 7-05, the 2008 Biological Opinion provides Willamette River mainstem minimum flow objectives at Salem and Albany. Because the water supply in the Willamette can vary significantly from year to year, the 2008 Biological Opinion allows for adaptive management (see section 7-07) of the reservoir system dependent upon predicted system water availability by mid-May. The 2008 Biological Opinion designates four levels of water availability, in terms of forecasted volume of storage in the Willamette Valley Project reservoirs by mid-May. The designation of a conservation season runoff forecast as “abundant”, “adequate”, “insufficient”, or “deficit” will lead to differing management approaches.

Table 7-2 summarizes the designation of Willamette Basin runoff observed over a 64-year period of record. Table 7-3 shows the minimum flow objectives for Salem in “deficit” years (column 6), and for “abundant” and “adequate” years (column 5). Minimum flow objectives for insufficient years are based on a sliding scale between columns 5 and 6. The minimum flow objective for Albany is the same for all years. The flow objectives for April through June are flow objectives for fish while the summer and fall flows at Albany help maintain water quality. For years designated as “abundant” or “adequate”, minimum flow objectives during spring, summer, and fall would be expected to be met or exceeded whenever possible (e.g., considering factors such as the accuracy of weather forecasts, constraints in the accuracy of operational adjustments at dams, and delayed system response time between the points of storage release and Salem), therefore these years would not be considered drought years. For years designated as “insufficient” or “deficit”, the minimum flow objectives are not expected to be met, and these would be considered drought years. The mainstem spring flow objectives may be temporary actions and are subject to review and revision in accordance with results of appropriate monitoring and evaluation.

Table 7-1. 2008 Biological Opinion and Congressional Minimum Reservoir Outflow

Location	2008 NMFS Biological Opinion			Water Control Manual		House Document No. 531 Volume V	
	Date	Minimum Flow (cfs)	Remarks	Date	Minimum Flow (cfs)	Date	Minimum Flow for Fish[1]
Detroit/Big Cliff	1 Feb - 15 Mar	1000	Rearing/adult migration	Feb-Jun	1,000	Feb-Jun	1,000
	16 Mar - 31 May	1500	steelhead spawning	Jul-Nov	750	Jul - Nov	750
	1 Jun - 15 Jul	1200	steelhead incubation				
	16 Jul - 31 Aug	1000	rearing				
	1 Sep - 15 Oct	1500	chinook spawning				
	16 Oct - 31 Jan	1200	chinook incubation				
Blue River	1 Feb - 31 Aug	50	rearing	Jul-Nov	50	Feb-Jun	30
	1 Sep - 15 Oct	50	chinook spawning			Jul - Nov	30
	16 Oct - 31 Jan	50	chinook incubation				
Cottage Grove	1 Feb - 30 Jun	75		Feb-Jun	75	Feb-Jun	75
	1 Jul - 31 Oct	50		Jul-Oct	50	Jul - Nov	50
	1 Nov - 31 Jan	inflow					
Cougar	1 Feb - 31 May	300	rearing	Feb-Jun	300	Feb-Jun	300
	1 Jun - 30 Jun	400	rearing adult migration			Jul - Nov	200
	1 Jul - 31 Aug	300	rearing				
	1 Sep - 15 Oct	300	chinook spawning				
	16 Oct - 31 Jan	300	chinook incubation				
Dorena	1 Feb - 30 Jun	190		Feb-Jun	190	Feb-Jun	190
	1 Jul - 31 Oct	100		Jul-Oct	100	Jul - Nov	100
	1 Nov - 31 Jan	inflow					
Fall Creek	1 Feb - 31 Mar	50	rearing	1 Feb - 15 Nov	30	Feb-Jun	30
	1 Apr - 31 Aug	80	rearing, adult migration (Jun)			Jul - Nov	30
	1 Sep - 15 Oct	200	chinook spawning				
	16 Oct - 31 Jan	50	chinook incubation				
Fern Ridge	1 Feb - 30 Jun	50		Dec-Jun	50	Feb-Jun	50
	1 Jul - 31 Oct	30		Jul-Nov	30	Jul - Nov	30
	1 Nov - 31 Jan	inflow					
Green Peter/Foster	1 Feb - 15 Mar	800	Rearing/adult migration	Feb-Arp	800	Feb-Apr	500
	16 Mar - 15 May	1500	steelhead spawning	May	750	May	450
	16 May - 30 Jun	1100	steelhead incubation	1 Jul - 15 Nov	400	Jun	300
	1 Jul - 31 Aug	800	rearing			Jul - Nov	300
	1 Sep - Oct 15	1500	chinook spawning				
	16 Oct - 31 Jan	1100	chinook incubation				
Hills Creek	1 Feb - 31 Aug	400	rearing	Feb-Nov	100	Feb-Jun	100
	1 Sep - 31 Jan	400	migration and rearing			Jul - Nov	100
Lookout Point/Dexter	1 Feb - 31 Aug	1200	rearing	Feb-Jun	1,200	Feb-Jun	1,200
	1 Sep - 15 Oct	1200	chinook spawning	1 Jul - 15 Nov	1,000	Jul - Nov	1,000
	16 Oct - 31 Jan	1200	chinook incubation				

[1] *House Document 531, Review Report on Columbia River and Tributaries, Appendix J, Willamette River Basin*, Table III-1. Minimum flows were adopted for the preservation of fish. At the power reservoirs (Hills Creek, Cougar, Green Peter, and Detroit) the releases during the power season (October - March, inclusive) are substantially greater than the minimum regulated flows shown.

Table 7-2. Evaluation of Spring Runoff and Conservation Operation

Volume in Storage by 10-20 May (MAF)	Designation	Occurrences (years)[1]	Percent of Years
< 0.9	Deficit	10	16
0.9 – 1.19	Insufficient	6	9
1.20 – 1.48	Adequate	11	17
> 1.48	Abundant	37	58
1.59	Maximum[2]	---	---

[1] Period of record 1936-1999 using flow objectives in columns 2, 4, and 5 in Table 7-3
[2] Maximum usable conservation storage.

Table 7-3. Minimum Mainstem Threshold Flows for Albany and Salem (cfs)

	Albany		Salem			
1	2	3	4	5	6	7
Period	**Minimum Average Flow[1]**	**HD 531[2]**	**Minimum Instantaneous Flow[3]**	**Minimum Weekly Flow Threshold Abundant and Adequate[4]**	**Minimum Weekly Flow Threshold Deficit Years[4]**	**HD 531[2]**
April	--	5,000	14,300	17,800[3]	15,000	6,500
May	--		12,000	15,000[3]	15,000	
1 – 15 June	4,500		10,500	13,000[3]	11,000	
16 – 30 June	4,500		7,000	8,700[3]	5,500	
July	4,500		--	6,000[1]	5,000	
1 – 15 August	5,000		--	6,000[1]	5,000	
16 – 31 August	5,000		--	6,500[1]	5,000	
September	5,000		--	7,000[1]	5,000	
October	5,000		--	7,000[1]	5,000	

[1] 2008 Biological Opinion Appendix D, Table D-2.
[2] Congressional minimum flows from House Document (HD) 531, Volume 5, paragraph 88.
[3] 2008 Biological Opinion Appendix D, Table D-1, biologically based minimum flow objectives.
[4] 2008 Biological Opinion Appendix D, Table D-4. Flows in Column 5 are for "Abundant", and "Adequate" years. Flows for "Insufficient" years are based on a sliding scale between Columns 5 and 6.

7-07. Adaptive Management. Adaptive management of flow objectives involve making adjustments to reservoir operations and flow releases based on changing conditions and changing forecasted hydrologic conditions. Current volume forecast methods do not differentiate between the significant contribution of snowmelt and the highly variable rainfall contribution which makes it difficult to forecast runoff volumes. It is not possible to foresee, describe, and model all of the possible management scenarios and contingencies. In

a rain-driven system like the Willamette Basin the best available hydrologic modeling early in the season may result in forecasts that differ significantly from actual conditions later in the conservation season. Since the plan calls for setting operational flow objectives at Salem beginning on 1 April based on a storage forecast for mid-May, flow objectives may need to be adjusted throughout the conservation release season. The availability of water will be re-assessed monthly (or as necessary) and related changes in management strategy will be made.

Adaptive management allows for spreading the risk of insufficient water among all authorized project purposes. Adaptive management is especially important during low water years to balance needs for flows during spring that support spawning and incubation of ESA-listed winter steelhead, needs for storage that provide flows during summer for water quality, and for fall spawning and incubation of ESA-listed Spring Chinook salmon.

8.0 Drought Management

8-01. Reservoir Regulation in Drought Conditions. Drought-related water management work is integrated within the overall USACE water management responsibilities and associated activities, which play a major role in characterizing drought conditions in the Willamette Basin. The Willamette Conservation Plan, consistent with the 2008 Biological Opinion, is the vehicle that sets the operational flow objectives in all water year conditions, including drought years. As drought conditions and priorities may vary from year to year, reservoir operational agreements will be made dependent upon the WCP and agreements made under the WATER forum and Flow Management Committee coordination, therefore a prescriptive procedure is not provided in this document. Operations in past drought years may provide an indication for operational strategies for future drought years. Operations used in past years is provided in the following paragraphs.

8-02. Flow Objectives in Past Drought Years. In previous years of extreme drought, interagency agreements resulted in minimum flow objectives at Salem that were less than the Congressional minimum flows at Albany and Salem of 6,500 cfs and 5,000 cfs, respectively. Tables 8-1 and 8-2 show the minimum flow objectives for Albany and Salem, respectively, in various drought years.

Table 8-1. Past Drought Year Interagency Minimum Flow Objectives, Albany

Period	**Drought Years**				
	1977	**1987**	**1988-91**	**1992**	**2015**
June	4,000	4,000	4,500	4,000	3,500
July 1-15	4,000	4,000	4,500	4,000	3,500
July 16-31	4,000	4,500	4,500	4,000	3,500
August 1-15	4,000	4,500	5,000	4,500	3,500
August 16-31	5,000	4,500	5,000	4,500	3,500
September	5,000	4,800	5,000	4,500	3,500

Table 8-2. Past Drought Year Interagency Minimum Flow Objectives, Salem

Period	Drought Years					
	1977	1987	1988-91	1992	2001	2015
June 1-15	5,000	5,000	6,000	5,500	11,000	5,000
June 16-30	5,000	5,000	6,000	5,500	5,500	5,000
July 1-15	5,000	5,000	6,000	5,500	5,000	5,000
July 16-31	5,000	5,500	6,000	5,500	5,000	5,000
August 1-15	5,000	5,500	6,000	5,500	5,000	5,000
August 16-31	6,000	5,500	6,500	5,500	5,000	5,000
September	7,000	7,000	7,000	6,000	5,000	5,000

8-03. Reservoir Regulations in Past Drought Years. The following is a description of reservoir operations and coordination used in recent low water years in the Willamette Basin in drought years.

a. Reducing Minimum Winter Flow. Refill of the reservoirs begins on 1 February. When the observed elevation was below an individual project's rule curve and the forecast was for dry weather, the USACE requested a reduced minimum flow from NOAA Fisheries.

b. Winter Steelhead in the Santiam Basin. In the Santiam Basin, Big Cliff and Foster Dams released minimum flows of 1,500 cfs for winter steelhead spawning. The release periods are from 16 March through 15 May for Foster and from 16 March through 31 May for Big Cliff. During low water years (drought), discussions with NOAA Fisheries took place as modeling showed reservoir levels well below the rule curve. In past years, NOAA Fisheries has agreed to reduce spawning flows to about 1,200 cfs below Big Cliff and 1,100 cfs below Foster.

After steelhead spawning, the steelhead incubation period occurs. This incubation period occurs from 16 May through 30 June at Foster, and from 1 June through 15 July for Big Cliff. In the past, NOAA Fisheries had agreed to reduce incubation flows to be equal to the reduced spawning flows minus 200 cfs.

Rearing flows are maintained during the dry season. Past operations have met the minimum biological opinion rearing flows or released higher flows in order to meet mainstem flows. The ODFW and the NOAA Fisheries have supported steady tributary flows that draft the projects to minimum conservation pool by 1 October without maintaining the mainstem minimum flows.

c. Chinook Spawning in the Santiam Basin. Chinook spawning occurs from 1 September – 15 October. For Big Cliff and Foster Dams, even when pool levels were low, the fisheries agencies preferred to release spawning flows. Although the preference is to provide the spawning flow (1,500 cfs), flows have been reduced by 200-300 cfs, have begun later, or have been stepped-up from the summer flow to the spawning flow over a week.

By the end of spawning, in years of little precipitation and when projects were near or at minimum conservation pool, NOAA Fisheries had expressed a need to use power pool storage

and inactive pool storage to provide water for fish. Under this condition, major impacts could occur. Any use of power pool water must be discussed and agreed upon by the BPA.

d. Mainstem Flows. Projects outside of the Santiam Basin have operated to minimum flows. Fisheries agencies have agreed to reduce mainstem flows slightly after April 1. When the observed elevation was below an individual project's rule curve and the forecast was for dry weather, the USACE requested a reduced mainstem flow from NOAA Fisheries. NOAA Fisheries has agreed to lower flows in April and May for the Willamette River at Salem as well as a fixed release from the projects and the elimination of minimum flows for the months of June thru September. The amount that NOAA Fisheries has reduced the mainstem flow requirement has varied from year-to-year based on the extent to which the reservoirs have drafted below rule curve.

8-04. Determination of Interim Draft Limits. Reservoir-specific interim draft limits will be used to avoid over-draft of stored water during the early part of the flow management season. The interim draft limits conserve water in order to meet minimum tributary and mainstem flows later in the summer and early fall. Beginning in May, regulators can use a spreadsheet to back calculate, from October to May, the required storage in the reservoirs at month-end throughout the spring and summer to meet the 2008 Biological Opinion flow objectives at Salem and Albany through 31 October. Modeling may include the use of 90% exceedance inflows from the Period of Record data; however, users can test different levels of inflow and outflow to see resulting reservoir levels within the spreadsheet for a risk assessment.

8-05. Priorities. In both "insufficient" and "deficit" year cases, recreational use would be considered a low priority. Hydropower generation, irrigation, and other authorized uses will be met to the fullest extent possible through both discharges of reservoir inflows during spring and release of storage during summer and fall to meet mainstem flow management objectives. Priority will be given to those flow needs directly related to human health and safety. Reservoir inflow in excess of that needed to meet the mainstem operational flow objectives during spring will be stored in a manner that maximizes the likelihood of being able to meet minimum discharge rates, mainstem Willamette River flow objectives at Albany and Salem during June through October, and Willamette Basin hydropower production needs.

As of 2017, due to low level of use for water service contracts, the USACE does not make special operational adjustments, such as increasing flow releases, to meet contract requirements at most projects with the exception of Fern Ridge and Detroit. However, in "deficit" water years, the National Marine Fisheries Service's (NOAA Fisheries) Reasonable and Prudent Alternative (RPA) requires the Reclamation to curtail water contract diversions. In other years, the RPA requires the USACE to release more than minimum flow to ensure the contract users do not take water intended for fish purposes from Fern Ridge and Detroit. In "deficit" water years, a partial water supply or no water supply may be available to satisfy irrigation contracts. Water deliveries may be ceased or curtailed under these conditions, per RPA 3.4.

9.0. USACE's Emergency Navigation

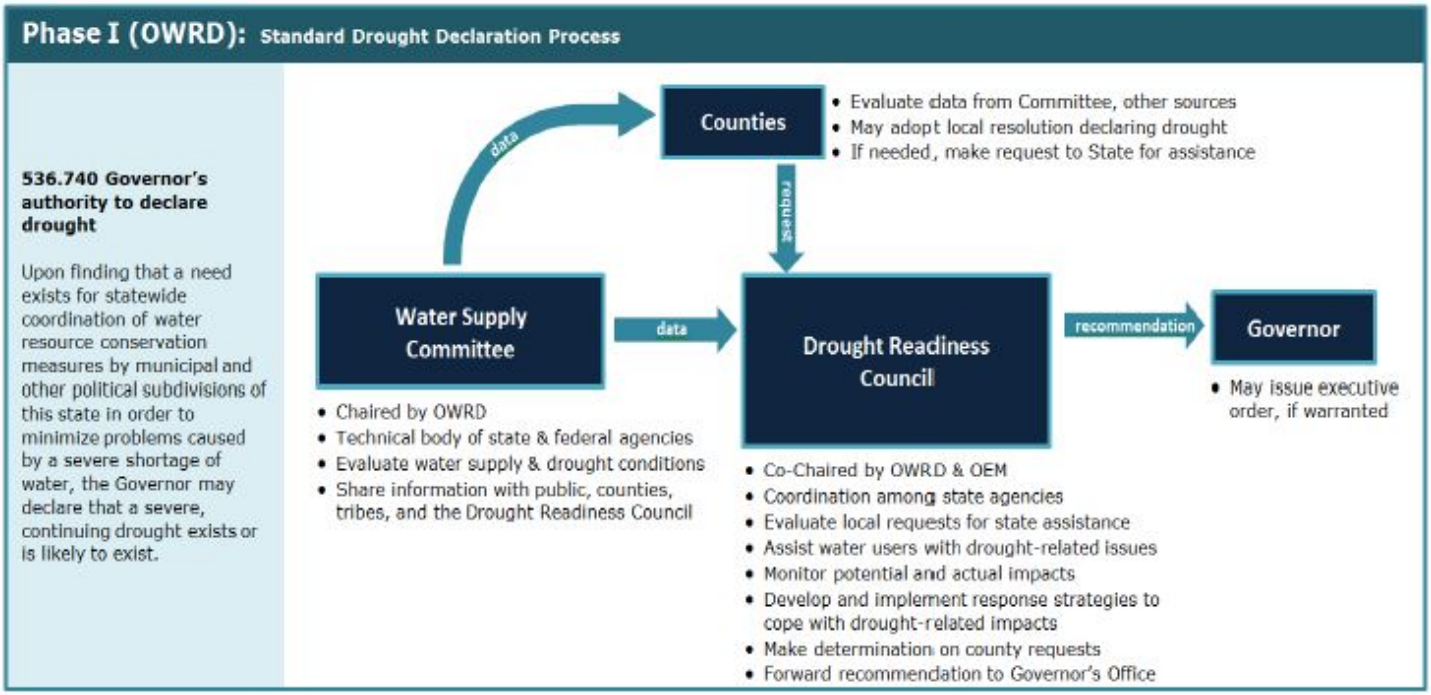
Although there is authorization for navigation in the mainstem Willamette River, there is currently little to no actual navigation for commercial purposes. There is no opportunity to move boats around the Willamette Falls at Oregon City except by trailer. Navigation did not seem to be an issue during the drought of 2001 or 2015. In December of 2011, the Willamette Falls Locks were placed in a non-operational status because of safety issues.

10.0 State of Oregon Drought Management

10-01. Authorities. The legal authorities for the State of Oregon's drought mitigation and response functions are found in ORS 536.700 - 536.780 and Oregon Administrative Rules (OAR) Chapter 690, Division 19. The Governor, through the request of a local jurisdiction, can declare an emergency under ORS 401.165. Under ORS 536.740, the Governor has authority to declare that a severe, continuing drought exists, or may exist, in any (or all) of the drainage basins in Oregon. Based on that declaration, the Governor or the Oregon Water Resources Commission can also direct state agencies and political subdivisions to implement a water conservation plan or water curtailment plan. Additionally, ORS 536.750 states that a drought declaration by the Governor allows the Water Resources Department to provide existing water right holders with access to temporary water management tools, described in OAR 690-019.

The Water Resources Commission is made up of seven members who represent different areas of the state. The commission is a citizen body that sets state water policy and oversees activities of the Water Resources Department. WRC meetings are held regularly at different locations around the state and is open to the public. The region areas in the Willamette Valley are the Northwest Region and the West Central Region.

10-02. Declaration of Drought. The declaration of drought in Oregon is performed by the Governor on a county-by-county or on a state-wide basis. The Governor's technical advisory group is the Oregon Drought Readiness Council (DRC) (see 10-02.a), and the interagency Water Supply Availability Committee (WSAC) (see 10-02.b) reports to the DRC. The two interagency groups evaluate water supply conditions and help assess and communicate potential drought related impacts. The State of Oregon's drought declaration process is shown on figure 10-1. A description of the DRC and WSAC and their activities are provided in the following sections, along with the State's drought strategy. The USACE does not make a declaration of drought conditions associated with its reservoirs in the Willamette Basin.



Source: Drought Annex, State of Oregon Emergency Operations Plan, January 2016.

Figure 10-1. Standard Drought Declaration Process

a. Drought Readiness Council. The DRC relies on information from the WSAC to assess how conditions may affect various sectors across the state, including instream and out-of-stream uses. The DRC reviews local requests for assistance and makes recommendations to the Governor regarding the need for state drought declarations. The DRC is responsible for ensuring coordination among state agencies and help water users access drought related information and assistance programs. The DRC consists of nine state agencies with natural resources management, public health, or emergency services expertise. Co-chairs of the Drought Readiness Council is the Administrator, Technical Services Division of the OWRD, and the Section Manager of the Office of Emergency Management.

b. Water Supply Availability Committee. The WSAC consists of ten state and federal science and emergency preparedness agencies that meet throughout the year to evaluate the potential for drought conditions. If drought is likely, monthly meetings occur shortly after release of the NRCS Water Supply Outlook reports to assess conditions. The WSAC communicates through the OWRD, the status of drought conditions to local, state, and tribal agencies. The WSAC is responsible for providing updates and reports on conditions to the Drought Readiness Council. As of 2016, the chair of the Water Supply Availability Committee is the Surface Water Hydrology Manager of the OWRD. The Chief of CENWP-EC-HR or designee represents the USACE on this committee.

10-03. Drought Strategies. Because of the 2015 drought, the Governor signed Executive Order 15-09, to direct state agencies to plan for resiliency to drought to meet the challenge that a changing climate brings. The document, *Report to the Governor Kate Brown, Implementation of Executive Order No. 15-09 Directing State Agencies to Plan for Resiliency to Drought*, dated 1 November 2015 (Report to the Governor) is in response to the Executive Order, and contains an overview of activities that Oregon's agencies, boards, and commissions are to do to prepare for and respond to drought now and in the future. The weblink for the Executive Order is provided in the Weblinks section of this document.

The Executive Order also directed the Office of Emergency Management and the Oregon Water Resources Department (OWRD) to update the *Drought Annex* to the State's *Emergency Operations Plan*. The *Drought Annex*, dated January 2016, was prepared by the Oregon Office of Emergency Management, OWRD. The purpose of the annex is to coordinate state and federal agency response to drought emergencies and to provide emergency water supplies for human consumption under conditions of inadequate supply. The annex outlines steps and lists responsibilities of various federal, state, and local jurisdictions. It also includes a description of federal drought assistance programs and guidelines for water curtailment planning and program development. The *Emergency Operations Plan* and the *Drought Annex* are provided in the Weblinks section of the document.

Two other state of Oregon strategies support the Drought Annex. The first, is the 2015 *Natural Hazards Mitigation Plan*, dated September 2015, which contains an up-to-date description of Oregon's natural hazards and their probability, the state's vulnerabilities, and its mitigation strategies and implementation capability. Cities and counties can use this information when preparing local natural hazard mitigation plans. The second, is the *Oregon's 2012 Integrated Water Resources Strategy*, dated August 2012. The purpose of the document is to describe the water needs of Oregon and to provide a strategy to meet those needs. The intent of the strategy is to provide a blueprint for future actions.

11.0 Coordination

11-01. USACE. The Chief, CENWP-EC-HR updates the Corporate Board (District Commander, Deputy District Engineer, and other CENWP Chiefs) of the drought situation, typically on a monthly basis. The reservoir regulation team, along with CENWD water management will meet at least weekly to discuss the drought situation, decisions to be made and the possible impacts of those decisions. Reports of the drought situation are prepared by the CENWP-EC-HR, and may be provided to USACE Headquarters (CECW-EC), through the CENWD. CENWP-EC-HR also reports to the Portland District Readiness Section (CENWP-OD-SE), who coordinates with the CENWD Regional Contingency Office (CENWD-RCO), for upward reporting to Head Quarters Emergency Management. The CENWP-EC-HR also coordinates with Portland District Public Affairs (CENWP-PA) to develop talking points for news releases and public inquiries (see section 12.0).

11-02. Regional. The USACE coordinates with the region on reservoir operations to meet the ESA and all other purposes of the Willamette Valley Project through the WATER

forum. WATER works as a collaborative regional forum among the sovereign governments (federal/state/tribal) with responsibility for assisting the federal Action Agencies (USACE, BPA, and Reclamation) in the coordinated implementation of the ESA and related measures. WATER is also responsible for making recommendations to the Action Agencies in implementing the Willamette Biological Opinions' RPA.

11-03. State of Oregon. The WSAC meets nearly monthly and discuss the status of water supply conditions across the state. The members of the WSAC are: NOAA, NRCS, Oregon Climate Change Research Institute, Oregon Department of Agriculture, Oregon Department of Forestry, Oregon Office of Emergency Management, Oregon Water Resources Department, USACE (CENWP-EC-HR), Reclamation, and the U.S. Geological Survey. The CENWP-EC-HR provides the status of the reservoirs and an assurance that project outflow will not be zero cfs, that in fact the rivers below USACE dams will still contain water. The Chief, CENWP-EC-HR coordinates with the State Engineer for the OWRD.

11-04. County Emergency Managers. The WSAC provides data to the counties and other sources. The counties may adopt a local resolution declaring a drought. If needed, counties make a request to the Drought Readiness Council for assistance. The Drought Readiness Council evaluates the local requests for assistance, and makes recommendations to the Governor, who in turn may make a request to the USACE for assistance.

12.0 Internal and External Communication

12-01. Congressional Briefs and Public Officials. The Deputy District Engineer for Program and Project Management (DDEPPM) meets with congressional representatives when requested. The Chiefs of CENWP-EC-H and CENWP-HR support the DDEPPM by providing technical information on specific questions they may have. Senior Management will maintain open communication with local officials and staff as needed, including the city and county commissioners and selected officials from the governor's office.

12-02. Public Communication. The CENWP-EC-HR coordinates with the CENWP-PA to provide the news media and the general public with water resources information related to the Willamette Valley Project, using a positive approach to deal with drought distress situations. The Willamette Valley Project staff and CENWP-EC-HR staff should attend watershed council meetings, chambers of commerce, and City Council meetings and civic organizations to help reinforce understanding of competing demands of authorized purposes on reservoirs. The CENWP-PA may attend public meetings and provide support to the Willamette Valley Project staff and CENWP-EC-HR by disseminating information through social media and by printing flyers and other materials. As required, news releases containing updated water resources facts concerning the drought, as they relate to USACE reservoir conditions, will be prepared and distributed by the CENWP-PA.

12-03. Internet. Reservoir levels, recreation updates, current issues, and other information will be posted on the District internet site. The internet is one of the District's most comprehensive public resources for information on USACE activities. The weblink for this information is provided in the Weblinks section of this document. In a drought year, the CENWP will create a public web page to share drought related information. Drought information include forecasts and impacts, current reservoir data, information on emergency water assistance, and links to State of Oregon and other federal agency websites. Current conditions related to drought is provided in the weblink in the Weblinks section of this document.

13.0 Emergency Assistance for Drought

The USACE authority for Drought Assistance is contained in section 6-5, Policy – Emergency Water Assistance Due to Drought, of Engineering Regulation 500-1-1, *Emergency Employment of Army and Other Resources, Civil Emergency Management Program*, dated 30 September, 2001. The Portland District, Business Operations Branch, Readiness Section (CENWP-OD-SE), is the point of contact for drought assistance.

The USACE is authorized to transport emergency supplies of clean drinking water for human consumption to any locality designated as a drought distressed area, and to construct wells in such drought distressed areas. Assistance will only be to meet minimum public health and welfare requirements. Assistance may be in the form of emergency supply of clean drinking water for human consumption, and construction of wells (at state/local expense) if not commercially possible. Water normally provided by tank trucks or small diameter pipelines. Beneficiaries are any locality faced with a threat to public health and welfare from a drought situation affecting the water system.

Application for program assistance to the CENWP must be initiated by the Governor or his/her authorized representative, but assistance is subject to approval at a higher level. The impacted area must be designated as a "drought distressed" area by Assistant Secretary of the Army for Civil Works. For other details on obtaining assistance during a drought, contact CENWP-OD-SE.

REFERENCES

NOAA's National Marine Fisheries Service, *Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation, Consultation on the "Willamette River Basin Flood Control Project,"* 11 July 2008.

Oregon Office of Emergency Management, Oregon Water Resources Department, *Drought Annex, State of Oregon Emergency Operations Plan*, January 2016,

Oregon Partnership for Disaster Resilience for the State of Oregon, Oregon Emergency Management, *Natural Hazards Mitigation Plan, Drought Chapter*, February 2012,

Oregon Water Resources Department, *Water Rights in Oregon, An Introduction to Oregon's Water Laws*, November 2013.

Oregon Climate Change Research Institute, *Historical Trends and Future Projections of Climate and Streamflow in the Willamette Valley and Rogue River Basins*, June 2015 and revised March 3, 2016.

Pinson, A., A. Jordan, B. Baker, K. D. White, R. Vermeeren, and K. Fagot (2015), *USACE Drought Contingency Planning in the Context of Climate Change*, Civil Works Technical Report, CWTS 15-15, US Army Corps of Engineers: Washington, DC, September 2015.

U.S. Army Corps of Engineers, *2011 USACE Climate Change Adaptation Plans and Report*, dated September 2011.

U.S. Army Corps of Engineers, *2012 USACE Climate Change Adaptation Plans and Report*, dated June 2012.

U.S. Fish and Wildlife Service and Oregon Fish and Wildlife Office, *Final Biological Opinion on the Willamette River Basin Flood Control Project, Biological Opinion on the Continued Operation and Maintenance of the Willamette Basin River Project and Effects to Oregon Chub, Bull Trout and Bull Trout Critical Habitat Designated Under the Endangered Species Act*, 11 July 2008.

WEBLINKS (as of May 2017)

NOAA's Climate Prediction Center ENSO status:
http://www.cpc.ncep.noaa.gov/products/expert_assessment/ENSO_DD_archive.shtml

Drought Monitor Update Report for Oregon:
http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?OR

NRCS Oregon Snow Survey Reports: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/snow/

Oregon Water Supply Outlook Reports:
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/snow/waterproducts/?cid=nrcs142p2_048083

Oregon Surface Water Supply Index (SWSI):
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/snow/waterproducts/?cid=stelprdb1244919

CWTS Report 15-15: http://www.corpsclimate.us/ccaupddr.cfm.

The State of Oregon's Governor Executive Order:
http://www.oregon.gov/owrd/pages/wr/drought.aspx#Implementing_the_Drought_Executive_Order.

State of Oregon's Emergency Operations Plan and the Drought Annex:
http://www.oregon.gov/OMD/OEM/Pages/plans_train/EOP.aspx.

Portland District internet site: http://www.nwp.usace.army.mil/

Portland District current conditions related to drought:
http://www.nwp.usace.army.mil/Missions/Water/Drought.

Reservoir storage capacity tables:
http://wmlocal.nwd.usace.army.mil/nwp/ratings/www/index.html

Attachment 1

USACE-City Agreement Template
Temporary Withdrawal of Water

AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
[CITY]
FOR
TEMPORARY WITHDRAWAL OF WATER
FROM
[RESERVOIR], [STATE]
PURSUANT TO
SECTION 6 OF THE FLOOD CONTROL ACT OF 1944

THIS AGREEMENT, entered into this ____ day of MONTH, YEAR, by and between the DEPARTMENT OF THE ARMY (hereinafter called the "Government") represented by the District Engineer executing this Agreement, and CITY, (hereinafter called the "User"*);

WITNESSETH THAT:

WHEREAS, pursuant to the Flood Control Acts of 1938 (Public Law 75-761) and 1950 (Public Law 81-516), the Government has constructed and is operating [Project] on the [waterway], (hereinafter called the "Project"); and

WHEREAS, Section 6 of the Flood Control Act of 1944 (Public Law 78-534), as amended (33 U.S.C. 708), provides that the Secretary of the Army is authorized to enter into agreements with states, municipalities, private concerns, or individuals, at such prices and on such terms as the Secretary may deem reasonable, for domestic and industrial uses for surplus water that may be available at any reservoir under the Secretary's control provided that no agreements for such water shall adversely affect the existing lawful uses of such water; and

WHEREAS, pursuant to Section 6 of the Flood Control Act of 1944, as amended, the Government has determined that up to [volume] acre-feet of storage, as described in the [supporting document] (hereinafter called the "Report"), approved [date], is available at the Project as surplus water for municipal and industrial use, as the withdrawal of such amount will not interfere with Project purposes, nor adversely affect the existing lawful uses of water from the Project; and

WHEREAS, the User desires to enter into an agreement with the Government for the withdrawal of up to [volume] acre-feet of surplus water downstream from the Project for municipal purposes; and

WHEREAS, the User, as shown in Exhibit "A", attached to and made a part of this Agreement, is empowered to enter into an agreement with the Government and is vested with all necessary powers of accomplishment of the purposes of this Agreement.

NOW, THEREFORE, the parties do mutually agree as follows:

ARTICLE 1 - Withdrawal of Surplus Water

a. The Government grants the User the right to withdraw water from the Project, or request releases to be made by the Government through the outlet works of the Project, for municipal use, subject to the User's compliance with its responsibility for water rights as set out in Article 3 of this Agreement.

The rate of such withdrawal shall not exceed [rate], and the volume shall not to exceed [volume] acre-feet per year, during the term of this Agreement as specified in Article 5 hereof.

b. The User's rights under this Agreement are subject to the Government's control and use of any or all storage in the Project to fulfill the authorized purposes of the Project. In the event that the Government determines that withdrawals of any or all of the surplus water identified in the Report are resulting in unexpected adverse impacts to other Project purposes or operations, the User shall immediately suspend withdrawals.

c. The Government further reserves the right to take such measures as it determines in its sole discretion to be necessary to inspect, operate, maintain, and repair the Project, including taking any and all measures necessary to protect life and property.

d. The water which may be available for withdrawal by the User pursuant to this Agreement is raw water only. The Government makes no representation with respect to the quality of water which may be available and assumes no responsibility therefore, or for treatment of the water.

e. The Government makes no guarantee with respect to the availability of water. The water level of the Project will be maintained at elevations which the Government deems will best serve the authorized purposes of the Project, and this Agreement shall not be construed as giving the User any rights to have the water level maintained at any elevation.

ARTICLE 2 – Metering and Recordkeeping

For the purpose of maintaining an accurate record of the water withdrawn from the Project, the User agrees to furnish and install, or cause to be installed, meters or measuring devices satisfactory to the District Engineer, without cost to the Government. Such devices shall be available for inspection by Government representatives at all reasonable times. The User agrees to furnish to the District Engineer: (i) advance estimates of need; and (ii) records of the quantity of water actually withdrawn as requested by the District Engineer, but in any event no less frequently than once a year.

ARTICLE 3 - Regulation of and Right to the Use of Water

The regulation of the use of water withdrawn or released from the storage space under this Agreement shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with applicable law, and if necessary to establish or defend, any and all water rights needed for the water withdrawn or released from the Project under this Agreement. The Government shall not be responsible for the use of water by the User, nor will it become a party to any controversies involving the water use, except as such controversies may affect the operations of the Project.

ARTICLE 4 - Consideration and Payment

a. In consideration of the right to withdraw [volume] acre-feet between [timeframe] per year for a period not to exceed five (5) years from the Project for municipal and industrial water supply purposes, the User shall pay the Government $[capital cost] per year in capital costs, the first of which shall be due and payable within thirty (30) days of the effective date of the Agreement as set forth in Article 5 herein. In addition to the annual capital cost payment, the User shall be responsible for a share of the Operations and Maintenance (O&M) costs of the Project. The first payment will be for $[O&M cost] and is due within thirty (30) days of the effective date of the Agreement. Future capital and O&M payments thereafter will be due and payable on the anniversary date the first payment is due.

b. The repayment amount shown in Article 4(a) is based upon joint use and specific water supply construction costs updated to [month year] price levels using appropriate indices and the Fiscal Year [FY] water supply interest rate of [interest rate] percent as computed by the Secretary of the Treasury in accordance with Section 932 of the Water Resources Development Act of 1986 (Public Law 99-662).

c. If the User shall fail to make any payment under this Agreement within thirty (30) days of the date due, the delinquent payment shall be charged interest at the Current Value of Funds Rate, as determined by the Secretary of the Treasury that is applicable on the date that the payment became delinquent, with such penalty interest as may be required by Federal law or regulation. This provision shall not be construed as waiving any other rights the Government may have in the event of default by the User, including but not limited to the right to terminate this Agreement for default.

ARTICLE 5 - Duration of Agreement

This agreement shall become effective upon the date it is signed by the Government, and shall continue in full force and effect under the conditions set forth herein for a period of not to exceed five (5) years from the said date of approval. Upon expiration, this agreement may be extended by mutual agreement for additional periods of not to exceed five (5) years each. All such agreement extensions shall be subject to recalculation of reimbursement. Nothing in this agreement, nor in any extension thereto, shall imply a permanent right to utilize the storage space.

ARTICLE 6 - Termination of Agreement

a. The User may terminate the Agreement upon fourteen (14) days written notice.

b. The Government may terminate this Agreement upon thirty (30) days written notice in the event the Government determines that withdrawals of any or all of the surplus water identified in the Report are resulting in unexpected adverse impacts to other Project purposes or operations.

c. The Government may terminate this Agreement and the User's right to withdraw water upon thirty (30) days written notice if the User shall default in performance of any obligation of this Agreement. Upon such a termination, the User shall continue to be liable to the Government for any monies owed and for any costs incurred by the Government as a result of the default.

d. In the event of any termination pursuant to this Article or Article 5, User shall, upon request of the Government, promptly remove, at User's expense, any facilities constructed on Project land for water withdrawal and restore premises around the removed facilities to a condition satisfactory to the Government.

e. Not later than ten (10) calendar days from the date of the written notice to terminate, the Government shall commence a final accounting of the financial obligations of the User under Article 4.a. of this Agreement. The results of the final accounting will be furnished by written notice to the User.

(i) Should the final accounting show that the User owes the Government further payment under this Agreement, the User, not later than ninety (90) calendar days after receipt of the written notice from the Government, shall provide the Government with the full amount by delivering a check payable to "FAO. USAED, Portland" to the District Engineer, or by providing an Electronic Funds Transfer of the required funds in accordance with procedures established by the Government.

(ii) Should the final accounting show that the amount of funds provided by the User exceeds its financial obligations under this Agreement, the Government, subject to the availability of funds, shall refund the excess amount to the User within ninety (90) calendar days of the date of completion of the final accounting, or if funds are not available, shall seek such appropriations as are necessary to make the refund.

ARTICLE 7 - Rights-of-Way

Occupancy and use of Project lands shall be in accordance with any permits, rights-of-way, or easements granted to the User by the Government.

ARTICLE 8 - Release of Claims

The User shall hold and save the Government, including its officers, agents, and employees, harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the withdrawal or release of water from the Project made pursuant to the terms of the Agreement, or as a result of the construction, operation or maintenance of any facilities or appurtenances owned and operated by the User except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE 9 - Transfer or Assignment

The User shall not transfer or assign this Agreement nor any rights acquired thereunder, nor grant any interest, privilege or license whatsoever in connection with this Agreement, without the approval of the Secretary of the Army or his duly authorized representative, provided that this restriction shall not be construed to apply to any water withdrawn or obtained from the Project and furnished by the User to any third party or parties, or to the rates charged therefor.

ARTICLE 10 - Officials Not to Benefit

No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this Agreement if made with a corporation for its general benefit.

ARTICLE 11 - Covenant Against Contingent Fees

The User warrants that no person or selling agency has been employed or retained to solicit or secure this Agreement upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies by the User for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this Agreement without liability, or in its discretion, to add to the Agreement price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 12 - Environmental Quality

During any construction, operation, and maintenance by the User of any facilities, specific actions will be taken to control environmental pollution which could result from such activity and to comply with applicable Federal, State and local laws and regulations concerning environmental pollution. Particular attention should be given to (1) reduction of air pollution by control of burning, minimization of dust, containment of chemical vapors, and control of engine exhaust gases, and of smoke from temporary heaters; (2) reduction of water pollution by control of sanitary facilities, storage of fuels and other contaminants, and control of turbidity and siltation from erosion; (3) minimization of noise levels; (4) onsite and offsite disposal of water and spoil; and (5) prevention of landscape defacement and damage.

ARTICLE 13 - Civil Rights Assurance and Certification Regarding Lobbying

a. The User furnishes, as part of the Agreement, an assurance (Exhibit C) that it will comply with Title VI of the Civil Rights Act of l964 (78 Stat. 252; 42 U.S.C. 2000d, et seq.) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 195 of Title 32, Code of Federal Regulations.

b. The user furnishes, as part of this Agreement, a certification (Exhibit D) that no appropriated funds have been paid or will be paid to an officer or employee of a Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the execution of this Agreement; and that any funds other than appropriated funds that have been paid or will be paid to such persons will be disclosed on the appropriate form.

ARTICLE 14 - Approval of Agreement

This Agreement shall be subject to the written approval of the Secretary of the Army or his duly authorized representative and shall not be binding until so approved.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the day and year first above written.

FOR THE DEPARTMENT OF THE ARMY

By _____
[Commander]
Colonel, U.S. Army
District Engineer
U.S. Army Engineer District
Portland, Oregon

DATE:_____

FOR THE [CITY]

By _____
[name of signatory]
[position or title]

DATE:_____

EXHIBIT A: CERTIFICATION

I _____, Attorney for the [ENTITY], have reviewed the foregoing agreement executed by _____ and, as principal legal officer for the [ENTITY], certify that the [ENTITY] is legally and financially capable of entering into the contractual obligations contained in the foregoing agreement and that, upon acceptance by the Department of the Army, it will be legally enforceable.

Given under my hand, this _____ day of _____ [YEAR].

_____

Attorney for [ENTITY]

EXHIBIT B

The cost charged to the user for [volume] acre-feet of storage for five years is $[total cost], plus an annual O&M fee. For a surplus water supply agreement, the user will pay the annual fees as listed in the table below.

TOTAL ANNUAL COST TO USER
FOR SURPLUS WATER SUPPLY STORAGE

Item	Type of Use	Computation	Cost
Interest and amortization	Annual cost of storage space	$[cost per acre-foot] x [acre-feet], (based on 30 year repayment plan) and 5 payments at interest rate of [interest rate]%.	$[total cost]
Operation and maintenance [1]	Joint-use actual for FY [previous FY]	[ ]% [2] x $[total joint-use O&M for previous FY]	$[share of O&M]
Repair, rehabilitation and replacement [3]	Joint-use actual for FY [previous FY]	[ ]% [2] x $[total joint-use O&M for previous FY]	$[share of RR&R]

Notes:

1 Payment due and payable on the date specified in Article 4(a).

2 Percent of Users share of the Usable storage space in the project.

3 Repair, rehabilitation and replacement costs are payable only when incurred as specified in Article 5(b).

EXHIBIT C: ASSURANCE OF COMPLIANCE

ASSURANCE OF COMPLIANCE WITH THE DEPARTMENT OF DEFENSE DIRECTIVE UNDER TITLE VI OF THE CIVIL RIGHTS ACT OF 1964, AS AMENDED; THE AGE DISCRIMINATION ACT OF 1975; AND THE REHABILITATION ACT OF 1973, AS AMENDED

The party executing this assurance, being the applicant recipient of Federal financial assistance under the instrument to which this assurance is attached hereby agrees that, as a part of its obligations under the aforesaid instrument, it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), as amended (42 U.S.C. 2000d), and all requirements imposed by or pursuant to the Directive of the Department of Defense (32 CFR Part 195), issued as Department of Defense Directive 5500.11 pursuant to that title; The Age Discrimination Act of 1975 (42 U.S.C. 6102); the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), to the end that in accordance with the aforementioned Title, Directive and Acts, no person in the United States shall on the ground of race, color, age, sex, religion, handicap or national origin be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant-Recipient receives Federal financial assistance from the Department of the Army and gives assurances that it will immediately take any measures necessary to effectuate this agreement.

If any personal property or real property, or interest therein, or structure thereon is provided or improved with the aid of Federal financial assistance extended to the applicant-recipient by the Department of the Army, or if such assistance is in the form of personal property or real property, or interest therein or structure thereon, then this assurance shall obligate the applicant-recipient or in the case of any transfer of such property, any transferee, for the period during which the property is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits, or for the period during which it retains ownership or possession of the property whichever is longer. In all other cases, this assurance shall obligate the applicant-recipient for the period during which the Federal financial assistance is extended to it by the Department of the Army. The Department of the Army representatives will be allowed to visit the recipient's facilities. They will inspect the facilities to ensure that there are no barriers to impede the handicap's accessibility in either programs or activities.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the applicant-recipient by the Department of the Army, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The applicant-recipient recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the applicant-recipient, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the applicant.

Date _____ By _____

[position/title]
[entity]

Mailing Address:
[ ]

EXHIBIT D: CERTIFICATION REGARDING LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

_____

[position/title]
[entity]

DATE: _____