ASSOCIATED ATTACHMENTS/ENCLOSURES:

Attachment 02.04.03-8C: Dam Rating Curves, Blue Ridge

(199 Pages including Cover Sheet)

NPG CALCULATION COVERSHEET/CCRIS UPDATE

REV 0 EDMS/RIMS NO.	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
L58 090128 001	calculations(nuclear)	L58 091230 015

Calc Title: Dam Rating Curves, Blue Ridge

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV	REVISION APPLICABILITY
CURRENT	CN	NUC	GEN	CEB	CDQ000020080002	0	1	Entire calc ☒
NEW								Selected pages ☐

ACTION	NEW ☐ REVISION ☒	DELETE ☐ RENAME ☐	SUPERSEDE ☐ DUPLICATE ☐	CCRIS UPDATE ONLY ☐ (Verifier Approval Signatures Not Required)	No CCRIS Changes ☐ (For calc revision, CCRIS been reviewed and no CCRIS changes required)

UNITS	SYSTEMS	UNIDS
N/A	N/A	N/A

DCN,EDC N/A *See below	APPLICABLE DESIGN DOCUMENT(S) N/A	CLASSIFICATION E

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS and/or ISFSI SAR/CoC AFFECTED
Yes ☒ No ☐	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒

PREPARER ID	PREPARER PHONE NO	PREPARING ORG (BRANCH)	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
cjgrace	(205) 298-6074	CEB	Design Review	☐ Yes ☒ No

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
Chris J. Grace *[signature]*	12/22/2009	Bryant Bondurant *Bryant Bondurant*	12/22/09
VERIFIER SIGNATURE	**DATE**	**APPROVAL SIGNATURE**	**DATE**
L. Yu Lin *L. Lin*	12/22/09	K.R. Gates *K R Gates*	12/23/09

STATEMENT OF PROBLEM/ABSTRACT

Headwater rating curves for 20 dams are required as inputs to TVA's SOCH and TRBROUTE models, which perform flood-routing calculations for the Tennessee River and tributaries. The headwater rating curves for each dam provide total dam discharge as a function of headwater elevation. This calculation presents headwater rating curves for Blue Ridge Dam.

This calculation contains electronic attachments and must be stored in EDMS as an Adobe .pdf file to maintain the ability to retrieve the electronic attachments.

*EDCN 22404A (SQN), EDCN 54018A (WBN), EDCN Later (BFN)

Special Condition Note: The headwater rating curve provided in this calculation is limited in application to maximum PMF headwater elevation of 1707.0 feet (See Section 5.0 in the calculation for the basis of this limiting condition.)

MICROFICHE/EFICHE Yes ☐ No ☒ FICHE NUMBER(S)

- ☐ LOAD INTO EDMS AND DESTROY
- ☒ LOAD INTO EDMS AND RETURN CALCULATION TO CALCULATION LIBRARY. ADDRESS: LP4D-C
- ☐ LOAD INTO EDMS AND RETURN CALCULATION TO:

NPG CALCULATION COVERSHEET/CCRIS UPDATE

REV 0 EDMS/RIMS NO.	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
L58 090128 001	calculations(nuclear)	N/A

Calc Title: Dam Rating Curves, Blue Ridge

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV	REVISION APPLICABILITY
CURRENT	CN	NUC						Entire calc ☒
NEW	CN	NUC	GEN	CEB	CDQ000020080002	N/A	0	Selected pages ☐

ACTION	NEW ☒ REVISION ☐	DELETE ☐ RENAME ☐	SUPERSEDE ☐ DUPLICATE ☐	CCRIS UPDATE ONLY ☐ (Verifier Approval Signatures Not Required)	No CCRIS Changes ☐ (For calc revision, CCRIS been reviewed and no CCRIS changes required)

UNITS	SYSTEMS	UNIDS
N/A	N/A	N/A

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S) N/A	CLASSIFICATION
N/A		E

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS and/or ISFSI SAR/CoC AFFECTED
Yes ☒ No ☐	Yes ☒ No ☐	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒

PREPARER ID	PREPARER PHONE NO	PREPARING ORG (BRANCH)	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
C. Sattler	632-6443	CEB	Design Review	☐ Yes ☒ No

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
[signature] CLINT SATTLER	1/15/09	Chris Triplett [signature]	01/23/09
VERIFIER SIGNATURE [signature] DAVID B HUNT Dr. L. Yu Lin [signature]	01/23/09	APPROVAL SIGNATURE [signature] K.R. Spates	1/27/09

[handwritten initials] 1-26-09

STATEMENT OF PROBLEM/ABSTRACT

Headwater rating curves for 20 dams are required as inputs to TVA's SOCH and TRBROUTE models, which perform flood-routing calculations for the Tennessee River and tributaries. The headwater rating curves for each dam provide total dam discharge as a function of headwater elevation. This calculation presents headwater rating curves for Blue Ridge Dam.

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MICROFICHE/EFICHE Yes ☐ No ☒ FICHE NUMBER(S)

☐ LOAD INTO EDMS AND DESTROY

☒ LOAD INTO EDMS AND RETURN CALCULATION TO CALCULATION LIBRARY. ADDRESS:LP4D-C

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NPG CALCULATION COVERSHEET/CCRIS UPDATE

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	REV
	CN	NUC	GEN	CEB	CDQ000020080002	1

ALTERNATE CALCULATION IDENTIFICATION

BLDG	ROOM	ELEV	COORD/AZIM	FIRM	Print Report Yes ☐
				BWSC	

CATEGORIES SR/LC

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF TYPE	XREF PLANT	XREF BRANCH	XREF NUMBER	XREF REV
A	P	EN	WBN	CEB	54018	
A	P	EN	SQN	CEB	22404	
A	S	CN	GEN	CEB	CDQ000020080053	
D	S	CN	GEN	CEB	CDQ000020080054	

CCRIS ONLY UPDATES:
Following are required only when making keyword/cross reference CCRIS updates and page 1 of form NEDP-2-1 is not included:

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
PREPARER PHONE NO.	EDMS ACCESSION NO.		

NPG CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER CDQ000020080002	
Title	Dam Rating Curve, Blue Ridge
Revision No.	DESCRIPTION OF REVISION
0	Initial Issue Total Pages – 96 Attachments 1-3, 5-13, 27, A1, A2, A5-A13, A15, A16, A18-A25 - 1 Page Each Attachments 4, 14, A3, A4 - 2 Pages Each Attachment A14 - 5 Pages Attachment A17 - 6 Pages

1	This calculation was revised to address the following:
	• PER 203951. The verification of the previous calculation was completed by personnel who had not completed the required NEDP-7 Job Performance Record (JPR). A verification JPR is now in place for all personnel engaged in verification tasks. Checking includes only changes made in this revision as the checking of the calculation was not impacted by PER 203951. The verification is inclusive of work completed prior to this revision.
	• PER 203872. Replace NEDP-2 forms on Pages 1 through 7 with the forms for the NEDP-2 revision in effect at the time of Rev 0 issue of this calculation.
	• PER 210898. An error was identified in the Rev 0 issue of this calculation concerning the Spillway Bridge Overflow coefficient. This error was corrected in this edition resulting in minor decreases to the flow values calculated for headwater elevations above 1710 feet.
	• UVA 3.2.1. Removed and replaced with:
	  o Assumption 3.1.3 based on Reference 15 and,
	  o Assumption 3.1.5 based on Appendix C.
	• UVA 3.2.2. Removed and replaced with Assumption 3.1.4 based on Technical Justification.
	• Add Reference 15.
	• Added a Limiting Condition to calculation based on gate failure evaluation. Applicability of this calculation is limited to headwater elevations no greater than 1707.0 feet.
	
	Significant changes to text in Revision 1 are marked with a right hand margin revision bar. Administrative changes and typos are excluded.
	
	Pages Deleted: None
	Pages Revised: 1 – 6, 11, 12, 16, 17, 18, 20, 21, 21a, 22, 23
	New Pages added: 1a, 6a, C1-C3
	
	Total hardcopy pages Revision 1: 101
	
	Additional Comments:
	• Rev. 0 coversheet is page 1a
	• Rev. 0 Verification Form is page 6a
	• Updated Coversheet and CCRIS pages
	• Inserted number of pages per Attachments in Table of Contents
	• Updated page numbers
	• Corrected C_f value for Spillway Bridge Overflow and updated Section 4.5.1 and Figures 2, 2a, 3 and 4 to reflect changes
	• Added Appendix C

NPG CALCULATION TABLE OF CONTENTS

Calculation Identifier: CDQ00020080002	Revision: 1

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NPG CALCULATION TABLE OF CONTENTS (continued)

Calculation Identifier: CDQ000020080002	Revision:	1

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Note: N/A indicates an electronic file that is not paginated

NPG CALCULATION VERIFICATION FORM

Calculation Identifier CDQ000020080002 Revision 1

Method of verification used:		Verifier L. Yu Lin Date 12/22/09
1. Design Review	☒	
2. Alternate Calculation	☐	
3. Qualification Test	☐	L. Lin

Comments:

This calculation entitled, "Dam Rating Curve, Blue Ridge," was verified by independent design review. The process involved a critical review of the calculation to ensure that it is correct and complete, uses appropriate methodologies, and achieves its intended purpose. The inputs were reviewed and determined to be appropriate inputs for this calculation. The results of the calculation were reviewed and were found to be reasonable and consistent with the inputs provided. Backup files and documents were consulted as necessary to verify data and analysis details found in the calculation.

Detailed comments and editorial suggestions for the changes made in this revision were transmitted to the author and reviewer by email along with a marked up copy of the calculation

The operability of the gates in the open position is based solely on the conclusions of the Watts Bar Dam – Flood and Earth Quake Analysis on Radial Spillway Gates. Appendix B uses the same assumptions, methodology, and approach developed in the Watts Bar radial gate analysis to determine the forces on the radial gates in a closed position, but does not assert that a structural analysis has been preformed beyond that found in the Watts Bar radial gate calculation.

(Note: The design verification of this calculation revision is for the total calculation, not just the changes made in the revision. This complete re-verification is performed to disposition PER 203951 as described in the Calculation Revision Log on Page 3).

NPG CALCULATION VERIFICATION FORM

Calculation Identifier CDQ000020080002	Revision 0
Method of verification used: 1. Design Review ☒ 2. Alternate Calculation ☐ 3. Qualification Test ☐	David B Hunt for Scott Zinkham DAVID B HUNT per telecon Verifier Dr. L. Yu Lin Date 01/23/09 L. Lin

Comments:

NPG COMPUTER INPUT FILE
STORAGE INFORMATION SHEET

Document CDQ000020080002	Rev. 0	Plant: GEN	

Subject:
Dam Rating Curve, Blue Ridge

☐ Electronic storage of the input files for this calculation is not required. Comments:

There are no electronic input or output files associated with this calculation.

☒ Input files for this calculation have been stored electronically and sufficient identifying information is provided below for each input file. (Any retrieved file requires re-verification of its contents before use.)

These files are electronically attached to the parent ADOBE.pdf calculation file. All files are therefore stored in an unalterable medium and are retrievable through the EDMS number for this calculation.

Attachment 15: Excel Spreadsheet – Blue Ridge Rating Curve.xls
Attachment 16: Complete PDF copy of TVA Water Control Project Manual (Blue Book) for Blue Ridge Dam, TVA River Operations, January, 2004
Attachment 17: Complete PDF copy of TVA Report WR28-2-900-123, "Method for Estimating Discharge at Overflow Spillways with Curved Crests and Radial Gates"
Attachments 18-25: High Resolution Copies of Refs. 1, 3, 7-8 and 10-13
Attachment 26: Complete PDF copy of Blue Ridge Dam Spillway Discharge Tables

Attachment A26: Excel Spreadsheet – Blue Ridge Rating Model Data for Headwater Rating Curve.xls
Attachment A27: Excel Spreadsheet – Auxiliary Crest Parameters.xls
Attachment A28: Relevant Pages From "Design of Small Dams," United Stated Department of the Interior, Bureau of Reclamation, 3rd Edition
Attachments A29: High Resolution Copy of Ref. A14

☐ Microfiche/eFiche

1. Purpose

Headwater rating curves for twenty dams geographically located on the Tennessee River and its tributaries above the existing Bellefonte Nuclear facility are required as inputs to TVA's SOCH and TRBROUTE models, which perform flood-routing calculations. The headwater rating curves for each dam provide total dam discharge as a function of headwater elevation. This calculation presents headwater rating curves for Blue Ridge Dam.

TVA developed methods of analysis, procedures, and computer programs for determining design basis flood levels for nuclear plant sites in the 1970's. Determination of maximum flood levels included consideration of the most severe flood conditions that may be reasonably predicted to occur at a site as a result of both severe hydrometerological conditions and seismic activity. This process was followed to meet Nuclear Regulatory Guide 1.59. At that time, there were no computer programs available that would handle unsteady flow and dam failure analysis. As a result of this early work and method development, TVA developed a runoff and stream course modeling process for the TVA reservoir system. This process provided a basis for currently licensed plants (Sequoyah Nuclear Plant, Watts Bar Nuclear Plant, and Browns Ferry Nuclear Plant). The Bellefonte Nuclear Plant (BLN) Units 1 & 2 Final Safety Analysis Report (FSAR) was also based on this process.

BLN Unit 3 & 4 Combined Operating License Application (COLA) was submitted using data and analysis that was determined for the original BLN FSAR (Unit 1 and Unit 2) and was documented in a 1998 reassessment. In 1998, the analysis process and documentation was brought under the nuclear quality assurance process for the first time. A quality assurance audit conducted by NRC staff in early 2007 raised several questions related to past work regarding design basis flood level determinations. This calculation supports a portion of the effort to improve this design basis documentation.

Preparation of all calculations supporting nuclear development and licensing are subject to TVA Standard Department Procedure NEDP-2. This standard dictates the process in which calculations are prepared, checked, verified, stored, and cross referenced in a goal to provide the highest quality nuclear design input and output possible.

Figure 1 is the plan and elevation views (Ref. 1) of Blue Ridge Dam. A photograph is included as Attachment 2. For headwaters in the normal operating range, discharge is passed through the turbine, low level outlet, spillway and auxiliary spillway. The main spillway consists of eight spillway bays, each with a radial, or tainter, gate to control discharge. The auxiliary spillway consists of six uncontrolled spillway bays. If, as during a probable maximum flood (PMF) event, headwater rises above the normal operating range, discharge may also pass over the bridge above the main spillway.

Rating curves are presented for the following two cases

Case 1 – Valid for rising headwaters and for falling headwaters as long as the headwater elevation does not flood the switchyard (TW<1560')

Case 2 – Valid for falling headwaters after the switchyard has been flooded.

These headwater rating curves are based on the configuration of Blue Ridge Dam as defined on the current design drawings. The purpose of this calculation does not evaluate the design loading conditions for the dam.

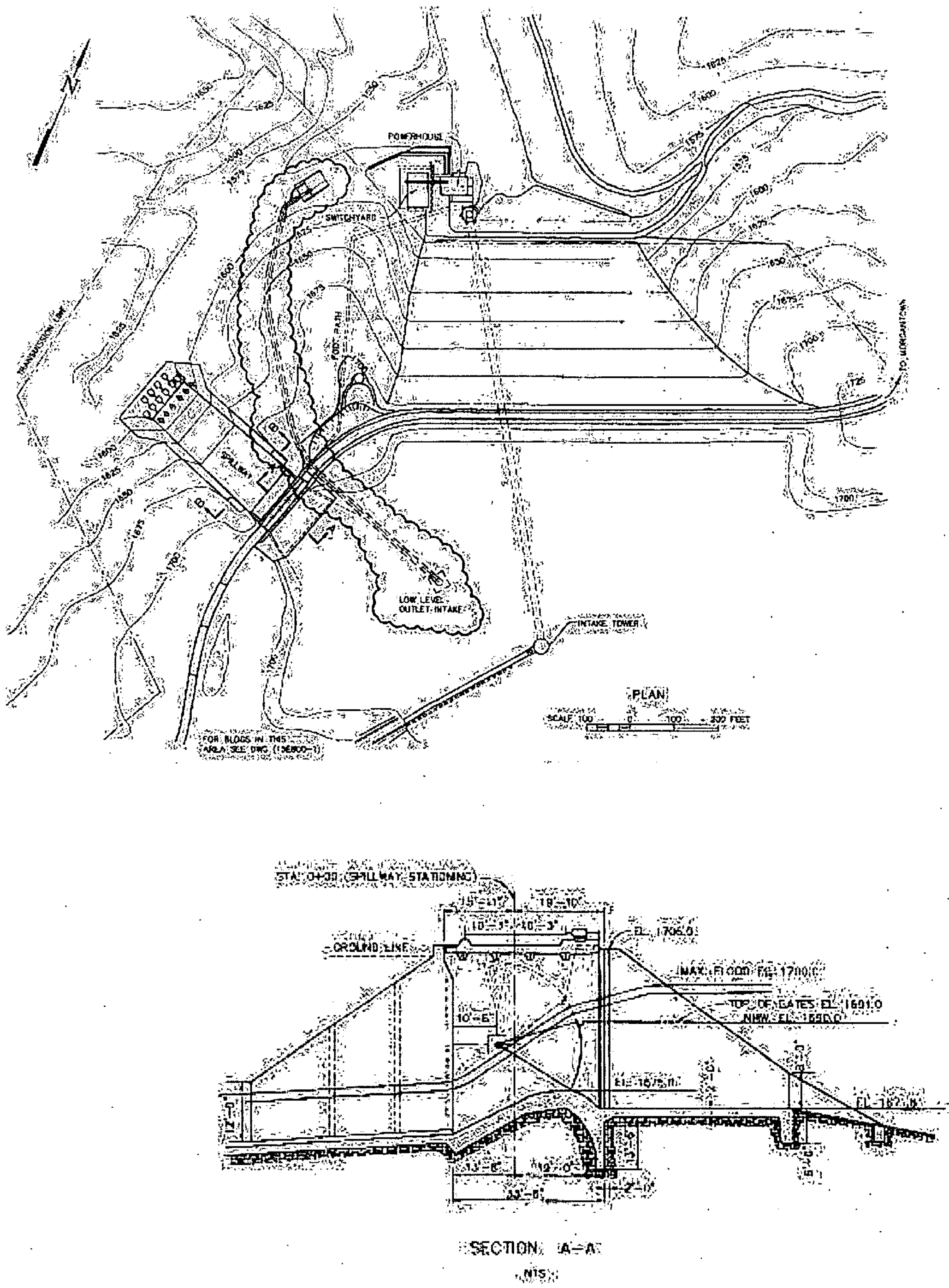

Figure 1 – Blue Ridge Dam, General Plan and Elevation (Ref. 1).

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2. References

1. TVA drawing no: 21W200, R1 (Attachments 1 & 18).
2. TVA Water Control Project Manual (Blue Book) for Blue Ridge Dam, TVA River Operations, January, 2004 (Attachment 16).
3. TVA drawing no: 75W210, R6 (Attachments 3 & 19).
4. TVA files, binder "River Scheduling: Tailwater Rating Curves by Projects."
5. "Hydraulic Design Criteria," USACE (U. S. Army Engineer Waterways Experiment Station), Eighteenth issue, Vicksburg, MS, 1988.
6. TVA Report WR28-2-900-123, "Method for Estimating Discharge at Overflow Spillways with Curved Crests and Radial Gates", E. Dean Harshbarger, Billy J Clift, James W. Boyd, January 1985 (Attachment 17).
7. TVA drawing no: 51E210-1, R3 (Attachments A15 & 20).
8. TVA drawing no: 51W290-1, R1 (Attachments A22A & 21).
9. "Blue Ridge Dam Spillway Discharge Tables," River Operations, Tennessee Valley Authority, 2008, EDMS #L58 081212 810.
10. TVA drawing no: 51W290-2, R1 (Attachments 6 & 22).
11. TVA drawing no: 81W200, R1 (Attachments 10 & 23).
12. TVA drawing no: 81W300-1, R1 (Attachments 11 & 24).
13. TVA drawing no: 51E200, R2 (Attachments 12 & 25).
14. "Design of Small Dams," United Stated Department of the Interior, Bureau of Reclamation, 3rd Edition, Washington DC, 1987 (Attachment A28).
15. "Basis for Dam Spillway Gate/Outlet Open Configuration for Flood Analyses," Tennessee Valley Authority, May 29, 2009 (EDMS No. L58 090529 800).

3. Assumptions & Methodology

The headwater rating curves developed in these calculations will be used in simulations of probable maximum flood events. Consequently, the rating curves have been calculated well above the normal operating range of the dam.

3.1 Assumptions

3.1.1 Assumption: Power generation will continue during the PMF event until the switchyard is flooded.
Technical Justification: Because the headwater elevation is not expected to exceed the elevation of the top of the dam [3.2.2], the powerhouse will not be overtopped. Power generation is assumed to stop when tailwater reaches an elevation of 1560 feet, at which point the tailwater will inundate the switchyard (Attachment 3, Ref. 3).

3.1.2 Assumption: The attached tailwater rating curve (Attachment 4) is sufficient for computing submergence effects on the headwater rating curves.
Technical Justification: The tailwater rating curve attached to this calculation was generated by the TVA Flood Risk group. This tailwater rating curve is used by TVA during actual flooding events to drive river management decisions and is therefore considered the best available source of tailwater elevation data. Riverware and HEC-RAS data show an acceptable level of agreement with tailwater curves generated from 1948 hand calculations and actual data and is therefore each is considered valid as a confirmatory alternate analysis within the level of accuracy required in this calculation. Tailwater would have to rise another 83.9' from its maximum level in order to influence discharge over the main spillway (See Section 7, 1675'-1591.1'= 83.9')

3.1.3 Assumption: All spillway gates will be set to the maximum openings specified in the spillway discharge tables.
Technical Justification: See "Basis for Dam Spillway Gate/Outlet Open Configuration for Flood Analyses" (Reference 15) for technical justification.

3.1.4 Assumption: Dam will not be overtopped during a PMF event.
Technical Justification: The maximum headwater considered for the dam rating curve is based on very conservative estimations of the maximum PMF elevation at the dam. Previous simulations have indicated that the dam is not overtopped during a PMF event. A headwater elevation of 1713 feet is a reasonable upper limit for this dam rating curve. However, although the headwater rating curve provided in this calculation extends to the elevations noted above, Section 5.0 of this calculation limits the applicability of this curve to the headwater elevation defined in Section 5.0. If the SOCH/TRBROUTE analysis identifies PMF elevations higher than 1707.0 feet, this issue will be identified by the analyst and a revision of this calculation will be required.

3.1.5 Assumption: All spillway gates will remain operable in the closed position and in the maximum opened position as specified in the spillway discharge tables.
Technical Justification: The radial gates will remain operable in the maximum opened position based on the findings of the "Watts Bar Dam – Flood and Earthquake Analysis on Radial Spillway Gates" (Reference C1). Appendix C uses the same assumptions, methodology, and approach as the Watts Bar radial gate analysis to compare forces on the gates in a closed position with forces on the gates in the maximum open position to provide technical justification for the gates to remain operable in the maximum open position during a PMF.

3.2 Unverified Assumptions

None

3.3 Methodology -- Discharge Equations

Discharges past the dam are computed as either "free" discharge or "orifice" discharge. Free discharge refers to free surface overflow and is computed using a weir-type equation as follows. Reference 5 shows weir flow equations for overflow discharges:

$$Q_f = C_f L H_c^{1.5} \quad (1)$$

in which Q_f = free discharge (cfs), C_f = free discharge coefficient ($ft^{0.5}$/sec), L = length of overflowing section (ft), H_c = head on crest (ft) = HW - Z_c, HW = headwater elevation (ft), and Z_c = top, or crest, elevation of overflowing section (ft). This equation need not be modified to account for tailwater submergence, as no portion of the dam which has free surface overflow will be submerged by tailwater.

Flow over the main spillway crest is treated as free discharge for headwater elevations below $H_c = H_{Lmin}$, the head at which the overflowing nappe first touches the bottoms of the open gates. H_{Lmin} varies with gate opening, V, defined as the vertical distance between the bottom of the gate and the spillway crest. Flow over the auxiliary crest is treated as free discharge for all headwater elevations relevant to this calculation.

For headwater elevations above $H_c = H_{Lmin}$ flow through the main spillway gates is treated as orifice discharge. Orifice discharge refers to flow passing through a contracted opening and is computed using an orifice-type equation as follows (Reference 6):

$$Q_g = C_g G L \sqrt{2g(H_m)} \quad (2)$$

in which Q_g = orifice discharge (cfs), C_g = orifice discharge coefficient (dimensionless -- varies with gate opening and H_c), G = effective gate opening = distance between the gate lip and the crest (ft), g = acceleration of gravity, and H_m = vertical distance between the mid-point of G and the headwater elevation. This equation need not be modified to account for tailwater submergence as the tailwater will never reach the crest elevation and influence discharge.

3.4 Methodology – Main Spillway Discharge Calculations

The discharge coefficient, C_f, for free discharge over a spillway crest varies with head, H_c (References 5 and 6). For the Blue Ridge main spillway, the relationships $H_{Lmin}(G,H_o)$ and $C_f(H_c/H_o)$ are available from composite model test data (Appendix A) as no model study specific to Blue Ridge Dam was ever conducted. The relationship between orifice discharge coefficient, C_g, and head, H_c, for each gate opening, G, is also available from the composite model test data. The main crest length, L, and main crest elevation, Z_c are shown on TVA drawings (References 7 and 8). The parameters G and H_m are determined from geometry (Appendix A).

The physical models used to measure spillway discharge included several bays and the piers between them. Consequently, pier contraction effects are implicitly included in the discharge coefficients derived from the model test data.

Under the assumption that all spillway gates are fully open (3.2.1), the two end bays (first and last) are the only spillway bays subject to end contraction effects. These effects, which may reduce discharge through these two bays by a few percent, are neglected in this calculation. According to Hydraulic Design Chart 111-3/2 (Attachment 14-2), end contraction losses effectively reduce the length of the overflowing spillway crest, L=176 ft (for the main spillway, see Section 4), by $2*K_a*H_e$, in which K_a = abutment contraction coefficient (dimensionless), and $H_e = H_c$ =energy head on the crest (in ft.). The maximum possible value for $K_a = 0.2$ (Att. 14-2), which means the maximum possible impact of abutment effects (calculated at maximum H_c, 23.96 ft on the main spillway, see Section 7, maximum elevation for free discharge) is equal to:

$$\left[1-\frac{L-2K_a(H_c)}{L}\right]*100\% = \left[1-\frac{176'-2(0.2)(23.96')}{176'}\right]*100\% = 5.4\%$$

3.5 Methodology—Low Level Outlet

Blue Ridge Dam has a low level outlet controlled by 24-inch and 72-inch cone valves. The spillway discharge tables (Ref. 9, relevant page included as Attachment 5) provide the flow for both valves open to their maximum position, the configuration considered in this calculation. These values likely do not include tailwater interactions; however, tailwater effects on the low level outlet will be neglected. In the upper portion of the Blue Ridge rating curve from headwater elevations 1691' (crest elevation of auxiliary spillway) to 1713' (the uppermost elevation in this calculation), discharge from the low level outlet accounts for 1%-4.4% of the total discharge (see Results section, Case 1). Adjusting for tailwater effects may change the flow through the low level outlet by a few percent, but since the discharge through the low level outlet is such a small portion of the overall discharge past the dam, neglecting tailwater effects has negligible impact on the final rating curve.

3.6 Auxiliary Spillway Discharge Calculations

The discharge coefficient, C_{faux}, for free discharge over an Ogee crests varies with head according to relationships based on the geometry of the spillway (Reference 14). Ogee relationships will be used as no model data specific to the Blue Ridge auxiliary spillway is available and because the auxiliary crest is dissimilar from the standard crests used to develop Reference 6. Because the auxiliary spillway is an uncontrolled crest, only free discharge occurs. Auxiliary crest length, L_{aux}, and auxiliary crest elevation, Z_{caux}, are shown on TVA drawings (References 7 and 8). Discharge past the auxiliary crest is corrected for frictional losses that occur in the approach channel (Appendix A).

Because the auxiliary spillway bay is longer than the main spillway(see Section 4), and has a lower energy head over the crest (see Section 7), abutment effects are even lower on that particular spillway and are also neglected in this calculation.

4. Design Input

Sect.	Input Parameter	Source	Symbol	Value
4.1	**Acceleration of gravity**	Common knowledge, Ref. 8, sheet. 000-1 for example	g	32.2 ft/sec^2
4.2	**Main Spillway crest parameters**			
4.2.1	Crest length	Eight 22-foot wide bays; Ref. 7	L	176 feet
4.2.2	Crest elevation	Ref. 7	Z_c	1675 feet
4.2.3	Free discharge coefficient	Polynomial fit to model data given in Att. A19 and discussed in Appendix A	$C_f(H_c)$	Equations A7.1 & A7.2
4.2.4	Design head	Justified in Appendix A	H_o	34 feet
4.3	**Main Spillway gate parameters**			
4.3.1	Vertical opening	Average of field measurements given in Att. A3 and discussed in Appendix A	V	19.195 feet
4.3.2	Effective gate opening	Computed in Appendix A	G	19.195 feet
4.3.3	Distance from spillway crest to point at which nappe touches gates	Estimated in Appendix A from data in Reference A2	H_{Lmin}	23.96 feet
4.3.4	Headwater elevation at which nappe touches gates	H_{Lmin} estimated in Appendix A	$H_{Lmin} + Z_c$	1698.96 feet
4.3.5	Orifice discharge coefficient	Curve given in Att. A22 and discussed in Appendix A	$C_g(H_c)$	Equations A8.1- A8.2
4.4	**Auxiliary Spillway crest parameters**			
4.4.1	Crest length	6 46-foot 8-inch wide bays; Ref. 8	L_{aux}	280 feet
4.4.2	Crest elevation	Ref. 8	Z_{caux}	1691 feet
4.4.3	Free discharge coefficient	Polynomial fit to model data given in Att. A25 and discussed in Appendix A	$C_{fcor}(H_{cup})$	Equation A17
4.4.4	Design head	Justified in Appendix A	H_o	22 feet
4.5	**Spillway Bridge Overflow**			
4.5.1	Discharge coefficient	Justification in Appendix B	C_f	2.65
4.5.2	Overflow elevation	Ref. 13	Z_c	1710 feet
4.5.3	Overflow length	Determined in Appendix B	L	200 feet
4.6	**Turbine Discharge**			
4.6.1	Q_t v/s Head on Turbine	Paragraph 4.9	$Q_t(H_t)$	Equation 3
4.7	**Tailwater Curve**			
4.7.1	TW v/s Total Discharge, Q	Paragraph 4.10	TW(Q)	Equations 4.1 and 4.2
4.8	**Low Level Outlet Discharge**			
4.8.1	Q_{ll} v/s HW	Paragraph 4.11	$Q_{ll}(HW)$	Equation 5

4.9 Discharge through Turbine

Discharge through the turbine, Q_t, was determined from Attachment 7 (From Ref. 2) at 100% gate opening. Points were scaled from Attachment 7 and a curve fit to turbine discharge versus gross head, H_t in feet, was developed in Attachment 8. The resulting polynomial is presented in Attachment 8 and repeated below.

$$Q_t = -0.0382(H_t)^2 + 18.398(H_t) + 119.55 \qquad (3)$$

in which Q_t = turbine discharge in cfs and H_t = gross head on the turbine (HW-TW) in feet. Because turbine discharge is a function of tailwater elevation, an iterative process will be used to calculate tailwater elevation in Case 1.

4.10 Tailwater Rating Curve

The tailwater rating curve used in this calculation was developed from data contained in Attachment 4. The Blue Ridge tailwater rating curve (Attachment 9) was generated by plotting the tailwater elevations given in Attachment 4 versus the Blue Ridge discharge. The polynomial listed in Attachment 9 and listed below was used for headwater rating curve calculations.

$$TW = 1546.2 + 0.5647Q - 3.1\times10^{-3}Q^2 + 7\times10^{-6}Q^3 \quad \text{For } Q>1.48 \qquad (4.1)$$
$$TW = 1543.6 \quad \text{For } Q\leq1.48 \qquad (4.2)$$

in which Q = total discharge past the dam in cfs divided by 1000 ("1000 cfs").

Because tailwater elevations never reach the crest elevation at Blue Ridge Dam, tailwater does not affect spillway flow.

4.11 Low Level Outlet Discharge

Data from Attachment 5 was curve fit in Attachment 13 to determine the discharge from the low level outlet, Q_{ll}, when both valves are open to the maximum setting. The polynomial listed in Attachment 13 and repeated below was used in headwater rating curve calculations.

$$Q_{ll} = -0.02384*HW^2 + 88.047*HW - 78821.97 \qquad (5)$$

in which Q_{ll} = total discharge passing through the low level outlet.

4.12 Upper Limit on Headwater Elevation Included in Rating Curve

From past simulation experience, during a PMF event the headwater at Blue Ridge Dam is not expected to rise past 1713 feet and therefore the dam rating curve generated by this calculation ends at this headwater elevation [Assumption 3.1.4].

Although the headwater rating curve provided in this calculation extends to the elevations noted above, Section 5.0 of this calculation limits the applicability of this curve to the headwater elevation defined in Section 5.0.

5. Special Requirements/Limiting Conditions

Calculations performed in Appendix C demonstrate that the spillway gate PMF hydrostatic loads in the expected fully open position are comparable to the normal spillway gate design loads in the fully closed position. Although a detailed gate analysis could potentially demonstrate the capability of the gate to withstand higher headwater elevations, the applicability of the calculation is limited to headwater elevations no greater than 1707.0 feet. If PMF headwater elevations at the Blue Ridge Dam exceed 1707.0 feet, a revision of this calculation will be required.

6. Calculations

The calculations consist of computing main spillway, auxiliary spillway, turbine (in Case 1), low level outlet, and overflow discharges (from Equations 1, 2, 3 and 5) for a list of headwater elevations ranging from the crest elevation up to 1713 feet [4.9], the top of the dam. The headwater rating curve is a plot of headwater elevation versus total dam discharge.

Case 1

Discharge passes through the low level outlet and turbines first and then the main and auxiliary spillways as headwater rise above the appropriate crest elevations. As headwater elevations continue to rise, discharge may also pass over the bridge above the main spillway. Total discharge, given in "1000 cfs", is the sum of all discharges in cfs past the dam divided by 1000.

Figure 2 shows the spreadsheet calculations for the headwater rating curve (spreadsheet included as Attachment 15). The final result, the rating curve, is defined by the first two columns, HW vs. Total Discharge. The third column (TW) gives the tailwater elevation associated with the "Total Discharge" from the tailwater rating curve polynomial fit [4.10].

Because the tailwater level varies with total dam discharge, and turbine discharge varies with tailwater elevation, an iterative process is used to determine tailwater elevation. For the iterative process TW is assumed (red text column in Attachment 27), Q_{total} is calculated (using Q_t calculated from $TW_{assumed}$), and $TW_{calculated}$ is calculated. Iteration is accomplished by varying $TW_{assumed}$ until the difference between $TW_{assumed}$ and $TW_{calculated}$ is equal to 0, within convergence tolerances. The convergence tolerance was set to $1*10^{-6}$. The average difference for converged solutions is $1*10^{-7}$ feet (Attachment 27).

Discharge through the low level outlet, Q_{ll}, is calculated from the headwater elevation in the fourth column. Discharge is calculated from Equation (5).

Discharge through the main spillway is computed in the ninth column. H_c, H_c/H_o, H_m and $C_f|C_g$ are the parameters used to determine the spillway discharge, $Q_f|Q_g$. Free discharge occurs for elevations below 1698.96 feet [4.3.4] and orifice discharge occurs for headwaters above this elevation. The transition point is indicated by a horizontal line. Above the transition line, the listed discharge coefficient is C_f [4.2.3] and below the transition line the listed discharge coefficient is C_g [4.3.5]. Column $Q_f|Q_g$ is the spillway discharge computed from Equation (1) for free discharge and from Equation (2) for orifice discharge.

Discharge through the auxiliary spillway is computed in the twelfth column. H_{cup} is the parameter used to determine the spillway discharge, Q_{faux}. Free discharge occurs for all elevations relevant to this calculation as the auxiliary crest is an uncontrolled spillway crest. Column Q_{faux} is the spillway discharge computed from Equation (1).

The column following the spillway discharge columns shows "C_f=", "Z_c=", and "L=" in three rows to indicate the meaning of the values included in those rows in the "Overflow Discharge" columns.

The next column is overflow discharges in cfs for overflow of the main spillway bridge. The overflow discharge coefficient C_f ([4.5.1]), elevation Z_c ([4.5.2]), and length L ([4.5.3]) are indicated in the three rows above the computed discharges. Overflow discharge is computed using Equation (1).

Turbine discharge in cfs is computed by Equation (3) in the final column.

Case 2

Discharge passes through the low level outlet and the main and auxiliary spillways when headwater elevation is greater than the appropriate crest elevations. At the highest headwater elevations in this calculation, discharge may also pass over the bridge above the main spillway. Total discharge, given in "1000 cfs", is the sum of all discharges in cfs past the dam divided by 1000.

Figure 2a shows the spreadsheet calculations for the headwater rating curve (spreadsheet included as Attachment 15). The final result, the rating curve, is defined by the first two columns, HW vs. Total Discharge. The third column (TW) gives the tailwater elevation associated with the "Total Discharge" from the tailwater rating curve polynomial fit [4.10]. Results indicate that tailwater never reaches the crest elevations in order to influence flow from the main and auxiliary spillways.

Discharge through the low level outlet, Q_{ll}, is calculated from the headwater elevation in the fourth column. Discharge is calculated from Equation (5).

Discharge through the main spillway is computed in the ninth column. H_c, H_c/H_o, H_m and $C_f|C_g$ are the parameters used to determine the spillway discharge, $Q_f|Q_g$. Free discharge occurs for elevations below 1698.96 feet [4.3.4] and orifice discharge occurs for headwaters above this elevation. The transition point is indicated by a horizontal line. Above the transition line, the listed discharge coefficient is C_f [4.2.3] and below the transition line the listed discharge coefficient is C_g [4.3.5]. Column $Q_f|Q_g$ is the spillway discharge computed from Equation (1) for free discharge and from Equation (2) for orifice discharge.

Discharge through the auxiliary spillway is computed in the twelfth column. H_{cup} is the parameter used to determine the spillway discharge, Q_{faux}. Free discharge occurs for all elevations relevant to this calculation as the auxiliary crest is an uncontrolled spillway crest. Column Q_{faux} is the spillway discharge computed from Equation (1).

The column following the spillway discharge columns shows "C_f=", "Z_c=", and "L=" in three rows to indicate the meaning of the values included in those rows in the "Overflow Discharge" columns.

The next column is overflow discharges in cfs for overflow of the main spillway bridge. The overflow discharge coefficient C_f ([4.5.1]), elevation Z_c ([4.5.2]), and length L ([4.5.3]) are indicated in the three rows above the computed discharges. Overflow discharge is computed using Equation (1).

7. Results/Conclusions

For convenience, the headwater rating results, separate from the calculation details provided above, are tabulated as total discharge in cfs vs. headwater elevation in feet in Figure 3. The headwater rating curve is plotted in Figure 4.

The headwater rating curve developed in this calculation provides Blue Ridge total dam discharge vs. headwater elevation for use in TVA's SOCH and TRBROUTE models for simulation conditions satisfying the assumptions in Section 3. In particular, all of the spillway gates must all be fully raised, and the maximum sustainable discharge must be passing through the turbine (in Case 1 only) and low level outlet.

As discussed in Section 5.0, the dam rating curves provided in Figures 2, 2a, 3 and 4 are limited in applicability to headwater elevations no greater than 1707.0 feet.

Blue Ridge - Dam Rating Curve, Case 1

g = 32.2 ft/s²

Spillway Parameters: L = 176 ft; Z_c = 1675 ft; G = 19.195 ft; H_o = 34 ft

Aux Spill Parameters: L_{aux} = 280 ft; Z_{caux} = 1691 ft

Spillway Bridge Overflow: C_f = 2.65; Z_c = 1710; L = 200

Turbine Discharge Units 1&2 100% Open

HW feet	Q Total Discharge 1000 cfs	TW feet	Low Level Outlet cfs Q_{ll}	Main Spillway ft H_c	H_c/H_o	ft H_m	ft C_f | C_g	cfs Q_f | Q_g	ft H_{cup}	Aux Spillway C_{faux}	cfs Q_{faux}	Spillway Bridge Overflow	Gross Head ft	Qt cfs
1675	**3.61**	1548.2	1771	0.00	0.00		2.92	0	0	2.687	0	0	126.8	1838
1676	**4.15**	1548.5	1779	1.00	0.03		3.00	528	0	2.687	0	0	127.5	1844
1677	**5.16**	1549.0	1787	2.00	0.06		3.07	1528	0	2.687	0	0	128.0	1848
1678	**6.51**	1549.7	1795	3.00	0.09		3.14	2868	0	2.687	0	0	128.3	1851
1679	**8.15**	1550.6	1803	4.00	0.12		3.19	4499	0	2.687	0	0	128.4	1852
1680	**10.05**	1551.6	1811	5.00	0.15		3.25	6389	0	2.687	0	0	128.4	1852
1681	**12.19**	1552.6	1819	6.00	0.18		3.29	8514	0	2.687	0	0	128.4	1852
1682	**14.53**	1553.8	1827	7.00	0.21		3.33	10853	0	2.687	0	0	128.2	1851
1683	**17.07**	1555.0	1835	8.00	0.24		3.36	13382	0	2.687	0	0	128.0	1849
1684	**19.77**	1556.2	1842	9.00	0.26		3.38	16081	0	2.687	0	0	127.8	1847
1685	**22.62**	1557.5	1850	10.00	0.29		3.40	18929	0	2.687	0	0	127.5	1845
1686	**25.60**	1558.7	1858	11.00	0.32		3.41	21901	0	2.687	0	0	127.3	1842
1687	**26.84**	1559.3	1865	12.00	0.35		3.41	24975	0	2.687	0	0		
1688	**30.38**	1560.7	1873	13.00	0.38		3.46	28504	0	2.687	0	0		
1689	**33.93**	1562.1	1881	14.00	0.41		3.48	32051	0	2.687	0	0		
1690	**37.65**	1563.4	1888	15.00	0.44		3.50	35764	0	2.687	0	0		
1691	**41.53**	1564.8	1895	16.00	0.47		3.52	39639	0	2.687	0	0		
1692	**46.34**	1566.4	1903	17.00	0.50		3.54	43676	1	2.727	764	0		
1693	**51.97**	1568.2	1910	18.00	0.53		3.56	47873	2	2.766	2191	0		
1694	**58.23**	1570.0	1918	19.00	0.56		3.58	52227	3	2.804	4080	0		
1695	**65.03**	1571.7	1925	20.00	0.59		3.60	56740	4	2.842	6365	0		
1696	**72.35**	1573.5	1932	21.00	0.62		3.63	61409	5	2.878	9009	0		
1697	**80.16**	1575.2	1939	22.00	0.65		3.65	66235	6	2.913	11987	0		
1698	**88.44**	1576.7	1946	23.00	0.68		3.67	71215	7	2.947	15282	0		
1698.96	**97.34**	1578.3	1953	23.96	0.70	14.363	0.7461	76655	7.96	2.979	18731	0		
1700	**100.48**	1578.7	1960	25.00	0.74	15.403	0.7119	75746	9	3.012	22773	0		
1701	**104.73**	1579.4	1967	26.00	0.76	16.403	0.6905	75813	10	3.043	26948	0		
1702	**110.30**	1580.2	1974	27.00	0.79	17.403	0.6802	76933	11	3.074	31397	0		
1703	**117.10**	1581.1	1981	28.00	0.82	18.403	0.6793	79003	12	3.103	36114	0		
1704	**124.20**	1581.9	1988	29.00	0.85	19.403	0.6793	81121	13	3.131	41091	0		
1705	**131.50**	1582.8	1995	30.00	0.88	20.403	0.6793	83185	14	3.158	46321	0		
1706	**139.00**	1583.6	2001	31.00	0.91	21.403	0.6793	85200	15	3.184	51797	0		
1707	**146.69**	1584.4	2008	32.00	0.94	22.403	0.6793	87167	16	3.209	57514	0		
1708	**154.57**	1585.3	2015	33.00	0.97	23.403	0.6793	89092	17	3.234	63464	0		
1709	**162.64**	1586.2	2021	34.00	1.00	24.403	0.6793	90975	18	3.257	69641	0		
1710	**170.89**	1587.1	2028	35.00	1.03	25.403	0.6793	92820	19	3.279	76039	0		
1711	**179.85**	1588.2	2034	36.00	1.06	26.403	0.6793	94630	20	3.300	82652	530		
1712	**189.42**	1589.5	2041	37.00	1.09	27.403	0.6793	96405	21	3.320	89472	1499		
1713	**199.44**	1591.0	2047	38.00	1.12	28.403	0.6793	98148	22	3.340	96493	2754		

Figure 2 – Calculations for Headwater Rating Curve, Case 1

Blue Ridge - Dam Rating Curve, Case 2

g = 32.2 ft/s^2

Spillway Parameters: L = 176 ft; Z_c = 1675 ft; G = 19.195 ft; H_o = 34 ft

Aux Spill Parameters: L_{aux} = 280 ft; Z_{caux} = 1691 ft

Spillway Bridge Overflow: C_f = 2.65; Z_c = 1710; L = 200

HW feet	Q Total Discharge 1000 cfs	TW feet	Low Level Outlet cfs Q_{ll}	H_c ft	H_c/H_o	Spillway ft H_m	ft C_f | C_g	cfs Q_f | Q_g	ft H_{cup}	C_{faux}	cfs Q_{faux}	Spillway Bridge Overflow
1675	**1.77**	1547.2	1771	0.00	0.00		2.92	0	0	2.687	0	0
1676	**2.31**	1547.5	1779	1.00	0.03		3.00	528	0	2.687	0	0
1677	**3.32**	1548.0	1787	2.00	0.06		3.07	1528	0	2.687	0	0
1678	**4.66**	1548.8	1795	3.00	0.09		3.14	2868	0	2.687	0	0
1679	**6.30**	1549.6	1803	4.00	0.12		3.19	4499	0	2.687	0	0
1680	**8.20**	1550.6	1811	5.00	0.15		3.25	6389	0	2.687	0	0
1681	**10.33**	1551.7	1819	6.00	0.18		3.29	8514	0	2.687	0	0
1682	**12.68**	1552.9	1827	7.00	0.21		3.33	10853	0	2.687	0	0
1683	**15.22**	1554.1	1835	8.00	0.24		3.36	13382	0	2.687	0	0
1684	**17.92**	1555.4	1842	9.00	0.26		3.38	16081	0	2.687	0	0
1685	**20.78**	1556.7	1850	10.00	0.29		3.40	18929	0	2.687	0	0
1686	**23.76**	1558.0	1858	11.00	0.32		3.41	21901	0	2.687	0	0
1687	**26.84**	1559.3	1865	12.00	0.35		3.41	24975	0	2.687	0	0
1688	**30.38**	1560.7	1873	13.00	0.38		3.46	28504	0	2.687	0	0
1689	**33.93**	1562.1	1881	14.00	0.41		3.48	32051	0	2.687	0	0
1690	**37.65**	1563.4	1888	15.00	0.44		3.50	35764	0	2.687	0	0
1691	**41.53**	1564.8	1895	16.00	0.47		3.52	39639	0	2.687	0	0
1692	**46.34**	1566.4	1903	17.00	0.50		3.54	43676	1	2.727	764	0
1693	**51.97**	1568.2	1910	18.00	0.53		3.56	47873	2	2.766	2191	0
1694	**58.23**	1570.0	1918	19.00	0.56		3.58	52227	3	2.804	4080	0
1695	**65.03**	1571.7	1925	20.00	0.59		3.60	56740	4	2.842	6365	0
1696	**72.35**	1573.5	1932	21.00	0.62		3.63	61409	5	2.878	9009	0
1697	**80.16**	1575.2	1939	22.00	0.65		3.65	66235	6	2.913	11987	0
1698	**88.44**	1576.7	1946	23.00	0.68		3.67	71215	7	2.947	15282	0
1698.96	**97.34**	1578.3	1953	23.96	0.70	14.363	0.7461	76655	7.96	2.979	18731	0
1700	**100.48**	1578.7	1960	25.00	0.74	15.403	0.7119	75746	9	3.012	22773	0
1701	**104.73**	1579.4	1967	26.00	0.76	16.403	0.6905	75813	10	3.043	26948	0
1702	**110.30**	1580.2	1974	27.00	0.79	17.403	0.6802	76933	11	3.074	31397	0
1703	**117.10**	1581.1	1981	28.00	0.82	18.403	0.6793	79003	12	3.103	36114	0
1704	**124.20**	1581.9	1988	29.00	0.85	19.403	0.6793	81121	13	3.131	41091	0
1705	**131.50**	1582.8	1995	30.00	0.88	20.403	0.6793	83185	14	3.158	46321	0
1706	**139.00**	1583.6	2001	31.00	0.91	21.403	0.6793	85200	15	3.184	51797	0
1707	**146.69**	1584.4	2008	32.00	0.94	22.403	0.6793	87167	16	3.209	57514	0
1708	**154.57**	1585.3	2015	33.00	0.97	23.403	0.6793	89092	17	3.234	63464	0
1709	**162.64**	1586.2	2021	34.00	1.00	24.403	0.6793	90975	18	3.257	69641	0
1710	**170.89**	1587.1	2028	35.00	1.03	25.403	0.6793	92820	19	3.279	76039	0
1711	**179.85**	1588.2	2034	36.00	1.06	26.403	0.6793	94630	20	3.300	82652	530
1712	**189.42**	1589.5	2041	37.00	1.09	27.403	0.6793	96405	21	3.320	89472	1499
1713	**199.44**	1591.0	2047	38.00	1.12	28.403	0.6793	98148	22	3.340	96493	2754

Figure 2a – Calculations for Headwater Rating Curve, Case 2

Blue Ridge Headwater Curve

2008 Rating Case 1 HW feet	2008 Rating Case 1 Total Discharge 1000 cfs	2008 Rating Case 2 HW feet	2008 Rating Case 2 Total Discharge 1000 cfs
1675	3.61	1675	1.77
1676	4.15	1676	2.31
1677	5.16	1677	3.32
1678	6.51	1678	4.66
1679	8.15	1679	6.30
1680	10.05	1680	8.20
1681	12.19	1681	10.33
1682	14.53	1682	12.68
1683	17.07	1683	15.22
1684	19.77	1684	17.92
1685	22.62	1685	20.78
1686	25.60	1686	23.76
1687	26.84	1687	26.84
1688	30.38	1688	30.38
1689	33.93	1689	33.93
1690	37.65	1690	37.65
1691	41.53	1691	41.53
1692	46.34	1692	46.34
1693	51.97	1693	51.97
1694	58.23	1694	58.23
1695	65.03	1695	65.03
1696	72.35	1696	72.35
1697	80.16	1697	80.16
1698	88.44	1698	88.44
1698.96	97.34	1698.96	97.34
1700	100.48	1700	100.48
1701	104.73	1701	104.73
1702	110.30	1702	110.30
1703	117.10	1703	117.10
1704	124.20	1704	124.20
1705	131.50	1705	131.50
1706	139.00	1706	139.00
1707	146.69	1707	146.69
1708	154.57	1708	154.57
1709	162.64	1709	162.64
1710	170.89	1710	170.89
1711	179.85	1711	179.85
1712	189.42	1712	189.42
1713	199.44	1713	199.44

Figure 3 – Headwater Rating Results

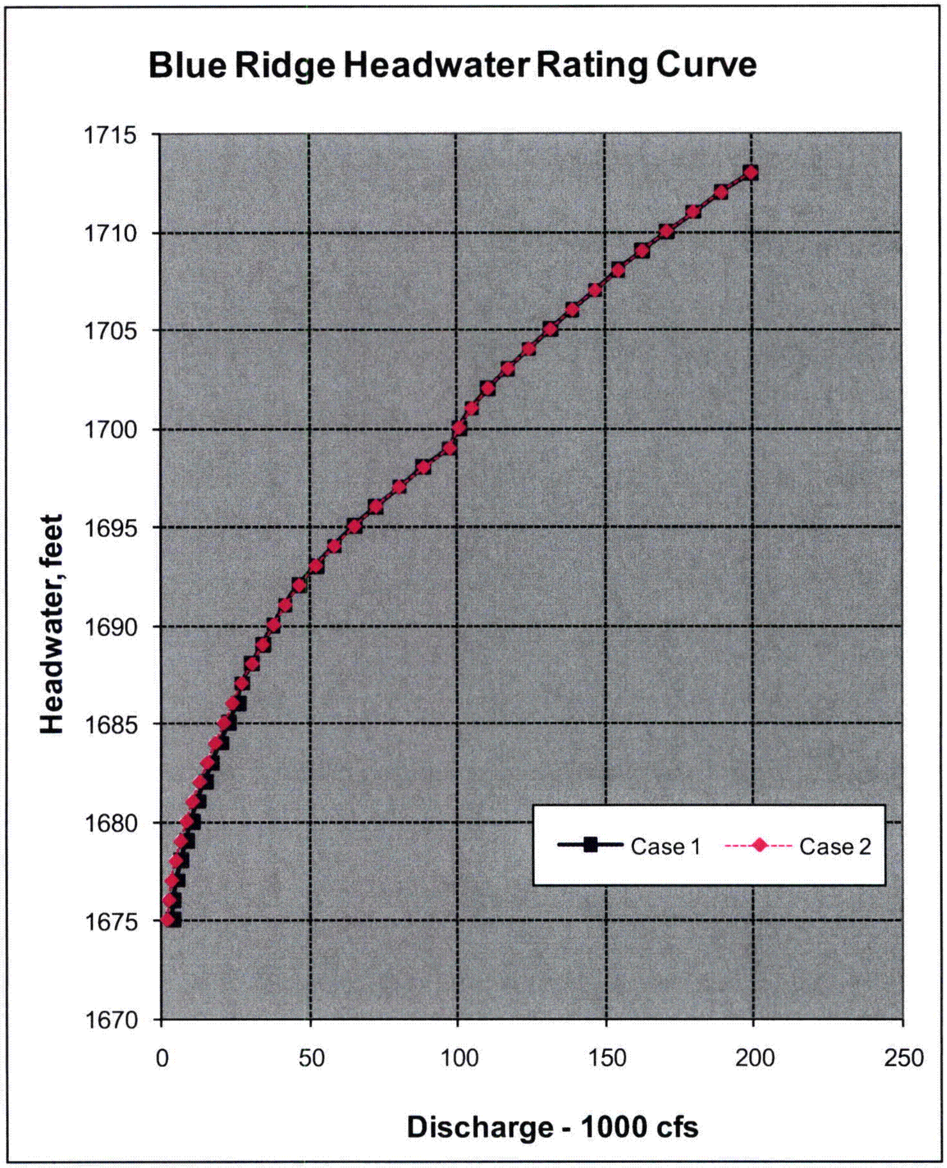
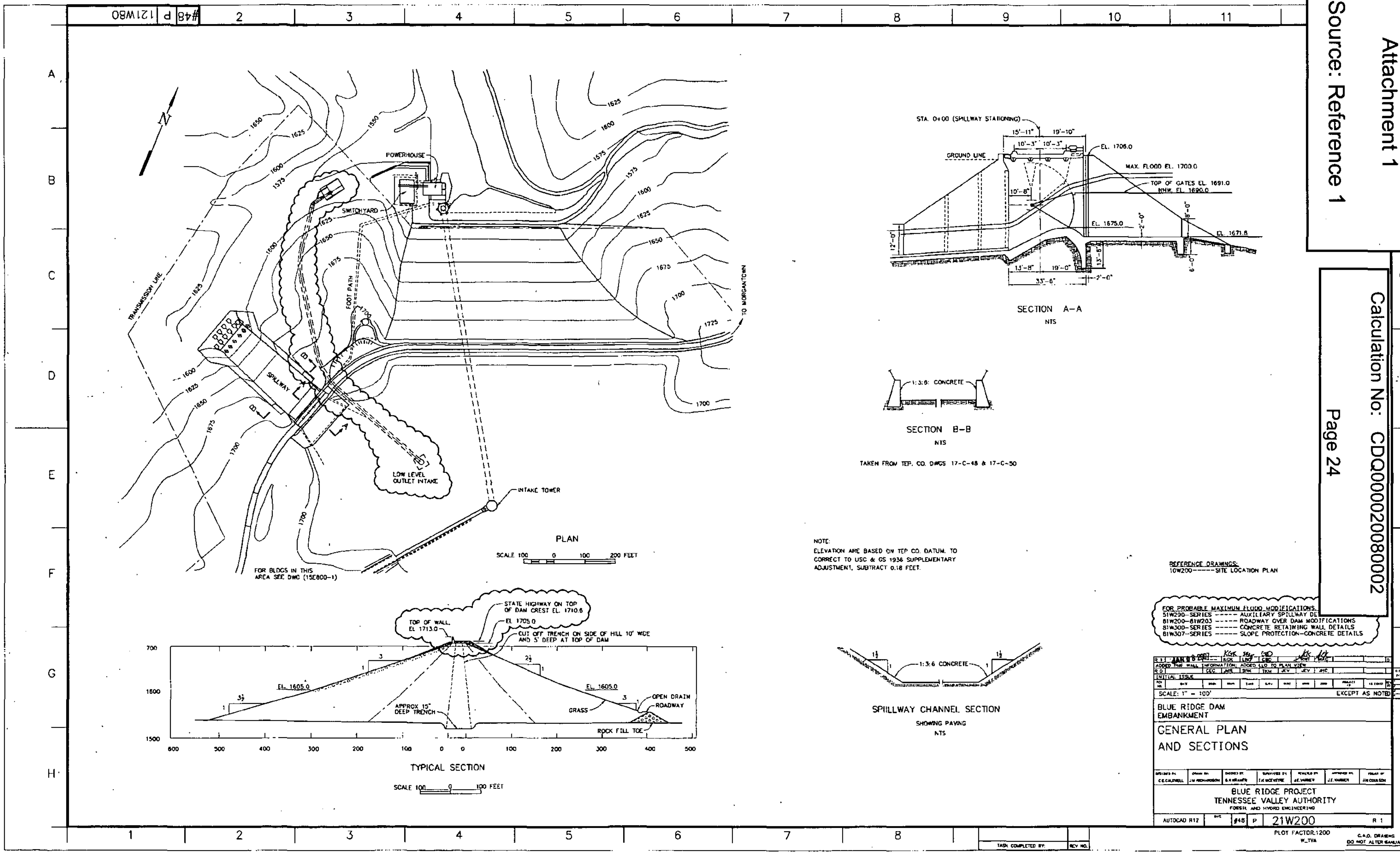


Figure 4 – Headwater Rating Curves

Attachment 1
Source: Reference 1

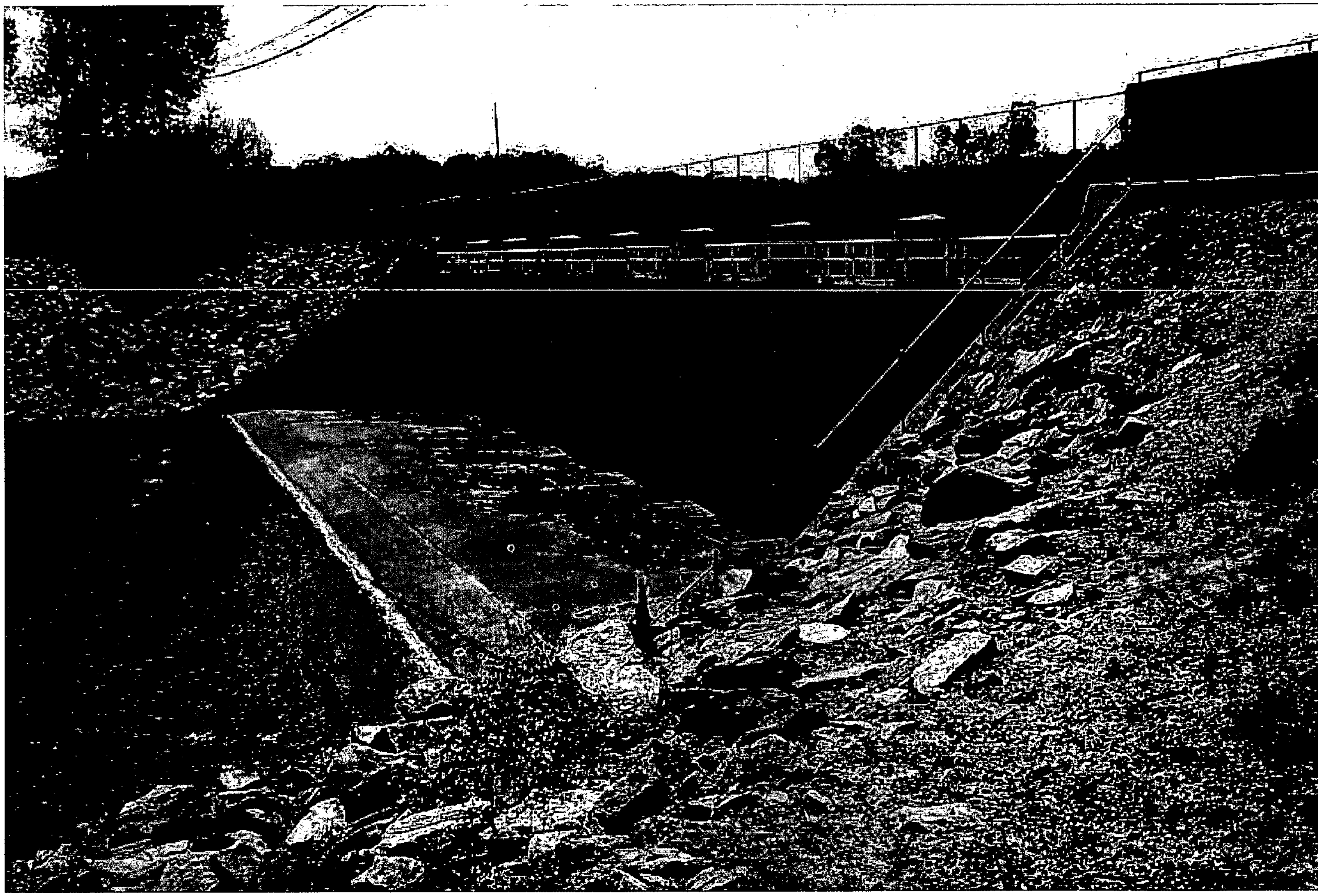
Calculation No: CDQ000020080002
Page 24



Attachment 2
Source: Reference 2

Figure 6

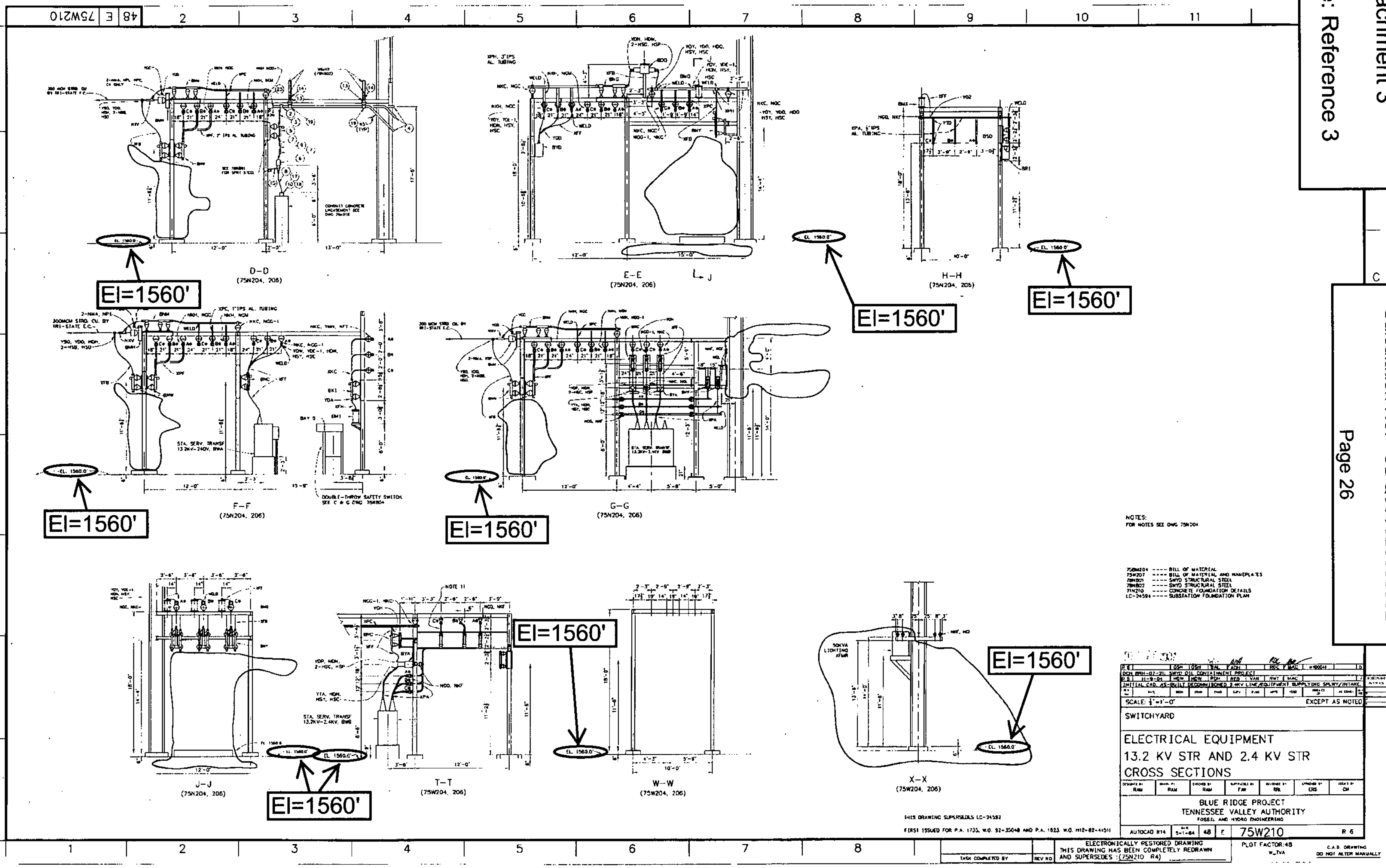
Blue Ridge Spillway



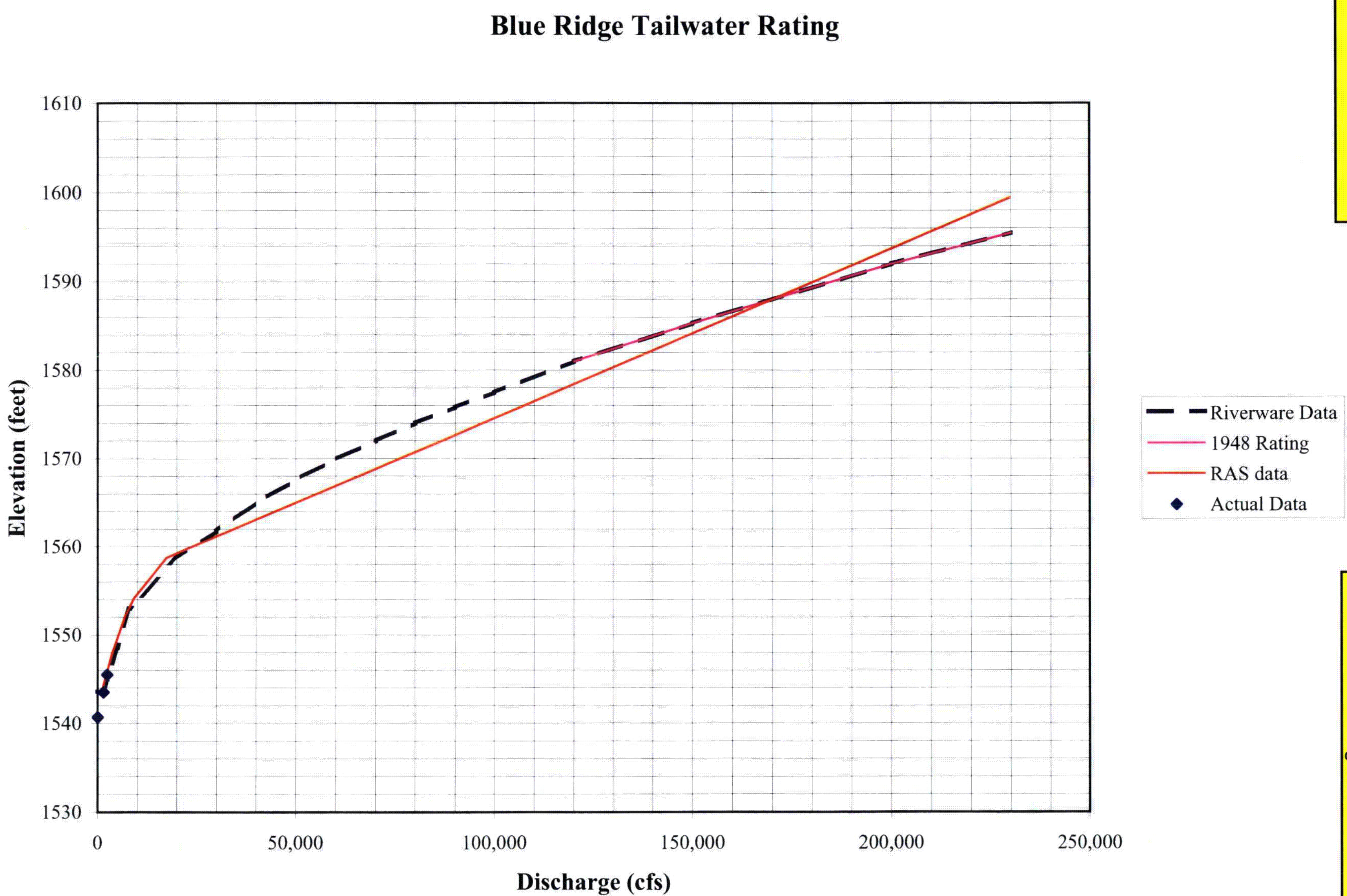
Calculation No: CDQ0000200800002
Page 25

Attachment 3
Source: Reference 3

Calculation No. CDQ000020080002
Page 26



Attachment 4-1
Source: Reference 4



Calculation No. CDQ0000020080002
Page 27

Attachment 4-2
Source: Reference 4

Blue Ridge Tailwater Rating

Riverware Rating

Q*1000	Q	Elevation
0	0	1543.6
1.48	1,480	1543.6
2.5	2,500	1545
5	5,000	1548.5
8	8,000	1553
10	10,000	1554
20	20,000	1558.7
30	30,000	1561.8
40	40,000	1565
50	50,000	1567.6
60	60,000	1569.9
70	70,000	1572
80	80,000	1574
90	90,000	1575.8
100	100,000	1577.5
120	120,000	1581
150	150,000	1585.3
200	200,000	1592
230	230,000	1595.5

Actual Data

Q	Elevation
133	1540.7
1610	1543.5
2505	1545.5

Flood Control Section
10/1948

Dicharge	**Elevation**
120,000	1581
150,000	1585.3
200,000	1592
229,800	1595.45
230,000	1595.5

RAS data

Q	Elevation
1500	1544.14
1880	1544.86
3690	1547.85
7050	1552.2
9290	1554.18
17500	1558.74
229800	1599.45

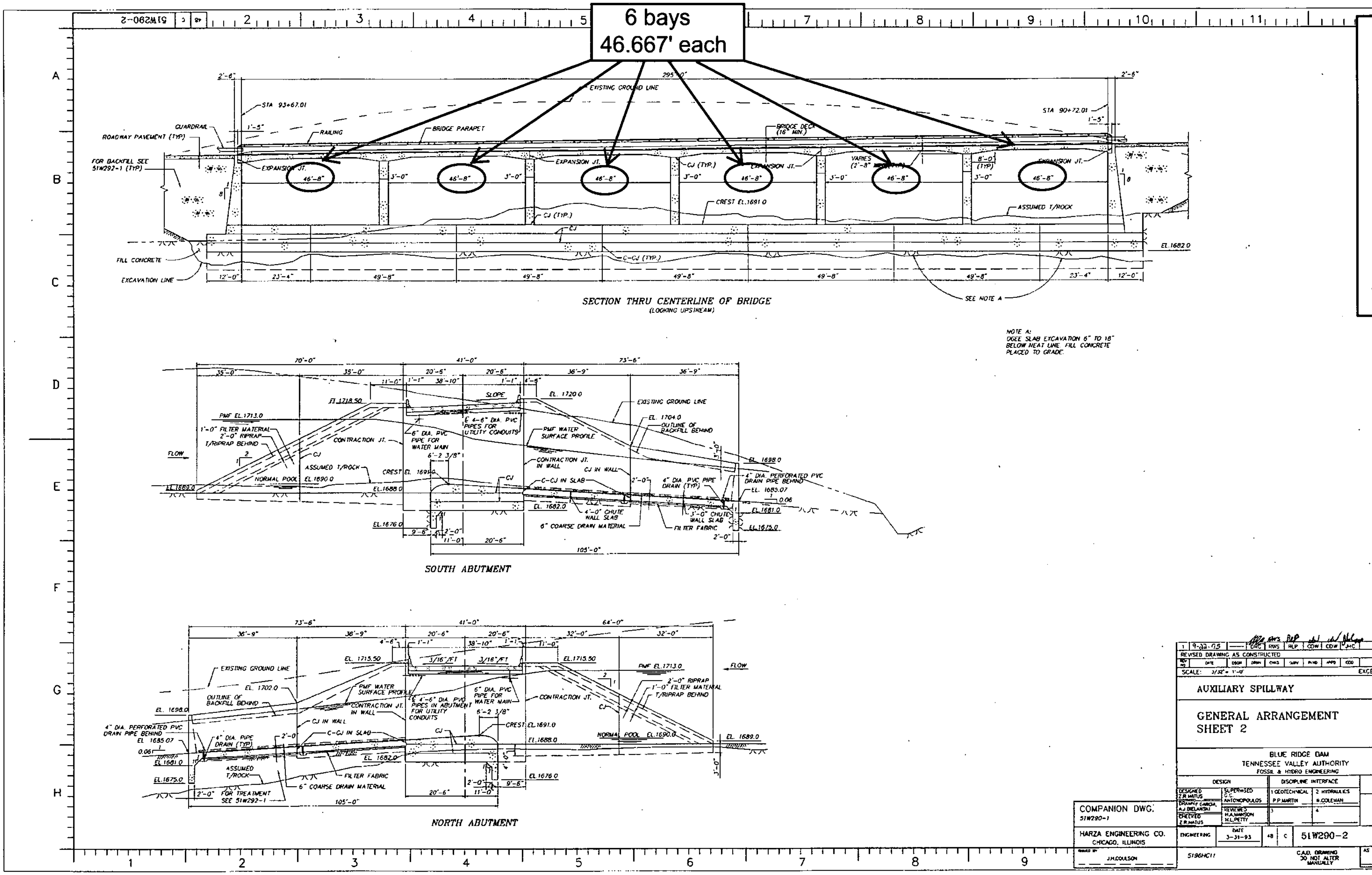
BLUE RIDGE DAM LOW LEVEL OUTLET

COMBINED DISCHARGE, BOTH VALVES 95 PERCENT OPEN

IN CUBIC FEET PER SECOND

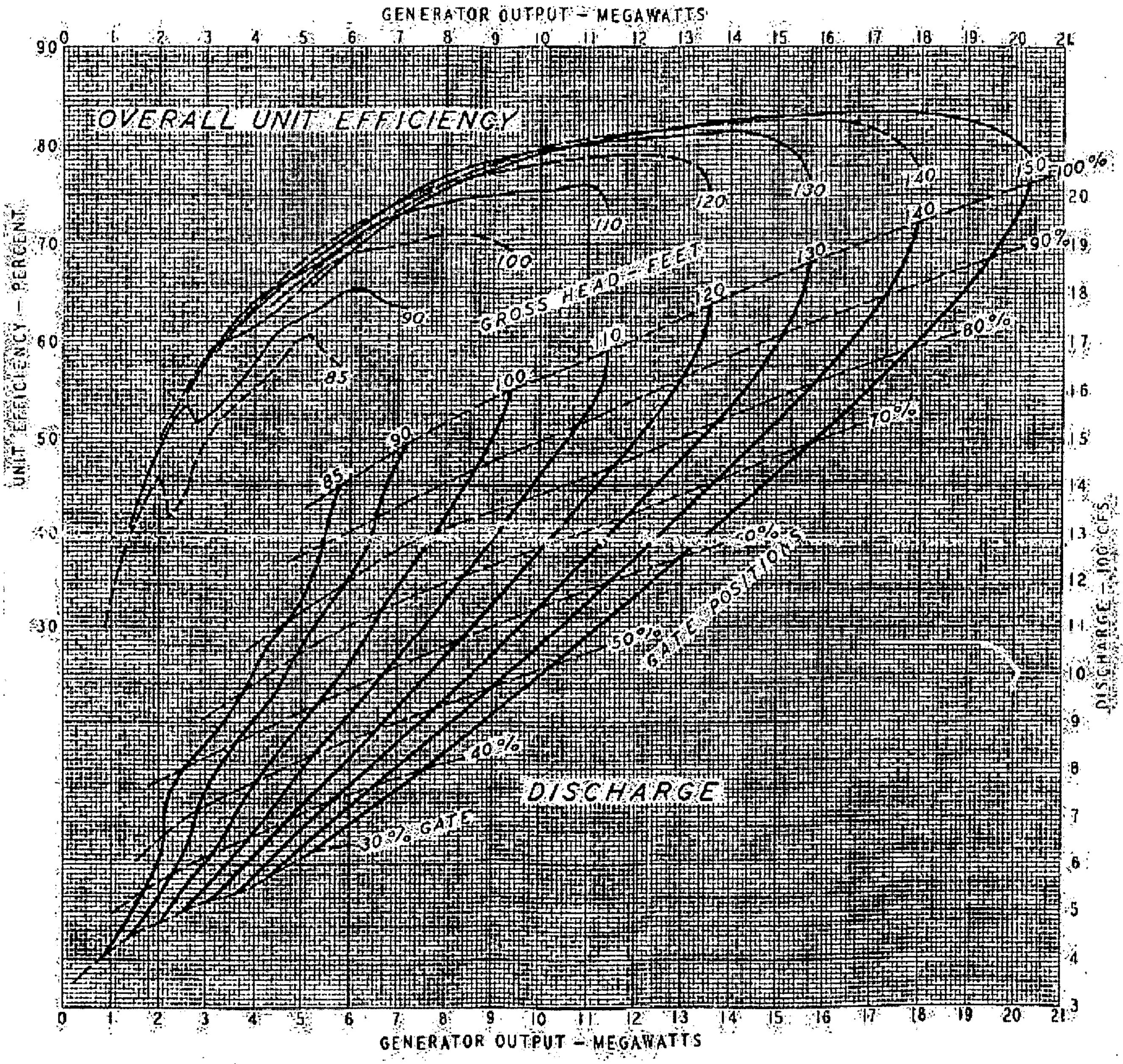
HEADWATER ELEVATION																
1620	1625	1630	1635	1640	1645	1650	1655	1660	1665	1670	1675	1680	1685	1690	1695	1700
1,250	1,300	1,360	1,410	1,460	1,510	1,560	1,600	1,650	1,690	1,730	1,770	1,810	1,850	1,890	1,930	1,970

Attachment 6
Source: Reference 8



Calculation No: CDQ000020080002
Page 30

Attachment 7
Source: Reference 2



NOTE: These curves are based on field test data taken at headwater elevations of 1687, 1672, 1657, 1649.5, 1635, and 1625.5.

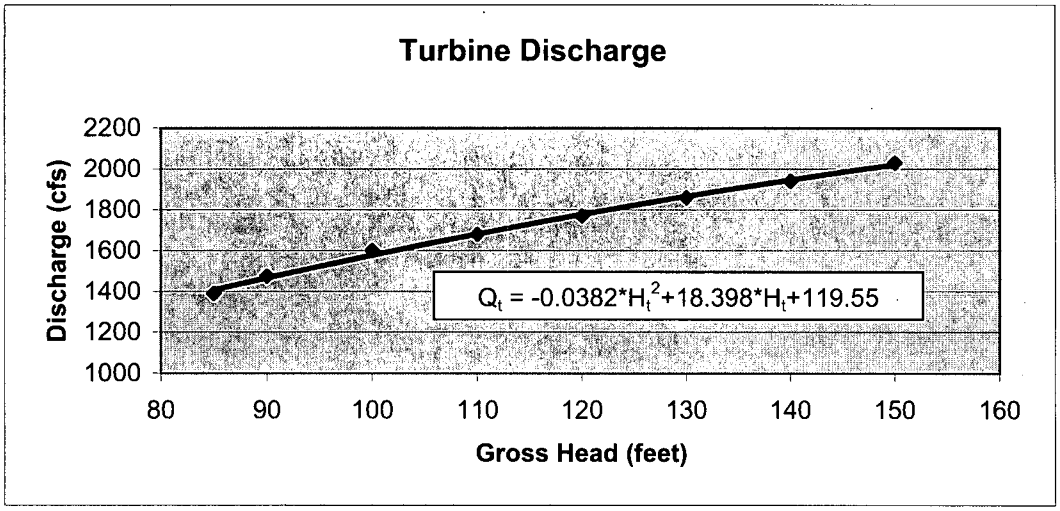
Discharges were obtained from current meter measurements made in the river below the plant by the U.S. Geological Survey. These were correlated with readings of the Winter – Kennedy scroll case piezometer taps at each five percent gate opening between 30 and 100 percent.

HYDRO GENERATING UNIT
OPERATING CHARACTERISTIC CURVES
BLUE RIDGE PROJECT TENNESSEE VALLEY AUTHORITY DIVISION OF WATER CONTROL PLANNING ENGINEERING LABORATORY
NORRIS 4-28-66 B100

Calculation No: CDQ000020080002
Page 31

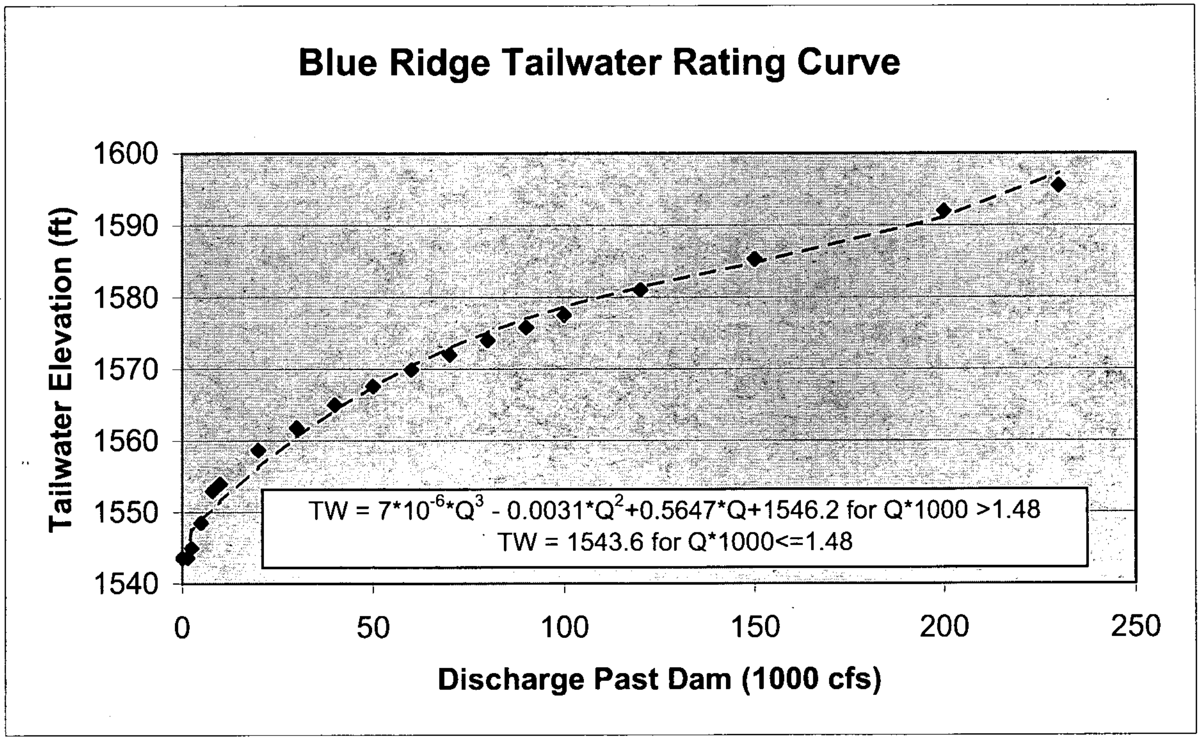
Blue Ridge Turbine Discharge
From Drawing B100
Gates 100% Open

Gross Head feet	Discharge cfs	fit to Discharge cfs
85	1390	1407
90	1475	1466
100	1600	1577
110	1680	1681
120	1770	1777
130	1860	1866
140	1940	1947
150	2030	2020



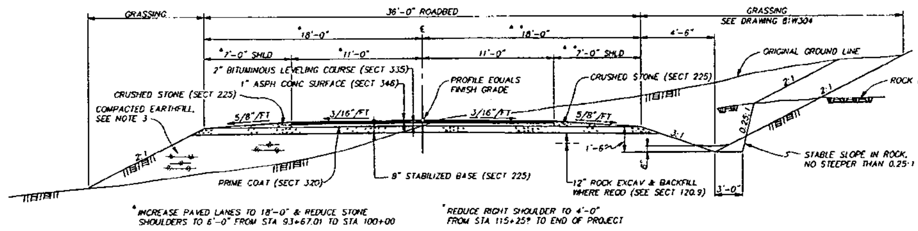
Electronic version available in Attachment 15

Q/1000	Elevation	fit to data Elevation
1000 cfs	ft	ft
0	1543.6	1543.6
1.48	1543.6	1543.6
2.5	1545	1547.592
5	1548.5	1548.947
8	1553	1550.523
10	1554	1551.544
20	1558.7	1556.31
30	1561.8	1560.54
40	1565	1564.276
50	1567.6	1567.56
60	1569.9	1570.434
70	1572	1572.94
80	1574	1575.12
90	1575.8	1577.016
100	1577.5	1578.67
120	1581	1581.42
150	1585.3	1584.78
200	1592	1591.14
230	1595.5	1597.26

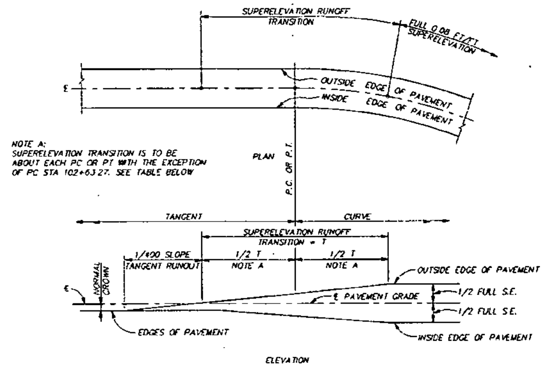


Electronic version available in Attachment 15

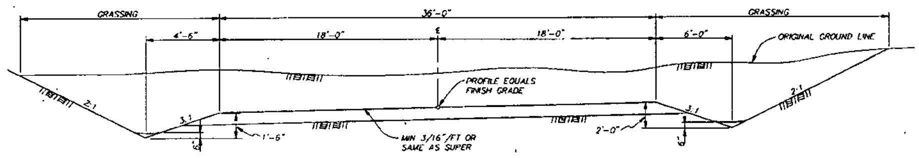
Attachment 10
Source: Reference 11



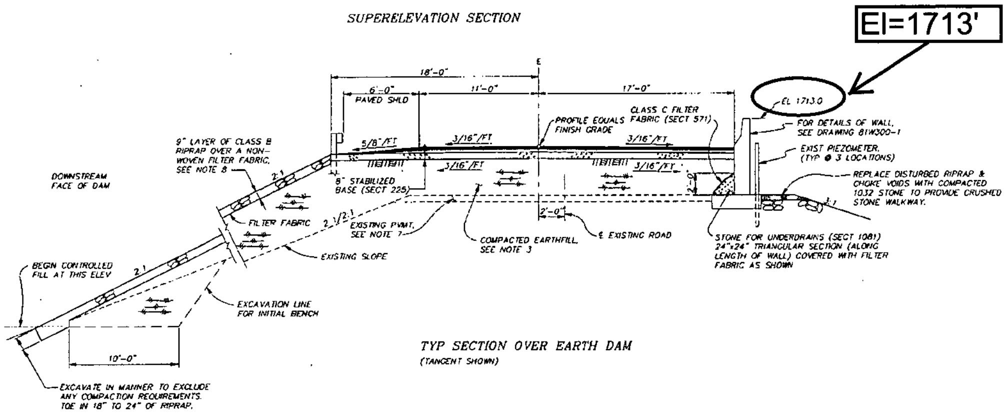
TANGENT SECTION



TYP SUPERELEVATION TRANSITION



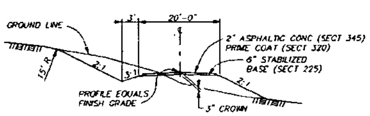
SUPERELEVATION SECTION



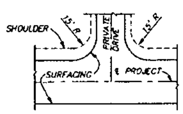
TYP SECTION OVER EARTH DAM
(TANGENT SHOWN)

SUPERELEVATION TABLE			
DESCRIPTION	STATION	LENGTH OF RUNOFF (FT)	(e) MAX FT/FT
BEGIN TANGENT RUNOUT	84+03.22		
BEGIN TRANSITION	84+80.00		
		160	
END TRANSITION	86+39.00		
BEGIN MAX (e)			0.08
END MAX (e)	89+92.01		
BEGIN TRANSITION			
		160	
END TRANSITION	91+52.01		
END TANGENT RUNOUT	92+64.33		
BEGIN TANGENT RUNOUT	102+11.76		
BEGIN TRANSITION	102+79.76		
		160	
END TRANSITION	104+39.76		
BEGIN MAX (e)			0.08
END MAX (e)	104+81.46		
BEGIN TRANSITION			
END TRANSITION	106+41.46		
END TANGENT RUNOUT	107+09.46		
BEGIN TANGENT RUNOUT	112+45.89		
BEGIN TRANSITION	113+13.89		
		160	
END TRANSITION	114+73.89		
BEGIN MAX (e)			0.08
END MAX (e)	115+42.79		
BEGIN TRANSITION			
		160	
END TRANSITION	117+02.79		
END TANGENT RUNOUT	117+70.79		

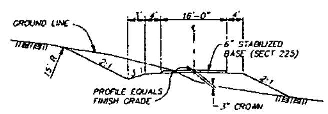
NOTES:
1. ALL WORK SHALL BE DONE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATION NO. T-1 UNLESS OTHERWISE NOTED. ALL SECTION NUMBERS REFER DIRECTLY TO THE T-1 SPECIFICATION
2. FOUNDATION PREPARATION FOR ALL EMBANKMENTS SHALL CONSIST OF REMOVING ORGANIC TOPSOIL TO A DEPTH THAT WILL REMOVE ALL ROOTS, AND EXCAVATION SHALL CONTINUE TO A DEPTH THAT WILL OBTAIN A FOUNDATION THAT WILL SUPPORT EARTHMOVING EQUIPMENT WITHOUT RUTTING INTO THE GROUND AND HEAVING THE GROUND SO AS TO REDUCE ITS STABILITY.
3. EARTHFILL SHALL BE CONSTRUCTED IN 8-INCH THICK LAYERS IN ACCORDANCE WITH SECTION 120. EACH LAYER SHALL BE COMPACTED TO AT LEAST 95% OF MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698. MOISTURE CONTENT SHALL BE BETWEEN 3% BELOW AND 3% ABOVE OPTIMUM MOISTURE CONTENT. IN-PLACE DENSITY TESTS USING THE SAND CONE (ASTM D1556) OR RUBBER BALLOON (ASTM D2167) TEST METHODS SHALL BE CONDUCTED AT A RATE OF AT LEAST ONE TEST PER EACH 2000 CY OF EARTHFILL PLACED OR A MINIMUM OF ONE PER DAY THAT FILL IS PLACED. IF NUCLEAR DENSITY METHODS ARE USED (ASTM D2922), SUFFICIENT NUMBERS OF THE SAND CONE OR RUBBER BALLOON TESTS WILL BE REQUIRED TO CORRELATE AND VERIFY THE NUCLEAR GAUGE RESULTS.
4. EARTH BORROW IS TO BE OBTAINED FROM THE DESIGNATED BORROW AREA OR FROM AN OFFSITE BORROW PIT APPROVED BY THE ENGINEER.
5. CLEARING AND GRUBBING SHALL BE IN ACCORDANCE WITH SECTION 101.
6. PROFILE GRADE REPRESENTS FINISHED GRADE ELEVATION ON CENTERLINE ALIGNMENT.
7. THE EXISTING ASPHALT IN THIS AREA IS TO BE BROKEN UP, REMOVED AND BURIED IN THE SPOIL AREA.
8. TYPE B RIPRAP SHALL BE 9" THICK. A MINIMUM OF 50%, BY WEIGHT, OF STONES SHALL BE 25 POUNDS EACH AND IN ACCORDANCE WITH SECTION 575. FILTER FABRIC SHALL BE NON-WOVEN, CLASS C PER TVA T-1 SPECIFICATION, SECTION 571.
9. ALL ELEVATIONS ARE BASED ON TENNESSEE ELECTRIC POWER COMPANY DATUM. TENNESSEE ELECTRIC POWER COMPANY DATUM IS USC & GS + 0.18'.
10. COORDINATES ARE GEORGIA (WEST) STATE SYSTEM OF RECTANGULAR COORDINATES.
11. FOR DESIGN CALCULATIONS, SEE RIMS NO. B65 930323 002.



TYP SECTION
PRIVATE DRIVE



TYP PLAN
PRIVATE DRIVE



TYP SECTION
ACCESS RD TO WATER TREATMENT PLANT

1	9-22-95	REVISE DRAWING AS CONSTRUCTED

SCALE: NTS — EXCEPT AS

RELOCATED ROADWAY OVER DAM
DAM SAFETY MODIFICATIONS

TYPICAL SECTIONS
OLD US HWY 76

BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY

DESIGNED B.W. SHARP — SUPERVISED H.L. PETTY
DRAWN D.B. COLLINS — REVIEWED H.L. PETTY
CHECKED C.B. DODD — H.L. PETTY
DATE 3-31-93 — 46 C 81W200

ISSUED BY J.H. COULSON

CAD SYSTEM
DO NOT CHANGE

BR81W200

Calculation No: CDQ000020080002
Page 34

Attachment 11
Source: Reference 12

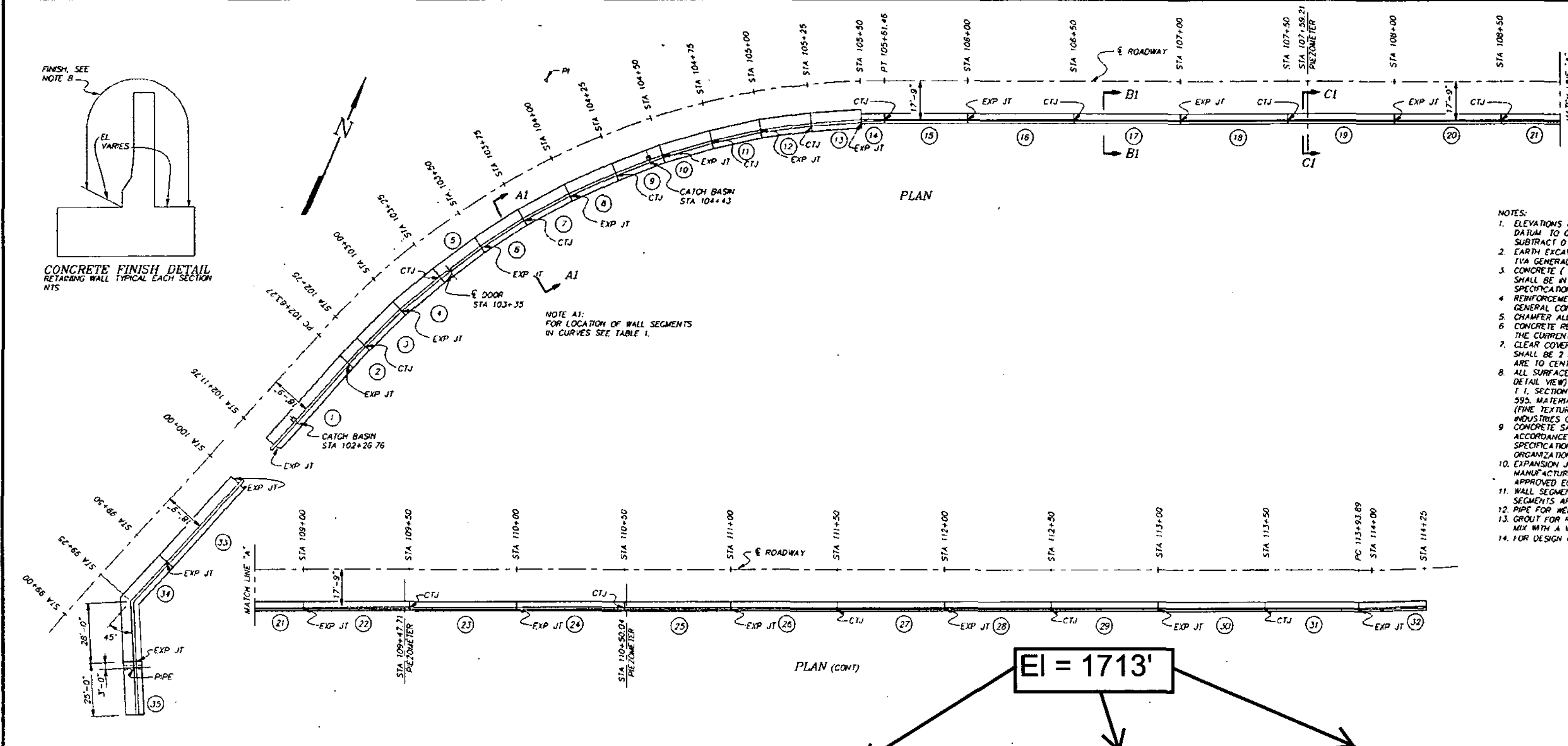
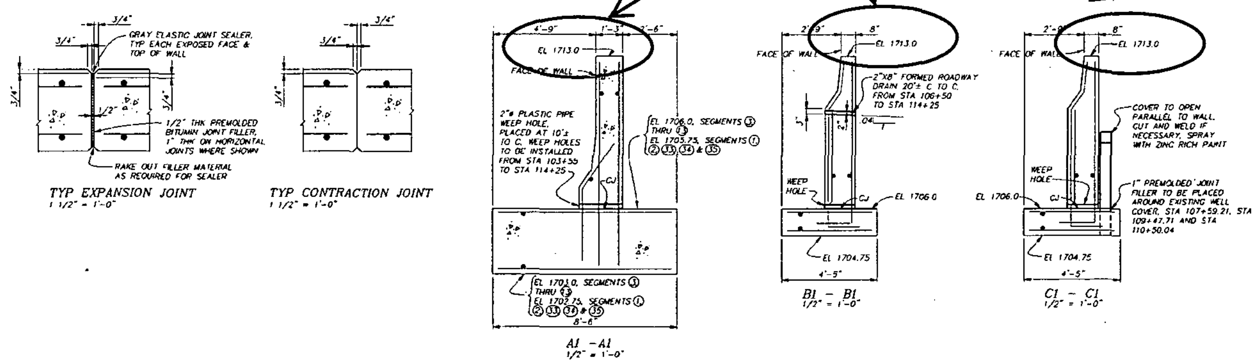


TABLE 1	
STATION	DISTANCE - ℄ ROAD TO FACE OF TOP OF WALL
102+11.76	18'-9"
102+63.27	18'-9"
102+75	18'-9"
103+00	18'-7 3/8"
103+25	18'-5 5/8"
103+50	18'-4"
103+75	18'-2 1/4"
104+00	18'-0 5/8"
104+25	17'-11"
104+50	17'-9"
104+75	17'-9"
105+00	17'-9"
105+25	17'-9"
105+50	17'-9"
105+61.46	17'-9"
113+93.89	17'-9"
114+25	17'-9"



NOTES:

1. ELEVATIONS ARE BASED ON TENNESSEE ELECTRIC PO[...] DATUM TO CORRECT TO USC & GS 1936 SUPPLEME[...] SUBTRACT 0.18 FEET.
2. EARTH EXCAVATION AND BACKFILL SHALL BE IN ACC[...] TVA GENERAL CONSTRUCTION SPECIFICATION T 1, SE[...]
3. CONCRETE (INCLUDING MATERIAL, FORMWORK, PLACEMENT AND CURING) SHALL BE IN ACCORDANCE WITH TVA GENERAL CONSTRUCTION SPECIFICATION T1, SECTION 400. CONCRETE SHALL BE CLASS X
4. REINFORCEMENT STEEL PLACEMENT SHALL BE IN ACCORDANCE WITH TVA GENERAL CONSTRUCTION SPECIFICATION T1, SECTION 425.
5. CHAMFER ALL EXPOSED EDGES 3/4 INCHES UNLESS OTHERWISE NOTED.
6. CONCRETE REINFORCMENT SHALL BE DEFORMED BILLET STEEL MEETING THE CURRENT REQUIREMENTS OF ASTM A 615, GRADE 60
7. CLEAR COVER FROM FACE OF CONCRETE TO NEAREST REINFORCING BAR SHALL BE 2 INCHES UNLESS OTHERWISE NOTED. ALL OTHER DIMENSIONS ARE TO CENTERLINE OF REINFORCING
8. ALL SURFACES EXPOSED TO PUBLIC ACCESS (SEE CONCRETE FINISH DETAIL VIEW) SHALL BE GIVEN A CLASS 1 ORDINARY SURFACE FINISH PER T 1, SECTION 400.27 AND AN APPLIED TEXTURE FINISH PER T1, SECTION 595. MATERIAL FOR TEXTURE FINISH SHALL BE ONE COAT OF TAMMSCOAT (FINE TEXTURE, COLOR-LIMESTONE) AS MANUFACTURED BY TAMMS INDUSTRIES CO., MENTOR, OH.
9. CONCRETE SAMPLING AND TESTING SHALL BE PERFORMED IN ACCORDANCE WITH THE REQUIREMENTS OF TVA GENERAL CONSTRUCTION SPECIFICATION T1, SECTION 400.10 BY AN INDEPENDANT TESTING ORGANIZATION CERTIFIED ACCORDING TO ASTM E 329.
10. EXPANSION JOINT SEALER SHALL BE DYNATROL 1, COLOR LIMESTONE, AS MANUFACTURED BY PECORA CORP., HARLEYVILLE, PA. OR AN APPROVED EQUAL.
11. WALL SEGMENTS DENOTED THUS ② ON PLAN. STATIONS SHOWN ON END OF SEGMENTS ARE STATIONS AT CENTERLINE OF ROADWAY.
12. PIPE FOR WEEP HOLES SHALL BE PVC SCH 40, WHITE.
13. GROUT FOR RAILING INSERTS SHALL BE A SAND-PORTLAND CEMENT MIX WITH A MAXIMUM MIX RATIO OF 3:1.
14. FOR DESIGN CALCULATIONS, SEE RIMS NO. B65 930323 002.

REVISE DRAWING AS CONSTRUCTED

SCALE: 1" = 20' EXCEPT AS [...]

ROADWAY RETAINING WALL
DAM SAFETY MODIFICATIONS

CONCRETE - RETAINING WALL
OUTLINE AND REINFORCEMENT
PLAN, SECTIONS AND DETAILS

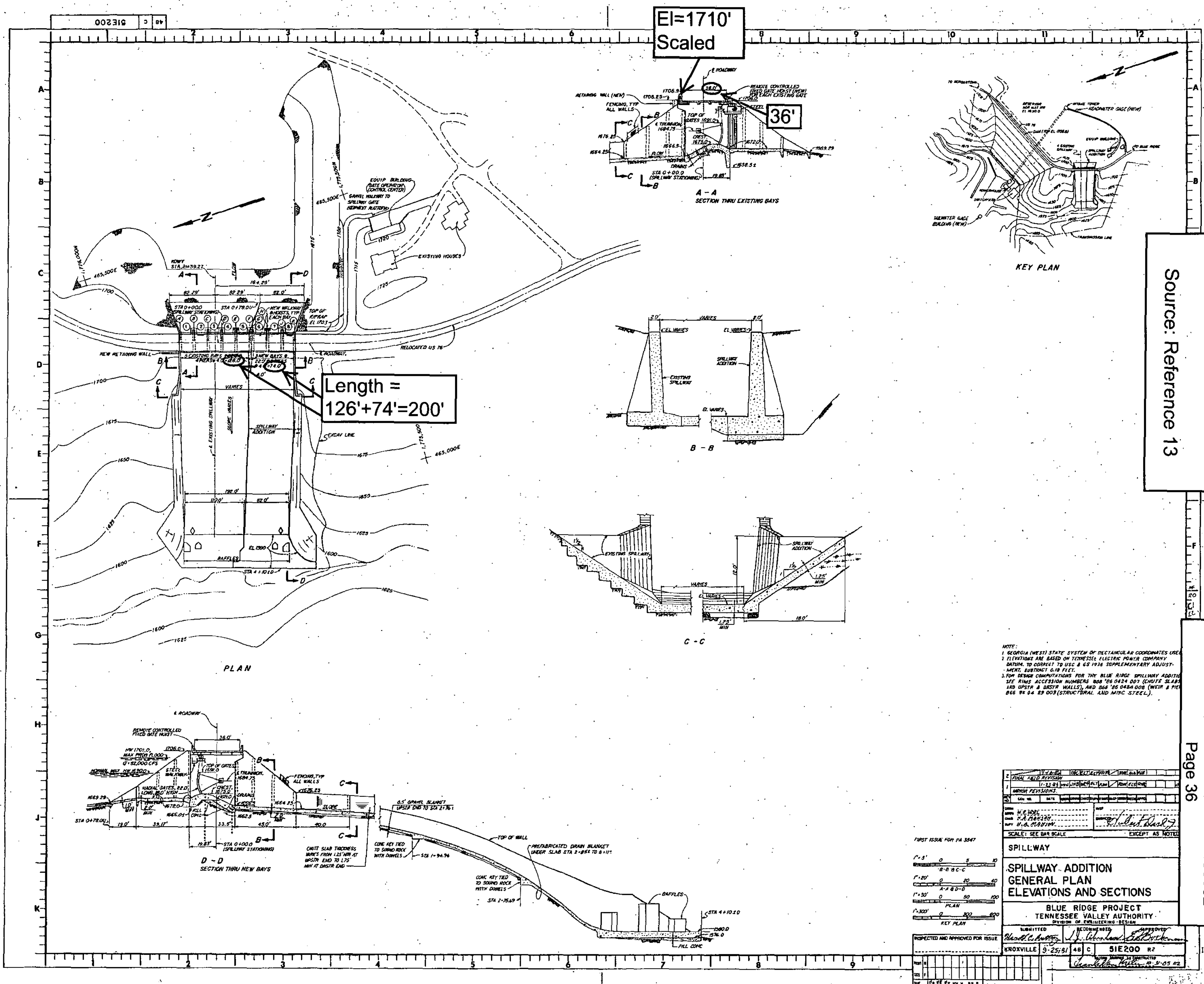
BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY

DESIGNED M. PETTY — SUPERVISED HA MANSON
DRAWN D. HICKEY — REVIEWED HA MANSON
CHECKED KB KNOWLES
DATE 3-31-93 — 48 C 81W300-1

J H COULSON

CAD SYSTEM
DO NOT CHANGE

Calculation No: CDQ000020080002
Page 35



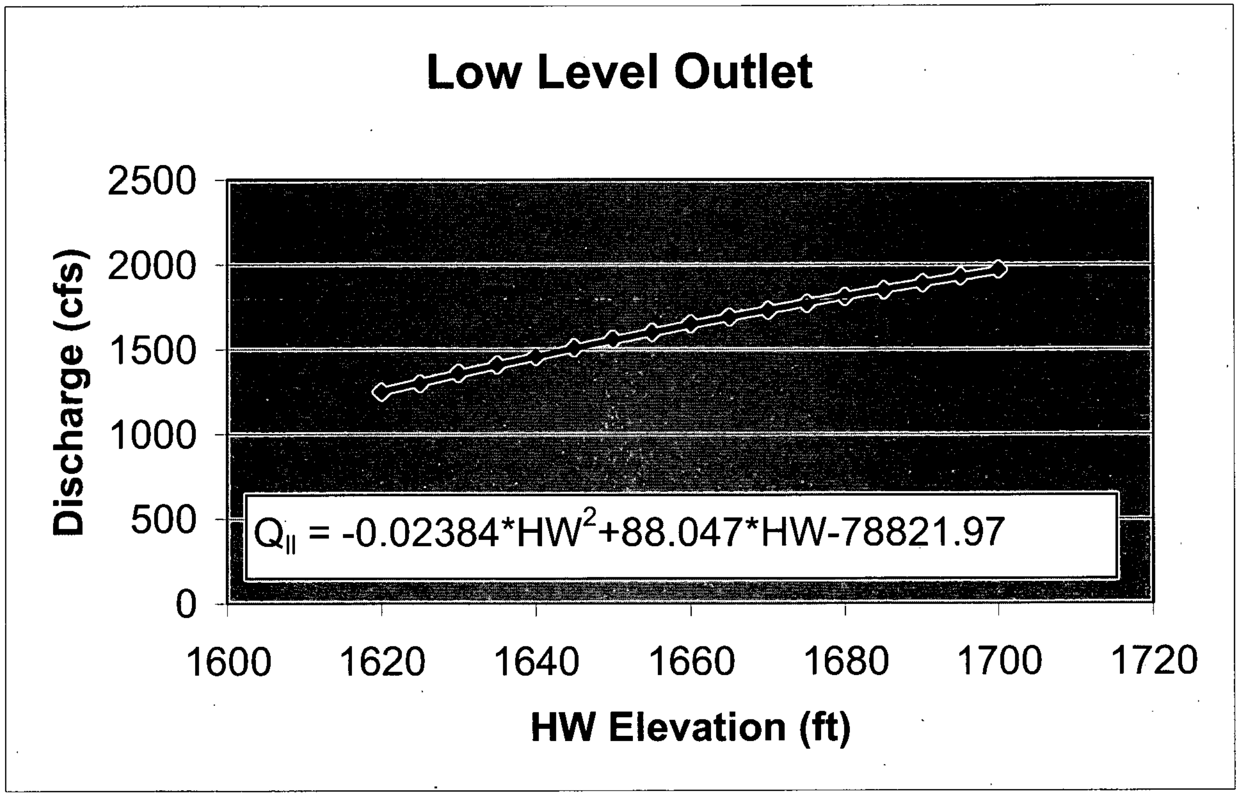
Attachment 12
Source: Reference 13

Calculation No. CDQ000020080002
Page 36

Attachment 13
Source: Reference 9

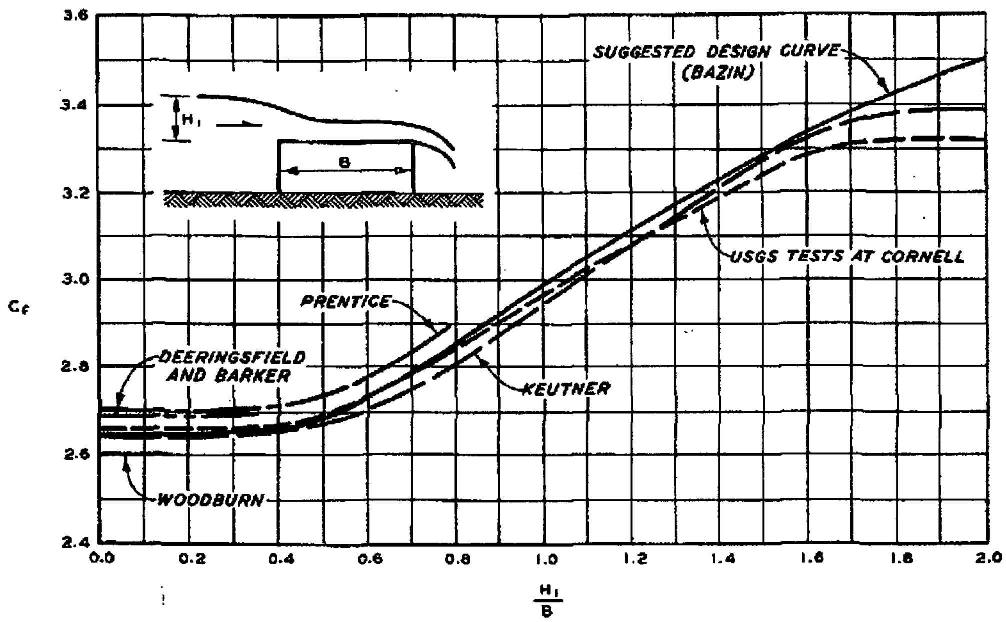
Discharge Through Low Level Outlet
From Blue Ridge Spillway Discharge Tables
Based on Prototype Measurements

HW feet	Discharge cfs	Fit to Discharge cfs
1620	1250	1248
1625	1300	1302
1630	1360	1354
1635	1410	1405
1640	1460	1455
1645	1510	1504
1650	1560	1551
1655	1600	1597
1660	1650	1643
1665	1690	1686
1670	1730	1729
1675	1770	1771
1680	1810	1811
1685	1850	1850
1690	1890	1888
1695	1930	1925
1700	1970	1960

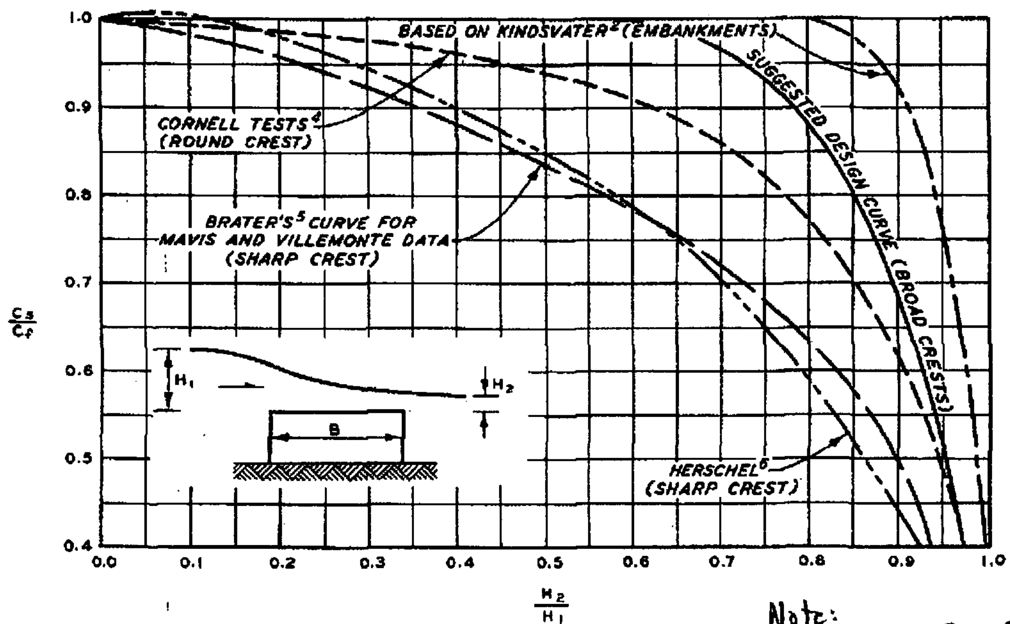


Electronic version available in Attachment 15

Calculation No: CDQ000020080002
Page 37



a. FREE FLOW



b. SUBMERGED FLOW

Note: $H_1 \equiv H_c$ $\frac{C_s}{C_f} \equiv S_f$ $H_2 \equiv d$

NOTE: C_f = FREE-FLOW COEFFICIENT
C_s = SUBMERGED-FLOW COEFFICIENT
NEGLIGIBLE VELOCITY OF APPROACH
RAISED NUMBERS ON SUBMERGED FLOW CHART ARE REFERENCE NUMBERS FROM TEXT.

LOW-MONOLITH DIVERSION DISCHARGE COEFFICIENTS

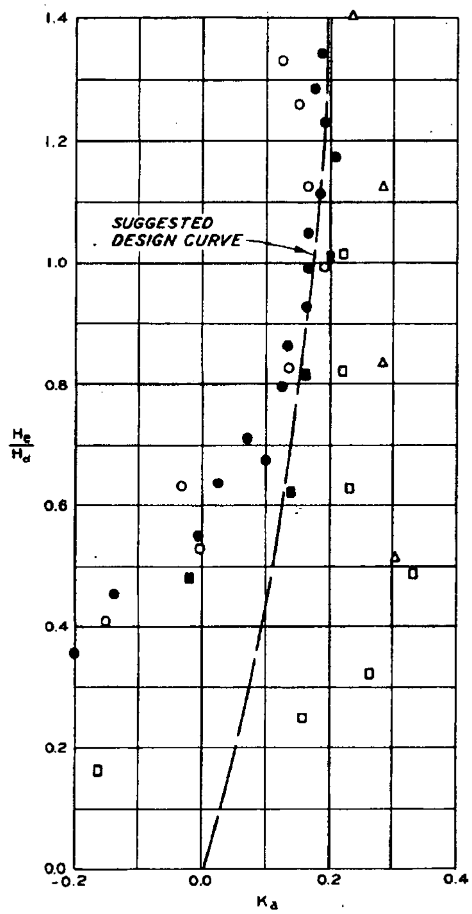
HYDRAULIC DESIGN CHART 711

WES 1-66

PREPARED BY U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MISSISSIPPI

Attachment 14-2 Source: Reference 5

Calculation No: CDQ000020080002 Page 39



BASIC EQUATION

$$Q = C[L' - 2(NK_p + K_a)H_e]H_e^{3/2}$$

WHERE:

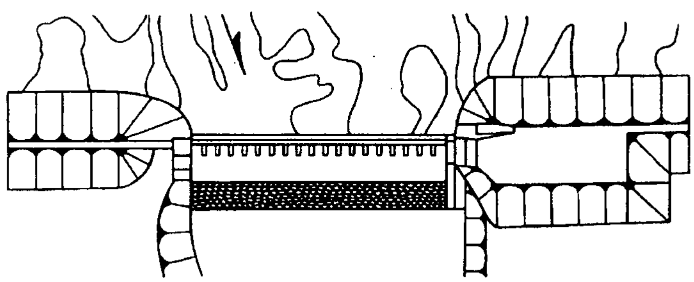
- Q = DISCHARGE, CFS
- C = DISCHARGE COEFFICIENT
- L' = NET LENGTH OF CREST, FT
- N = NUMBER OF PIERS
- K_p = PIER CONTRACTION COEFFICIENT
- K_a = ABUTMENT CONTRACTION COEFFICIENT
- H_e = ENERGY HEAD ON CREST, FT

LEGEND

SYMBOL	PROJECT	R	W/L	W/H
□	DORENA	2	5.60	10.7
■	DORENA	4	5.60	10.7
○	RED ROCK*	7.8	3.42	16.5
●	CARLYLE*	9	8.44	75.5
△	WALTER F. GEORGE*	4	5.44	55.3

*GATED SPILLWAY WITH PIERS

NOTE: R = RADIUS OF ABUTMENT, FT
W = WIDTH OF APPROACH REPRODUCED IN MODEL, FT
L = GROSS WIDTH OF SPILLWAY, FT
H = DEPTH OF APPROACH IN MODEL, FT
H_d = DESIGN HEAD ON CREST, FT



OVERFLOW SPILLWAY CREST WITH ADJACENT EMBANKMENT SECTIONS

ABUTMENT CONTRACTION COEFFICIENT

HYDRAULIC DESIGN CHART III-3/2

PREPARED BY U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MISSISSIPPI — REV 1-64 — WES 8-60

Attachment 27

Attachment 15 Blue Ridge Rating Curve.xls Calc (Case 1)

Calculation No: CDQ000020080002

Blue Ridge
Converged Tailwater Iterations

HW	TW (ft)		diff
feet	calc	assumed	ft
1675	1548.1979004562	1548.1979003642	-9.2E-05
1676	1548.4910172043	1548.4910170147	-0.0001896
1677	1549.0342192112	1549.0342182544	-0.00095682
1678	1549.7487614008	1549.7487614000	-7.2396E-07
1679	1550.6020213946	1550.6020213933	-1.2571E-06
1680	1551.5703239370	1551.5703239352	-1.8147E-06
1681	1552.6332856587	1552.6332856564	-2.3031E-06
1682	1553.7720993675	1553.7720993648	-2.6369E-06
1683	1554.9689536808	1554.9689536781	-2.7494E-06
1684	1556.2068778620	1556.2068778594	-2.5975E-06
1685	1557.4697636836	1557.4697636814	-2.161E-06
1686	1558.7424586280	1558.7424586280	6.8212E-10
1687	*	*	*
1688	*	*	*
1689	*	*	*
1690	*	*	*
1691	*	*	*
1692	*	*	*
1693	*	*	*
1694	*	*	*
1695	*	*	*
1696	*	*	*
1697	*	*	*
1698	*	*	*
1698.96	*	*	*
1700	*	*	*
1701	*	*	*
1702	*	*	*
1703	*	*	*
1704	*	*	*
1705	*	*	*
1706	*	*	*
1707	*	*	*
1708	*	*	*
1709	*	*	*
1710	*	*	*
1711	*	*	*
1712	*	*	*
1713	*	*	*
		Average	-1.0456E-07

* Iteration not required, turbine discharge no longer occurs at this headwater elevation

Electronic version available in Attachment 15

Appendix A: Spillway Discharge Coefficients and Submergence Factors for Blue Ridge Dam from Scale Model Test Data

TVA has model test data describing the relationships between discharge, headwater, tailwater, and gate opening for most of its spillways. These data are used in the headwater rating curve calculations.

Blue Ridge Dam has eight spillway bays, each controlled by a radial (tainter) gate, on the main spillway, and 6 uncontrolled spillway bays on an auxiliary spillway as illustrated in Attachment A1. For headwater rating curve calculations the gates are assumed to be open to their maximum opening position as specified in the Spillway Gate Arrangements table in Reference A1 and included as Attachment A2. As shown in this table, all eight gates are set to their maximum opening position, indicator reading "12," for gate arrangement number 96. 2006 field measurements (Attachment A3) indicate that at these settings, the average maximum gate opening is 19.195 feet.

Test data summarized in Reference A2 involve a compilation of data from Apalachia, Boone, Fort Patrick Henry, Hales Bar, Hiwassee, Melton Hill, Nickajack, Watts Bar and Wheeler model tests. These data, which define both free and orifice discharge coefficients with respect to gate opening, headwater elevation and crest shape, are used here to determine the free discharge and orifice discharge parameters on the Blue Ridge main spillway with gates open to 19.195 feet. As no model data is available specifically for Blue Ridge Dam, Reference A2 is considered the best source for approximating discharge coefficients. Uncertainties in the relationship of discharge coefficient versus head are within 2% for orifice (i.e. gated) flow and 1% for free discharge at maximum gate openings (Attachment A4-1 and A4-2).

Free discharge parameters on the auxiliary spillway are determined from standard data on Ogee crests (Reference A3, Attachment A28), as no model study for uncontrolled spillway discharge was conducted by the TVA on Blue Ridge Dam.

A.1 References

A1. "Blue Ridge Dam Spillway Discharge Tables," River Operations, Tennessee Valley Authority, 2008 (Attachment 26)
A2. TVA Report WR28-2-900-123, "Method for Estimating Discharge at Overflow Spillways with Curved Crests and Radial Gates, E. Dean Harshbarger, Billy J Clift, James W. Boyd, January 1985 (Attachment 17)
A3. "Design of Small Dams," United Stated Department of the Interior, Bureau of Reclamation, 3rd Edition, Washington DC, 1987 (Attachment A28)
A4. "Hydraulic Design Criteria," USACE (U. S. Army Engineer Waterways Experiment Station), Eighteenth issue, Vicksburg, MS, 1988.
A5. TVA drawing no: AEL99B105 (Attachment A6)
A6. TVA drawing no: AEL99B107 (Attachment A7)
A7. TVA drawing no: AEL99B115 (Attachment A8)
A8. TVA drawing no: AEL99B116 (Attachment A9)
A9. TVA drawing no: AEL99B117 (Attachment A10)
A10. TVA drawing no: AEL99B108 (Attachment A11)
A11. TVA drawing no: AEL99B106 (Attachment A12)
A12. TVA drawing no: AEL99B104 (Attachment A13)
A13. TVA drawing no: 51E210-1, R3 (Attachments A15 & 20)
A14. TVA drawing no: 54E200-1, R2 (Attachments A16 & A29)
A15. TVA drawing no: 51W290-1, R1 (Attachments A22A & 21)
A16. "Open Channel Hydraulics," Ven Te Chow, Ph.D., McGraw Hill, New York, 1959.

A.2 Discharge Equations

Attachment A5 is a definition sketch for flow over the Blue Ridge Dam spillway. Free discharge occurs for headwater elevations below the elevation at which the overflowing nappe first touches the bottom lip of the gate, or $H_c <= H_{Lmin}$, and is computed using a weir equation (e.g., Reference A4):

$$Q_f = C_f L H_c^{1.5} \qquad \text{(A1)}$$

in which Q_f = free discharge (cfs), C_f = free discharge coefficient ($ft^{0.5}$/sec), L = length of overflowing section (ft), H_c = head on crest (ft) = HW - Z_c, HW = headwater elevation (ft), and Z_c = top, or crest, elevation of overflowing section (ft). This equation need not be modified to account for tailwater submergence.

For headwater elevations above the elevation at which the nappe touches the gate lip, or $H_c > H_{Lmin}$, orifice flow occurs and is computed from (Reference A4).

$$Q_g = C_g G L \sqrt{2g(H_m)} \qquad \text{(A2)}$$

in which Q_g = orifice discharge (cfs), C_g = orifice discharge coefficient (dimensionless -- varies with gate opening and H_c), G = effective gate opening = vertical distance between the gate lip and the crest surface (ft), g = acceleration of gravity (32.2 ft/s^2 -- common knowledge, Reference A4, sheet. 000-1 for example), and H_m = vertical distance between the mid-point of G and the headwater elevation. Values may be made dimensionless by dividing by the equivalent standard crest design head, H_o, which is approximated and verified in Section A.3. This equation need not be modified to account for tailwater submergence.

A.3 Model Test Data for the Main Spillway

The model test data (Reference A2) are used to determine

- H_{Lmin}, $C_f(H_c/H_o)$, and $C_g(H_c)$ for V = 19.195 ft.

The Apalachia, Boone, Fort Patrick Henry, Hales Bar, Hiwassee, Melton Hill, Nickajack, Watts Bar and Wheeler model test results for $C_f(H_c/H_o)$ were published in graphical form in Reference A2. Reference A2 also includes relationships for $C_g(G/H_o)$ and $H_{Lmin}(G/H_o)$. The available model test data for both orifice and free discharge are used below to estimate H_{Lmin} and $C_g(H_c)$ for V = 19.195 feet and to establish a curve fit for $C_f(H_c/H_o)$.

Reference A2 refers to "reference drawings" that are not included within Reference A2. However, these drawings are available in TVA files and are included as References A5 through A12 (Attachments A6 through A13).

In order to use the relationships from Reference A2 correctly the equivalent standard crest design head, H_o, of the spillway must be determined. The H_o value can be calculated by comparing the Blue Ridge spillway crest with the standard crest. Hydraulic Design Chart 111-1 from Reference A4, included in Attachment A14, indicates that the equation for the downstream quadrant of standard crest is

$$\left(\frac{x}{H_o}\right)^{1.85} = 2\left(\frac{y}{H_o}\right) \qquad \text{(A3.1)}$$

or

$$y = 0.5H_o\left(\frac{x}{H_o}\right)^{1.85} \qquad \text{(A3.2)}$$

where x = distance downstream from crest, y = vertical distance below crest, and H_o = design head (H_d in Attachment A14).

The profile of the Blue Ridge spillway is determined from References A13 (Attachment A15) and A14 (Attachment A16). The spillway profile is determined as referenced from the trunnion.

According to Reference A14, the trunnion elevation is 1684.75' and the horizontal distance from the trunnion to the roadway centerline is 3.667' (in the downstream direction).

Mapping of the spillway profile will begin downstream from the spillway crest at an elevation of 1672.7292' (Attachment A15). According to Reference A13, the spillway surface at this elevation is 7 inches upstream from the roadway centerline. Therefore, the x (horizontal) coordinate of the starting point for the mapping of the spillway surface, x_{s0} is:

$$x_{so} = 3.667' + 0.583' = 4.25'$$

when the positive x direction is defined as extending in the upstream direction.

The corresponding y coordinate, y_{s0}, can be determined from the trunnion elevation and the elevation of x_{s0} (when the positive y direction is defined as from the trunnion to the spillway surface, Reference A13).

$$y_{so} = 1684.75' - 1672.7292' = 12.0208'$$

Upstream from this point, the spillway surface is characterized as a rounded segment defined by a circle with radius = 20 feet. The center of this circle is located at the following coordinates (referenced from the trunnion, Reference A13).

$$x_{c1} = 3.667' + 9.25' + 0.5833' = 13.5'$$

And

$$y_{c1} = 1684.75' - (1675' - 20') = 29.75'$$

The spillway surface is therefore defined by the following equation:

$$y_s = -\sqrt{20'^2 - (x_s - 13.5')^2} + 29.75' \quad for\ 4.25' \le x_s < 13.5' \qquad (A4.1)$$

Because of the way the coordinate system has been defined (with the positive y axis extending from the trunnion to the spillway surface), the negative sign before the radical gives the correct result for the spillway surface.

According to drawing Reference A13, upstream from this segment, the spillway surface is flat with an elevation equal to the crest elevation for a distance of 2'. Therefore:

$$y_s = (1684.75' - 1675') = 9.75' \quad for\ 13.5' \le x_s \le 13.5' + 2' = 15.5' \qquad (A4.2)$$

The next upstream segment is a rounded segment described as a circle with radius = 5'. The center of this circle is located at the following coordinates (referenced from the trunnion, Reference A13).

$$x_{c2} = 3.667' + 9.25' + 0.5833' + 2' = 15.5'$$

And

$$y_{c2} = 1684.75' - (1675' - 5') = 14.75'$$

The spillway surface is therefore defined by the following equation:

$$y_s = -\sqrt{5'^2 - (x_s - 15.5')^2} + 14.75' \quad for\ 15.5' < x_s \le 15.5' + 2.5' = 18' \qquad (A4.3)$$

Again, because of the way the coordinate system has been defined (with the positive y axis extending from the trunnion to the spillway surface), the negative sign before the radical gives the correct result for the spillway surface.

In order to calculate H_o for Blue Ridge Dam, the coordinates of the downstream side of the spillway crest calculated in Equations A4.1-A4.3 were compared to the coordinates (calculated from Equation A3.2) for the standard crest at various design heads. For this analysis, the spillway coordinates are corrected so that the origin, (0,0), is at the gate sill centerline. Accordingly, 15.177' (Reference A14, 3.667'+11.5104') was subtracted from the x coordinates (referenced from the trunnion) and the y coordinates (also referenced from the trunnion) are corrected by subtracting 9.75' (1684.75'-1675', Reference A14) in Attachment A26.

Ho = 34 feet minimizes the sum of square errors (i.e. Blue Ridge y coordinate – standard crest y coordinate) across the upper portion of the dam's crest. Results of this analysis, as well as results for bracketing H_o values are listed in Table A1. A plot comparing the standard crest with H_o = 34 feet to the Blue Ridge crest is contained in Figure A1.

Table A1: Coordinates of Blue Ridge Crest and Standard Crest for H_o = 33, 34 and 35 feet

Blue Ridge Dam Spillway									
Ref. From Trunnion		Ref. From Sill CL		Standard Crest, Ho = 33		Standard Crest, Ho = 34		Standard Crest, Ho = 35	
x_s	y_s	x_s	y_s	y_s	Sq. Error	y_s	Sq. Error	y_s	Sq. Error
ft	ft	ft	ft	ft	ft^2	ft	ft^2	ft	ft^2
4.25	12.0176	10.9271	2.2676	2.1353	0.0175	2.0818	0.0345	2.0312	0.0559
5	11.6461	10.1771	1.8961	1.8721	0.0006	1.8252	0.0050	1.7808	0.0133
6	11.2095	9.1771	1.4595	1.5461	0.0075	1.5074	0.0023	1.4707	0.0001
7	10.8357	8.1771	1.0857	1.2489	0.0266	1.2176	0.0174	1.1880	0.0105
8	10.5211	7.1771	0.7711	0.9812	0.0441	0.9566	0.0344	0.9333	0.0263
10	10.0586	5.1771	0.3086	0.5362	0.0518	0.5227	0.0458	0.5100	0.0405
11	9.9069	4.1771	0.1569	0.3605	0.0414	0.3514	0.0379	0.3429	0.0346
12	9.8063	3.1771	0.0563	0.2173	0.0259	0.2118	0.0242	0.2067	0.0226
13.5	9.7500	1.6771	0.0000	0.0666	0.0044	0.0650	0.0042	0.0634	0.0040
15.17708	9.7500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Sum of Square Error (ft^2)			0.21988		0.20571		0.20786

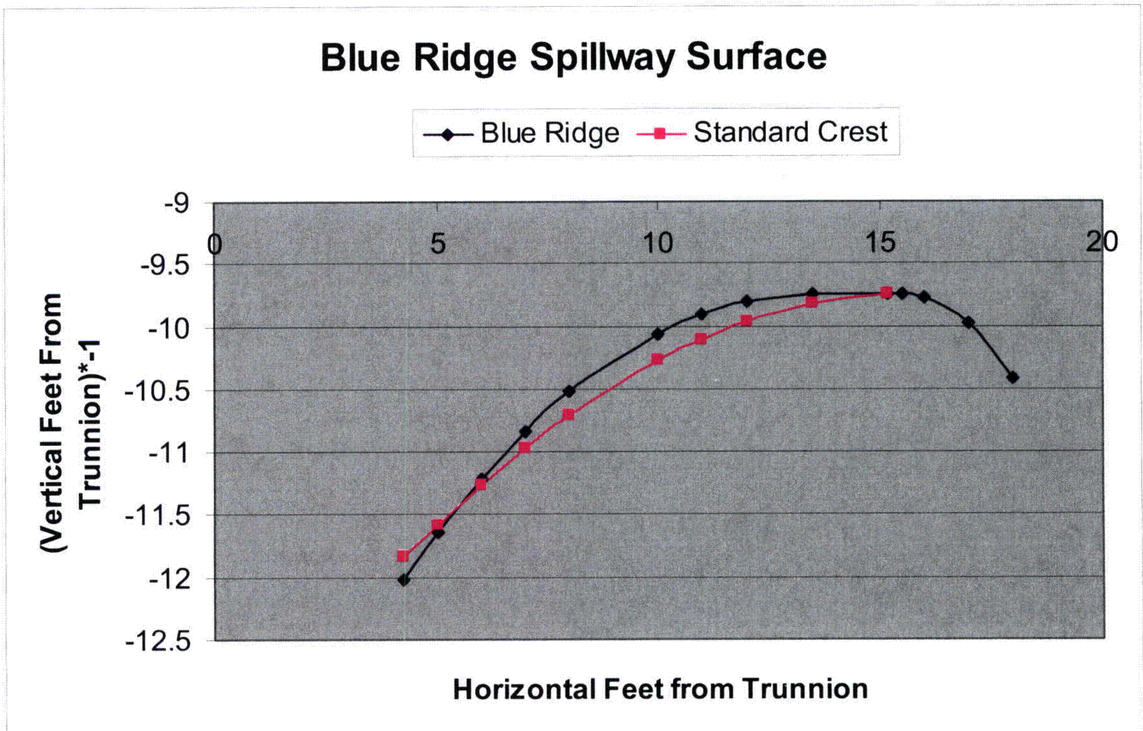


Figure A1: Standard Crest versus Blue Ridge Crest Profile

A.4 Geometry Calculations for the Main Spillway

Parameters G, H_m, and Z_o (gate overflow elevation) and are computed from crest and gate geometry as described in Attachment A17. Table A2 gives the values of these parameters for V = 19.195 feet.

Table A2: Geometrical Parameters for Relevant Gate Openings

V, feet	G, feet	Z_o, feet	H_o, feet	G/H_o
19.195	19.195	1702.675	34	0.5646

As an example, the procedure for computing the geometrical parameters for V = 19.195 feet is given here. From Attachment A16 (Reference A14),

- R = 18 feet
- Z_c = 1675 feet
- Z_{tr} = 1684.75 feet
- z_1 = 1684.75 – 1675 = 9.75 feet
- z_2 = 1691 – 1684.75 = 6.25 feet

where the parameters are defined in Attachment A17. Referring to Attachment A17:

Angle θ: $$\theta = \sin^{-1}\left(\frac{9.75}{18}\right) + \sin^{-1}\left(\frac{6.25}{18}\right) = 53.115°$$

Angle α: $$\alpha = \tan^{-1}\left(\frac{1684.75 - 1675 - 19.195}{\sqrt{18^2 - (1684.75 - 1675 - 19.195)^2}}\right) = -31.6495°$$

Overflow elevation Z_o: $$Z_o = 1684.75 + 18\sin[53.115 - (-31.6495)] = 1702.675 \ feet$$

According to Attachment A16, the bottom of the roadway is at an elevation of 1703.6 feet. Because the gate overflow elevation is less than 1 foot from the bottom of the roadway, discharge due to overflow of the gate will be neglected.

Gate lip y-coordinate: $$y_\ell = 1684.75 - 1675 - 19.195 = -9.445 \ feet$$

Gate lip x-coordinate: $$x_\ell = \sqrt{18^2 - (-9.445)^2} = 15.32 \ feet$$

G is calculated as follows

$$G = y_s - y_l \tag{A5}$$

Evaluating y_s at $x_s = x_l = 15.32$ yields $y_s = 9.75$. Therefore

$$G = 9.75 - (-9.445) = 19.195 feet$$

H_m is determined by the following relationship (see Attachment A17 for details):

$$H_m = HW - (Z_{cr} + V) + \frac{G}{2} \tag{A6}$$

in which H_m = vertical distance between the mid-point of G and the headwater elevation (ft), HW = headwater elevation (ft), V = vertical gate opening (ft), G = effective gate opening = distance between the gate lip and the crest (ft), and Zcr = elevation of spillway crest (ft).

A.5 Determination of H_{Lmin} at G = 19.195 feet for the Main Spillway

The relationship between the normalized effective gate opening, G/H_o, and the crest head at which the nappe touches the bottom of the gate, H_{Lmin}, can be determined from model data in Reference A5 (Attachment A6). The data were collected from Apalachia, Boone, Fort Patrick Henry, Hales Bar, Hiwassee, Melton Hill, Nickajack, Watts Bar and Wheeler model test results. Points from the upper portion of the curve were scaled from the drawing and modeled with a linear fit to find H_{Lmin} at G = 19.195 feet (Attachment A18). According to the linear fit, for the main spillway:

H_{Lmin} = 23.96 feet when G=19.195 feet.

A.6 Determination of $C_f(H_c/H_o)$ for the Main Spillway

Reference A12 (Attachment A13) shows the model test data for free discharge coefficient, C_f as a function of normalized head on the crest, H_c/H_o. A polynomial curve fit to the data (Attachment A19) is used for the headwater rating curve calculations. The curve fit was performed on two separate sections of the data. The model data from $H_c/H_o = 0$ to $H_c/H_o = 0.32$ was curve fit with a second order polynomial. The intercept of the fit was forced such that $C_f = 3.41$ at $H_c/H_o = 0.32$ (the y-intercept was forced to 3.41 when plotting C_f versus H_c/H_o - 0.32). The model data from $H_c/H_o = 0.32$ to $H_c/H_o = 1.38$ was fit with a linear equation. Again, the intercept was forced such that $C_f = 3.41$ at $H_c/H_o = 0.32$ (the y-intercept was forced to 3.41 when plotting C_f versus H_c/H_o - 0.32). The resulting curve fits are contained below.

$$C_f = 3.41 + 0.2437\left(\frac{H_c}{H_o} - 0.32\right) - 4.0473\left(\frac{H_c}{H_o} - 0.32\right)^2 \quad for\ 0 \le \frac{H_c}{H_o} \le 0.32 \qquad \text{(A7.1)}$$

And

$$C_f = 0.7247\left(\frac{H_c}{H_o} - .32\right) + 3.41 \quad for\ \frac{H_c}{H_o} > 0.32 \qquad \text{(A7.2)}$$

A.7 Determination of $C_g(H_c)$ for G = 19.195 feet, Main Spillway

Model data were available for $C_g(G/H_o)$ at various headwater elevations (H_{Lmin}, $H_{Lmin}+0.025H_o$, $H_{Lmin}+0.05H_o$, $H_{Lmin}+0.075H_o$, and $H_{Lmin}+0.1H_o$) and are shown in References A6-A11 (Attachments A7-A12). The data was fit with a linear equation in order to determine C_g at the maximum gate opening for each headwater elevation (Attachments A20 and A21). Calculated data for $G/H_o = 0.5646$ were plotted together and curve fit in Attachment A22B to determine $C_g(H_c)$ for the maximum gate opening at a design head of H_o=34 feet. The model data from H_c = 0' to H_c = 27.36' was curve fit with a second order polynomial. The intercept of the fit was forced such that C_g = 0.6793 at H_c = 27.36' (the y-intercept was forced to 0.6793 when plotting C_g versus H_c-27.36'). According to Reference A2, when headwater elevations rise above $H_{lmin}+0.100*H_o$, C_g is only a function of G/H_o. Therefore at headwater elevations greater than $H_{lmin}+0.100*H_o$ C_g is constant when gates are fully opened (Attachment A4).

$$C_g = 0.0056(H_c - 27.36)^2 - 0.0006(H_c - 27.36) + 0.6793 \quad for\ 0 \le H_c \le 27.36 \qquad \text{(A8.1)}$$

And

$$C_g = 0.6793 \quad H_c > 27.36 \qquad \text{(A8.2)}$$

A.8 Free Discharge, Auxiliary Spillway

In order to calculate the free discharge coefficient for the auxiliary spillway, the design head for the spillway must be determined. The auxiliary spillway is defined as an Ogee crest in Reference A15 (Attachment A22A). The upstream side of the crest is rounded, with R_1 and R_2 (the radii of curvature as defined in Reference A3, Figure 9-22) equal to 11.70' and 5.30' respectively (Note: R_1 and R_2 are interchanged in Reference A3 between Figures 9-22 and 9-21(A). The naming convention in Figure 9-21(A) will be used in this calculation). The parameters x_c and y_c (defined in Reference A3, Figure 9-21) are defined as follows (from Attachment A22A):

$$x_c = 6.1976'$$
$$y_c = 1691' - 1688.19' = 2.81'$$

If the velocity head, h_a (in feet), was considered negligible in the design of the auxiliary spillway, the design head, H_o (in feet), can be determined from Figure 9-22 in Reference A3. According to Figure 9-22 R_1, R_2 , x_c, and y_c are related to the design head of an Ogee crest.

$$R_1 = 0.530 * H_o \quad \text{(A9.1)}$$
$$R_2 = 0.235 * H_o \quad \text{(A9.2)}$$
$$x_c = 0.284 * H_o \quad \text{(A9.3)}$$
$$y_c = 0.127 * H_o \quad \text{(A9.4)}$$

Additionally, y_{R2}, the vertical distance between spanning the endpoints of the segment defined by R_2, is related to the design head as follows:

$$y_{R2} = 0.021 * H_o \quad \text{(A9.4)}$$

Calculation indicates that the design head, if the approach velocity was neglected, is 22 feet. Calculation results for H_o = 22 feet and bracketing cases are contained in Table A3.

Table A3. Design Head of Auxiliary Crest when Velocity Head is Neglected

	Actual	Ho = 21 feet		Ho = 22 feet		Ho = 23 feet	
	Value	Calc. Val.	Sq. Error	Calc. Val.	Sq. Error	Calc. Val.	Sq. Error
	ft	ft	ft²	ft	ft²	ft	ft²
R_1	11.7	11.13	0.325	11.66	0.002	12.19	0.240
R_2	5.3	4.935	0.133	5.17	0.017	5.405	0.011
y_{R2}	0.39	0.441	0.003	0.462	0.005	0.483	0.009
y_c	2.81	2.667	0.020	2.794	0.000	2.921	0.012
x_c	6.1979	5.964	0.055	6.248	0.003	6.532	0.112
	Sum of Sq. Error		0.536		0.026		0.384

As further justification that H_o = 22', adding 22' to the auxiliary crest elevation yields the PMF elevation shown on Attachment A22A.

P, the rise of the upstream side of the crest in feet, is calculated as:

$$P = 1691' - 1688' = 3'$$

Therefore,

$$\frac{P}{H_o} = \frac{3'}{22'} = 0.136$$

And, as read from Figure 9-23 of Reference A3, $C_o = 3.43$. This value will be compared to the C_o calculated when h_a is assumed to be nonzero. In this case, calculation of H_o is an iterative process. One iterative step (the converging step) is illustrated below.

Step 1: Assume value of $h_a/H_o = 0.145$
Step 2: From Figure 9-21 (Reference A3) determine the parameters x_c/H_o, y_c/H_o, R_1/H_o, R_2/Ho with a vertical upstream face graphically. For $h_a/H_o = 0.145$, these values are 0.203, 0.068, 0.435 and 0.196 respectively.
Step 3: For each of the above values, calculate P/H_o as follows:

$$\left(\frac{P}{H_o}\right)_{x_c} = P*\left(\frac{x_c}{H_0}\right)*\frac{1}{x_c} = \frac{3'(0.203)}{6.1976'} = 0.098$$

$$\left(\frac{P}{H_o}\right)_{y_c} = P*\left(\frac{y_c}{H_0}\right)*\frac{1}{y_c} = \frac{3'(0.068)}{2.81'} = 0.0726$$

$$\left(\frac{P}{H_o}\right)_{R_1} = P*\left(\frac{R_1}{H_0}\right)*\frac{1}{R_1} = \frac{3'(0.435)}{11.70'} = 0.112$$

$$\left(\frac{P}{H_o}\right)_{R_2} = P*\left(\frac{R_2}{H_0}\right)*\frac{1}{R_2} = \frac{3'(0.196)}{5.3'} = 0.111$$

Step 4: From Figure 9-23 of Reference A3, C_o (the Ogee crest discharge coefficient) as a function of P/H_o can be determined graphically. For each case this becomes:

$$(C_o)_{x_c} = 3.36$$
$$(C_o)_{y_c} = 3.30$$
$$(C_o)_{R_1} = 3.39$$
$$(C_o)_{R_2} = 3.40$$

Step 5: Calculate h_a/H_o from the defining equations on Figure 9-21, Reference A3. The calculation is converged when the average of the calculated h_a/H_o values is equal to the assumed h_a/H_o.

$$q = CH_o^{1.5} \quad \text{(A10)}$$

Where q = flow rate per linear feet if crest, in cfs/foot, and $C = C_o$, the Ogee crest discharge coefficient.

$$v_a = \frac{q}{(P + h_o)} \quad \text{(A11)}$$

Where v_a is equal to the approach velocity in feet/second and h_o = the difference between the design head and the velocity head $(H_o - h_a)$. Substitution and rearrangement of Equations A10 and A11 yields

$$\frac{h_a}{H_o} = \frac{1}{2g}\left(\frac{C}{1+\frac{P}{H_o}}\right)^2 \quad \text{(A12)}$$

Therefore, with the C_o and P/H_o values calculated above

$$\left(\frac{h_a}{H_o}\right)_{x_c} = 0.145$$

$$\left(\frac{h_a}{H_o}\right)_{y_c} = 0.147$$

$$\left(\frac{h_a}{H_o}\right)_{R_1} = 0.144$$

$$\left(\frac{h_a}{H_o}\right)_{R_2} = 0.145$$

The average value for h_a/H_o is 0.145, the assumed value. Therefore Equation A12 becomes;

$$0.145 = \frac{1}{2g}\left(\frac{C}{1+\frac{P}{H_o}}\right)^2 \quad \text{(A13.1)}$$

And rearrangement yields

$$H_o = \frac{P}{\frac{C}{\sqrt{(0.145*2g)}} - 1} \quad \text{(A13.2)}$$

Because C is a function of H_o, determining H_o is another iterative process.

Step A: Guess H_o, H_o = 27 feet

Step B: Determine C as a function of P/H_o from Figure 9-23. P/H_o = 3'/27' = 0.111 -> C = C_o=3.395

Step C: Calculate H_o from Equation A13.2. The solution is converged when the calculated H_o value is equal to the assumed H_o value.

$$H_o = \frac{3'}{\frac{3.395}{\sqrt{(0.145*2g)}} - 1} = 27'$$

Comparison of the C_o value calculated based on design heads of 22' (C_o = 3.43) and 27' (C_o = 3.395) indicate that the values are within approximately 1% of each other, therefore either value (22' or 27') could be used as the design head with minimal impact to the discharge coefficient for the auxiliary spillway. For this analysis, H_o = 22' will be used.

The free discharge coefficient, $C_f(H_c)$, is determined from Figure 9-24 from Reference A3. Points scaled from Figure 9-24 are fit to the following polynomial (Attachment A24):

$$\frac{C}{C_o} = 1 + 0.1275\left(\frac{H}{H_o} - 1\right) - 0.03876\left(\frac{H}{H_o} - 1\right)^2 + 0.04454\left(\frac{H}{H_o} - 1\right)^3 \quad \text{(A14.1)}$$

where $C \equiv C_f$ and $H \equiv H_c$. The dependant variable is H/H_o -1 to ensure that $C = C_o$ at $H=H_o$. Defining a_1 = 0.1275, a_2 = -0.03876, a_3 = 0.04454, and $h = H/H_o$:

$$\begin{aligned}
\frac{C}{C_o} &= 1 + a_1(h-1) + a_2(h-1)^2 + a_3(h-1)^3 \\
&= 1 + (h-1)\{a_1 + (h-1)[a_2 + a_3(h-1)]\} \\
&= 1 + (h-1)\{a_1 + (h-1)[a_3 h + (a_2 - a_3)]\} \\
&= 1 + (h-1)[a_1 + a_3 h^2 + (a_2 - a_3)h - a_3 h - (a_2 - a_3)] \\
&= 1 + (h-1)[a_3 h^2 + (a_2 - 2a_3)h + (a_1 - a_2 + a_3)] \\
&= 1 + a_3 h^3 + (a_2 - 2a_3)h^2 + (a_1 - a_2 + a_3)h - a_3 h^2 - (a_2 - 2a_3)h - (a_1 - a_2 + a_3) \\
&= 1 - (a_1 - a_2 + a_3) + (a_1 - 2a_2 + 3a_3)h + (a_2 - 3a_3)h^2 + a_3 h^3
\end{aligned}$$

With

$$1-(a_1-a_2+a_3)=0.7892$$
$$a_1-2a_2+3a_3=0.33864$$
$$a_2-3a_3=-0.17238$$

Therefore

$$\frac{C}{C_o}=0.7892+0.33864\left(\frac{H}{H_o}\right)-0.17238\left(\frac{H}{H_o}\right)^2+0.04454\left(\frac{H}{H_o}\right)^3 \qquad \text{(A14.3)}$$

With $C_o = 3.43$ and $H_o = 22'$:

$$C_f=2.707+0.0528(H_c)-0.001222(H_c)^2+1.435*10^{-5}(H_c)^3 \qquad \text{(A14.4)}$$

This polynomial is valid for $H/H_o \leq 1.6$, which is the upper limit on Figure 9-24 (Reference A3). With $H_o = 22'$, this corresponds to a maximum headwater elevation of 1691'+22'*1.6 = 1726.2' (Ref. A15), which is within the range of headwater elevations under investigation.in this study.

A.9 Frictional Losses in the Approach Channel

Frictional losses in the approach channel will decrease the elevation of the headwater in the channel, and therefore influence the head on the crest for the auxiliary spillway. According to Reference A16, the change in the energy line of the water in the approach channel is related to the change in potential energy (due to sloping of the channel) and the frictional losses via the following expression

$$\frac{dE}{dx} = S_o - S_f \qquad \text{(A15.1)}$$

Where E = energy in feet, x = length of the channel in feet (370 feet for entire channel, Ref. A15), S_o = slope of the potential energy line of the flowing water and S_f = slope of the energy line due to frictional losses. S_o is neglected because the bottom of the approach channel has negligible sloping (Section A1-A1 of Attachment A22A).

The slope of the energy line due to frictional losses can be calculated via Manning's Equation (Ref. A16).

$$S_f = \frac{n^2 v^2}{2.22 R^{4/3}} \qquad \text{(A15.2)}$$

Where n = manning friction factor, v = channel velocity, and R = hydraulic radius. Substituting v = q*channel width/y*channel width (where y = depth of water in channel) and R = y (approximation for a wide channel), and n = 0.02 (for an earthen channel, Attachment A23)

$$S_f = \frac{0.02^2 q^2}{2.22 y^{10/3}} \qquad \text{(A15.3)}$$

Substituting and integrating, with Δx = 370 (length of approach channel as scaled from Ref. A15) yields

$$\Delta E = \frac{q^2}{15 y^{10/3}} \qquad \text{(A15.4)}$$

Using Equation A15.4, a corrected discharge coefficient which corrects the flow over the crest to account for frictional losses in the approach channel can be calculated. The corrected discharge coefficient will be plotted versus headwater elevation for use in the dam rating curve. This is accomplished using the following steps

Step 1: Define H_c, the total head on the auxiliary crest. For the first data point in the plot, H_c = 1.1 feet.
Step 2: Calculate C_f from Equation A14.4. For H_c =1.1, C_f = 2.763
Step 3: Calculate $q = C_f H_c^{1.5}$. For H_c =1.1, q = 3.19 cfs/ft
Step 4: Calculate y, the depth of the channel. H_c is equal to the depth of the channel minus the height differential between the channel and the crest (1691'-1688' = 3', Ref A15) plus the velocity head, $h_a = v^2/2g$. Because v = q*channel width/y*channel width:

$$h_a = \frac{q^2}{2gy^2} \qquad \text{(A16.1)}$$

Therefore

$$0 = y + \frac{q^2}{2gy^2} - 3 - H_c \qquad \text{(A16.2)}$$

And y is determined by iteration. For $H_c = 1.1$, $y = 4.09'$

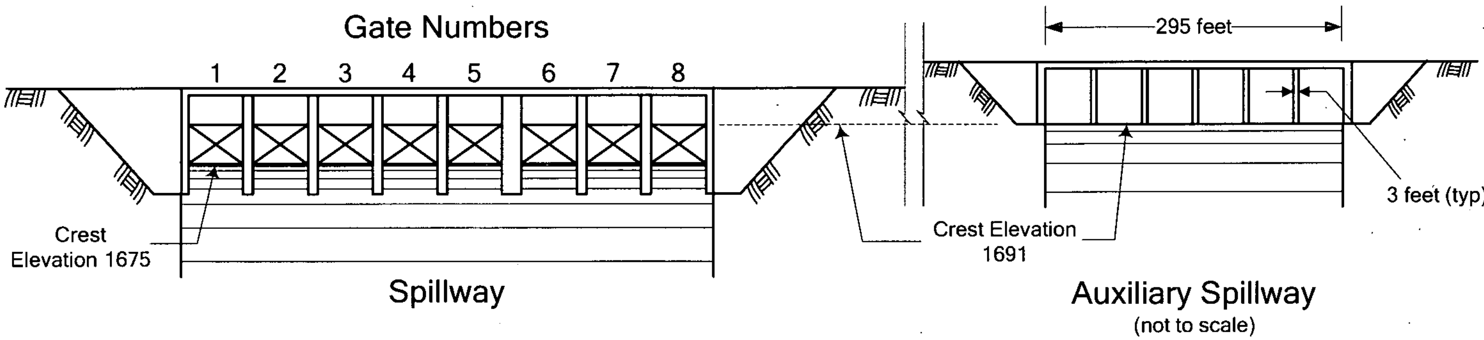
Step 5: Calculate ΔE from Equation A15.4. For $H_c = 1.1$, $\Delta E = 0.006$ feet.
Step 6: Calculate the head on the crest as it would exist upstream from the approach channel as $H_{cup} = H_c + \Delta E$. For $H_c = 1.1$, $H_{cup} = 1.106$ feet
Step 7: Calculate the corrected discharge coefficient, C_{fcor} as $C_{fcor} = q / H_{cup}^{1.5}$. For $H_c = 1.1$, $C_{fcor} = 2.74$.

This process is repeated for a variety of headwaters and the result curve fit to provide $C_{fcor}(HW)$. The resulting relationship (Attachment A25) is used in the dam rating curve.

$$C_{f_{cor}} = -4.98 * 10^{-4} * (H_{cup})^2 + 0.040623(H_{cup}) + 2.687 \qquad \text{(A17)}$$

BLUE RIDGE DAM

LOCATION OF SPILLWAY GATES



DOWNSTREAM ELEVATION

Attachment A1
Source: Reference A1

Attachment A2
Source: Reference A1

BLUE RIDGE DAM

SPILLWAY GATE ARRANGEMENTS

Arrangement Number	Gate Number							
	1	2	3	4	5	6	7	8
1	-	-	-	1	-	-	-	-
2	-	-	-	1	-	1	-	-
3	-	1	-	1	-	1	-	-
4	-	1	-	1	-	1	-	1
5	1	1	-	1	-	1	-	1
6	1	1	-	1	1	1	-	1
7	1	1	-	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	2	1	1	1	1
10	1	1	1	2	1	2	1	1
11	1	2	1	2	1	2	1	1
12	1	2	1	2	1	2	1	2
13	2	2	1	2	1	2	1	2
14	2	2	1	2	2	2	1	2
15	2	2	1	2	2	2	2	2
16	2	2	2	2	2	2	2	2
17	2	2	2	3	2	2	2	2
18	2	2	2	3	2	3	2	2
19	2	3	2	3	2	3	2	2
20	2	3	2	3	2	3	2	3
21	3	3	2	3	2	3	2	3
22	3	3	2	3	3	3	2	3
23	3	3	2	3	3	3	3	3
24	3	3	3	3	3	3	3	3
25	3	3	3	4	3	3	3	3
26	3	3	3	4	3	4	3	3
27	3	4	3	4	3	4	3	3
28	3	4	3	4	3	4	3	4
29	4	4	3	4	3	4	3	4
30	4	4	3	4	4	4	3	4
31	4	4	3	4	4	4	4	4
32	4	4	4	4	4	4	4	4

Arrangement Number	Gate Number							
	1	2	3	4	5	6	7	8
33	4	4	4	5	4	4	4	4
34	4	4	4	5	4	5	4	4
35	4	5	4	5	4	5	4	4
36	4	5	4	5	4	5	4	5
37	5	5	4	5	4	5	4	5
38	5	5	4	5	5	5	4	5
39	5	5	4	5	5	5	5	5
40	5	5	5	5	5	5	5	5
41	5	5	5	6	5	5	5	5
42	5	5	5	6	5	6	5	5
43	5	6	5	6	5	6	5	5
44	5	6	5	6	5	6	5	6
45	6	6	5	6	5	6	5	6
46	6	6	5	6	6	6	5	6
47	6	6	5	6	6	6	6	6
48	6	6	6	6	6	6	6	6
49	6	6	6	7	6	6	6	6
50	6	6	6	7	6	7	6	6
51	6	7	6	7	6	7	6	6
52	6	7	6	7	6	7	6	7
53	7	7	6	7	6	7	6	7
54	7	7	6	7	7	7	6	7
55	7	7	6	7	7	7	7	7
56	7	7	7	7	7	7	7	7
57	7	7	7	8	7	7	7	7
58	7	7	7	8	7	8	7	7
59	7	8	7	8	7	8	7	7
60	7	8	7	8	7	8	7	8
61	8	8	7	8	7	8	7	8
62	8	8	7	8	8	8	7	8
63	8	8	7	8	8	8	8	8
64	8	8	8	8	8	8	8	8

Arrangement Number	Gate Number							
	1	2	3	4	5	6	7	8
65	8	8	8	9	8	8	8	8
66	8	8	8	9	8	9	8	8
67	8	9	8	9	8	9	8	8
68	8	9	8	9	8	9	8	9
69	9	9	8	9	8	9	8	9
70	9	9	8	9	9	9	8	9
71	9	9	8	9	9	9	9	9
72	9	9	9	9	9	9	9	9
73	9	9	9	10	9	9	9	9
74	9	9	9	10	9	10	9	9
75	9	10	9	10	9	10	9	9
76	9	10	9	10	9	10	9	10
77	10	10	9	10	9	10	9	10
78	10	10	9	10	10	10	9	10
79	10	10	9	10	10	10	10	10
80	10	10	10	10	10	10	10	10
81	10	10	10	11	10	10	10	10
82	10	10	10	11	10	11	10	10
83	10	11	10	11	10	11	10	10
84	10	11	10	11	10	11	10	11
85	11	11	10	11	10	11	10	11
86	11	11	10	11	11	11	10	11
87	11	11	10	11	11	11	11	11
88	11	11	11	11	11	11	11	11
89	11	11	11	12	11	11	11	11
90	11	11	11	12	11	12	11	11
91	11	12	11	12	11	12	11	11
92	11	12	11	12	11	12	11	12
93	12	12	11	12	11	12	11	12
94	12	12	11	12	12	12	11	12
95	12	12	11	12	12	12	12	12
96	12	12	12	12	12	12	12	12

GATE OPENINGS

Figures in columns under each gate number refer to gate opening positions (see table on Page 3 for counter readings)
dash (-) indicates closed gate

Calculation No: CDQ000020080002
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Use the average of the Gate 1 and 3 measurements for Gates 1 through 4 (the original gates).

Use Gate 5 measurements for Gate 5 (more similar to Gates 6-8 than to Gates 1-3).

Use the average of the Gate 6, 7, and 8 measurements for Gates 6 through 8 (the new gates).

CURVES THROUGH DATA

Counter	V - 19/1600*C for Gates 1 through 4	Assumed V	Counter	V - 19/1600*C for Gates 6 through 8	Assumed V	Counter	V - 19/1600*C for Gate 5	Assumed V
0	0	0.000	0	0	0.000	0	0	0.000
60	-0.17	0.543	60	-0.13	0.583	60	-0.13	0.583
120	-0.282	1.143	119	-0.24	1.173	119	-0.24	1.173
210	-0.388	2.106	197	-0.345	1.994	198	-0.309	2.042
300	-0.4	3.163	256	-0.385	2.655	300	-0.336	3.227
380	-0.403	4.110	380	-0.364	4.149	380	-0.345	4.168
462	-0.4	5.086	459	-0.335	5.116	463	-0.335	5.163
530	-0.394	5.900	600	-0.275	6.850	600	-0.275	6.850
600	-0.35	6.775	711	-0.18	8.263	693	-0.17	8.059
701	-0.23	8.094	799	-0.01	9.478	764	-0.027	9.046
805	-0.067	9.492	1000	0.32	12.195	1026	0.32	12.504
975	0.15	11.728	1115	0.532	13.773	1155	0.532	14.248
1155	0.442	14.158	1258	0.727	15.666	1258	0.727	15.666
1300	0.71	16.148	1365	0.984	17.193	1379	0.984	17.360
1400	0.93	17.555	1450	1.15	18.369	1455	1.15	18.428
1450	1.05	18.269	1505	1.3	19.172	1500	1.3	19.113
1490	1.19	18.884	1526	1.428	19.549	1510	1.48	19.411
1514	1.362	19.341						

Table Settings

Gate Opening Positions	Desired V's	Counter, Gates 1 through 5	Counter, Gates 6 through 8	Average Counter	**Prescribed Counter**	**V, Gates 1 through 4**	**V, Gate 5**	**V, Gates 6 through 8**
0	0	0.0	0.0	0	**0**	**0**	**0**	**0**
1	1.3	134.7	131.1	133	**130**	**1.250**	**1.294**	**1.289**
2	2.7	260.6	260.0	260	**260**	**2.693**	**2.762**	**2.703**
3	4.2	387.6	384.2	386	**390**	**4.229**	**4.287**	**4.271**
4	5.7	513.3	506.5	510	**510**	**5.660**	**5.742**	**5.743**
5	7.25	636.4	630.3	633	**630**	**7.167**	**7.240**	**7.232**
6	8.9	760.9	755.2	758	**760**	**8.887**	**8.990**	**8.940**
7	10.6	889.2	881.6	885	**880**	**10.479**	**10.577**	**10.573**
8	12.2	1010.0	999.3	1005	**1000**	**12.066**	**12.161**	**12.195**
9	13.9	1135.9	1124.3	1130	**1130**	**13.820**	**13.910**	**13.971**
10	15.6	1260.1	1248.6	1254	**1250**	**15.461**	**15.556**	**15.560**
11	17.3	1381.9	1372.7	1377	**1380**	**17.274**	**17.374**	**17.401**
12	19.2	1506.6	1506.6	1507	**1505**	**19.169**	**19.262**	**19.172**

Blue Ridge Gate Openings
2006 Field Measurements
Vertical Opening at Gate Position 12

Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Gate 6	Gate 7	Gate 8
V in feet	V in feet	V in feet	V in feet	V in feet	V in feet	V in feet	V in feet
19.196	19.196	19.196	19.196	19.262	19.172	19.172	19.172

Average Value = 19.195 feet

$$HL_1 = HL_{cr} + \frac{H_c}{H_o} H_o \qquad (2)$$

Where:

HL_1 = headwater elevation at which spillway discharge touches but does not impinge upon the gate, ft
HL_{cr} = spillway crest elevation, ft
H_c = head on crest, ft
H_o = standard crest design head, ft
H_c/H_o = dimensionless ratio specified by G/H_o in Figure 2b

Once HL_1 is known, the discharge coefficients for higher headwater elevations can be determined as shown in Figure 2a. For transition headwater elevations HL_1 through HL_5 in Figure 2a, increased headwater elevation may not cause increased discharge and may even cause decreased flow because of flow contraction losses and friction losses resulting from increased water impingement upon the gate. At headwater elevations greater than HL_5 there is no significant increase in the various flow losses, and therefore the discharge coefficient is constant and equal to the discharge coefficient for headwater elevation HL_5. At small gate openings (say less than a foot), there may be little, or no transition and the discharge coefficients may be constant at some headwater elevation less than headwater elevation HL_5. The general uncertainty of the H_c/H_o vs G/H_o relationship is within ± 10 percent at small vertical gate openings and ± 2 percent at large openings based on the maximum deviations from the trend.

At headwater elevation HL_1, gated discharge is equal to free discharge described later in this report. However, due to the uncertainties of the discharge coefficient relationship and the H_c/H_o relationship to headwater elevation HL_1, either the gated discharge coefficient for headwater elevation HL_1 at large vertical gate openings or the headwater elevation HL_1 at small vertical gate openings may require adjustment as described later in this report to mathematically ensure gated discharge equivalent to free discharge.

In some cases, headwater elevation HL_1 may be the headwater elevation for maximum spillway discharge at the maximum vertical gate opening. This maximum spillway discharge elevation is critical in extreme flood control situations. Although the relationship between headwater HL_1 and the ratio H_c/H_o in Figures 2a and 2b is satisfactory for most spillway operations, deviations from the average trend are inherent due to variations in gate designs and locations. Other computation methods may have the same uncertainty because they require friction factors, kinetic energy factors, etc., that are best evaluated through individual model or prototype tests.

FREE DISCHARGE

Free spillway discharge occurs when water discharges freely through the vertical gate opening, as shown in Figure 3, without impinging on the gate. For each vertical gate opening, free discharge is limited by headwater elevation HL_1 previously described. The equation for free spillway discharge through a single spillway bay is:

$$Q = C\ L\ H_c^{3/2} \qquad (3)$$

in which

- Q = discharge, ft^3/s
- C = discharge coefficient, dimensionless
- L = spillway bay width, ft
- H_c = head on crest measured from the reservoir headwater elevation, ft

This equation is similar to the general equation for weirs across open channels. The free discharge coefficient varies with the head on crest, H_c, shown in Figure 3, and with the standard crest design head. The relationship between discharge coefficients, head on crest, and the standard crest design head is shown in Figure 4. The uncertainty of the discharge coefficient relationship is within ± 1 percent based on the maximum deviation from the average trend (Kirkpatrick, 1972).

GATE ARRANGEMENTS AND IDENTIFICATION

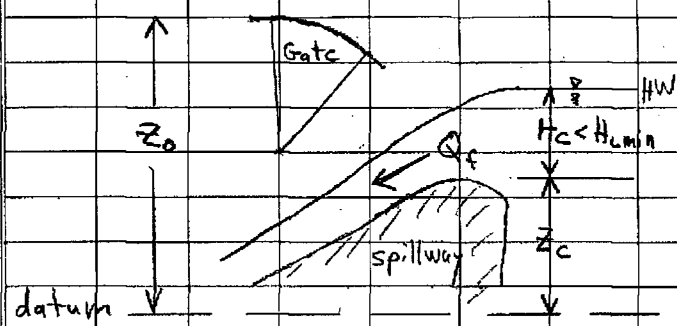
Gate opening arrangement, or the pattern of open gates across the spillway is important at installations with several spillway bays and

Definition Sketch for Spillway Discharge

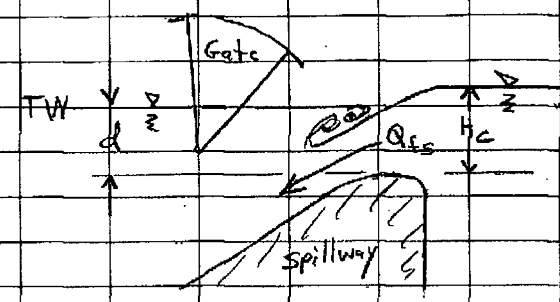
COMPUTED GAS DATE 8/12/2008

CHECKED DATE

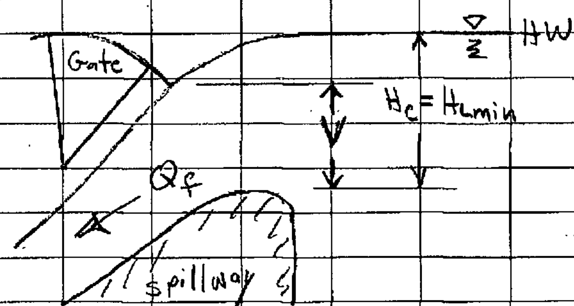
Free Discharge - No Tailwater effect



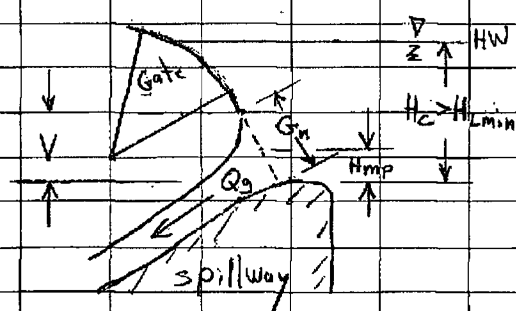
Free Discharge affected by Tailwater



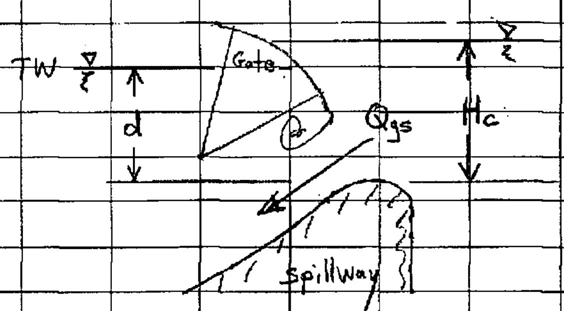
Nappe Touches Gate



Orifice Discharge - No Tailwater Effect



Orifice Discharge affected by Tailwater



Calculation No: CDQ000020080002

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Attachment A6

Source: Reference A5

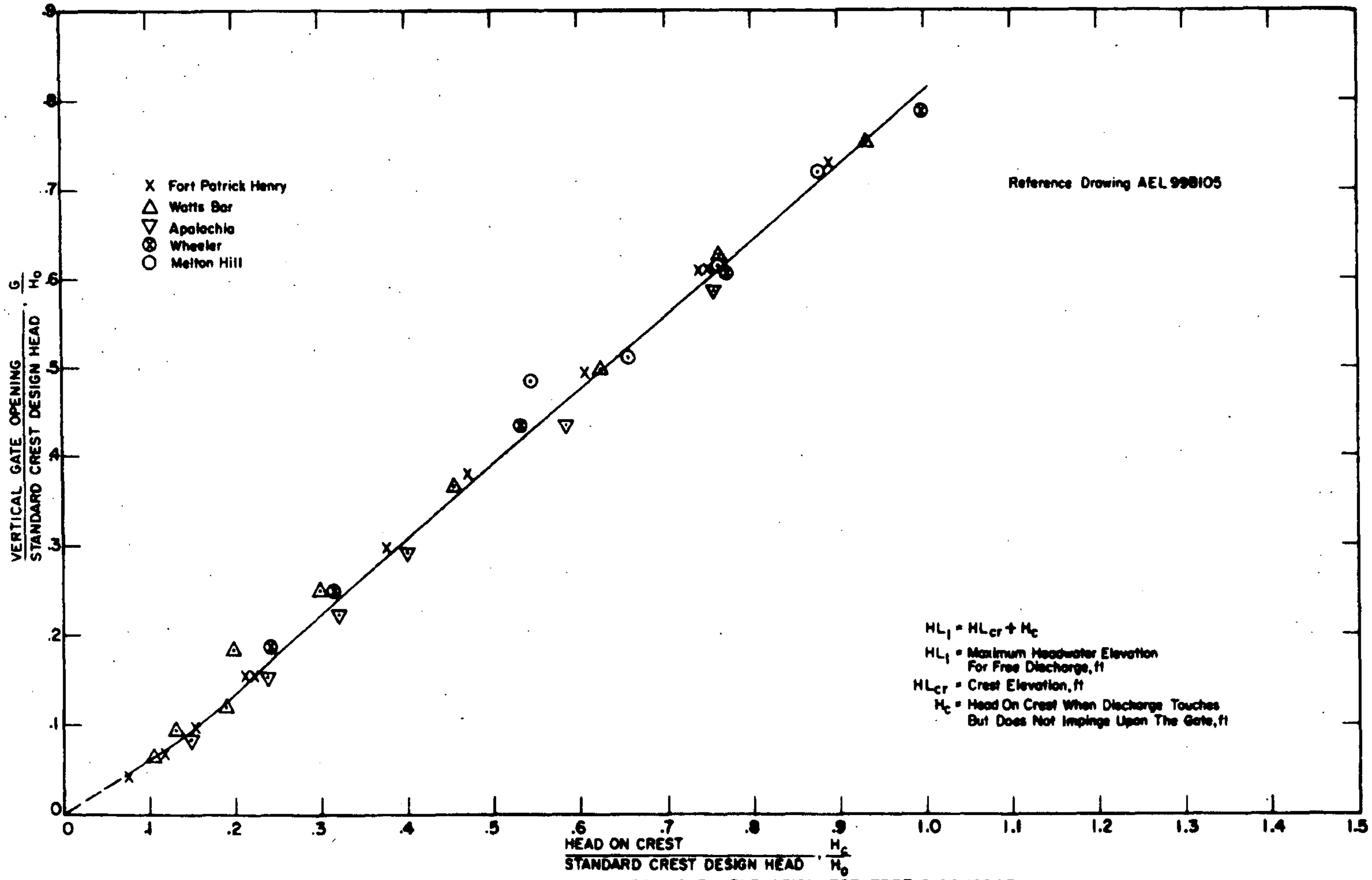


FIGURE A2: MAXIMUM HEADWATER ELEVATION FOR FREE DISCHARGE

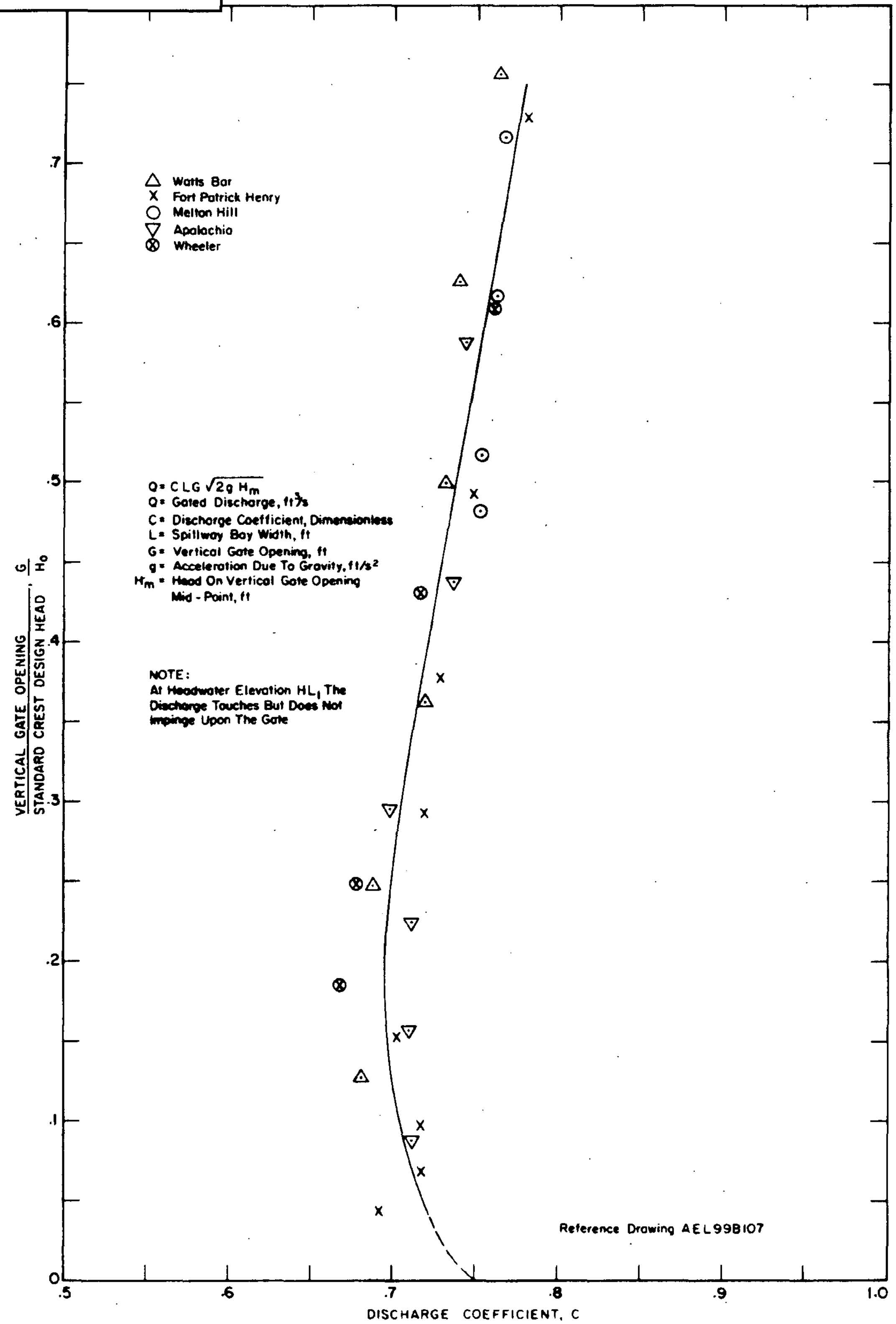


FIGURE A3: GATED DISCHARGE COEFFICIENTS FOR HEADWATER ELEVATION HL_1

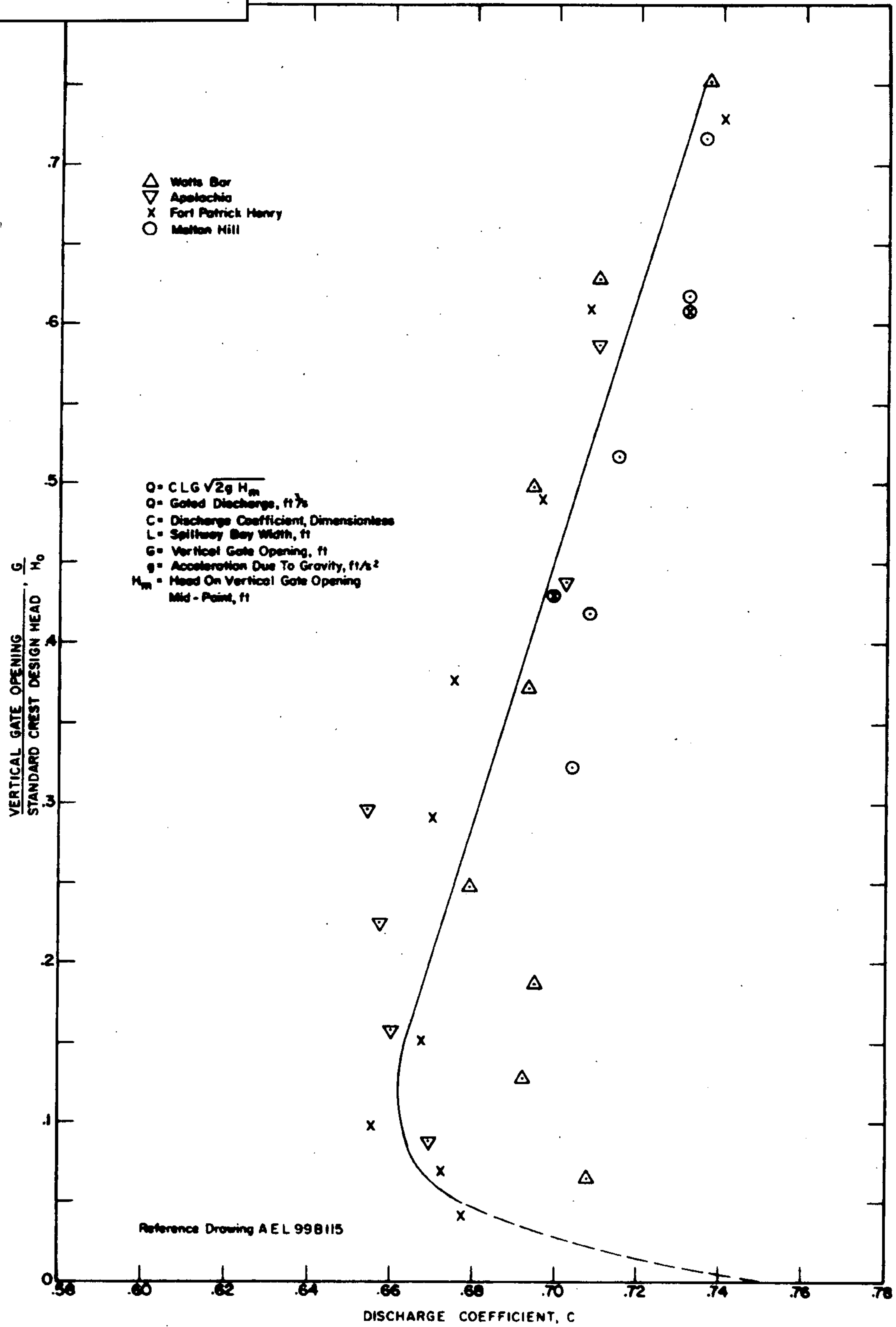


FIGURE A4: GATED DISCHARGE COEFFICIENTS FOR HEADWATER ELEVATION $HL_1 + 0.025\ H_o$

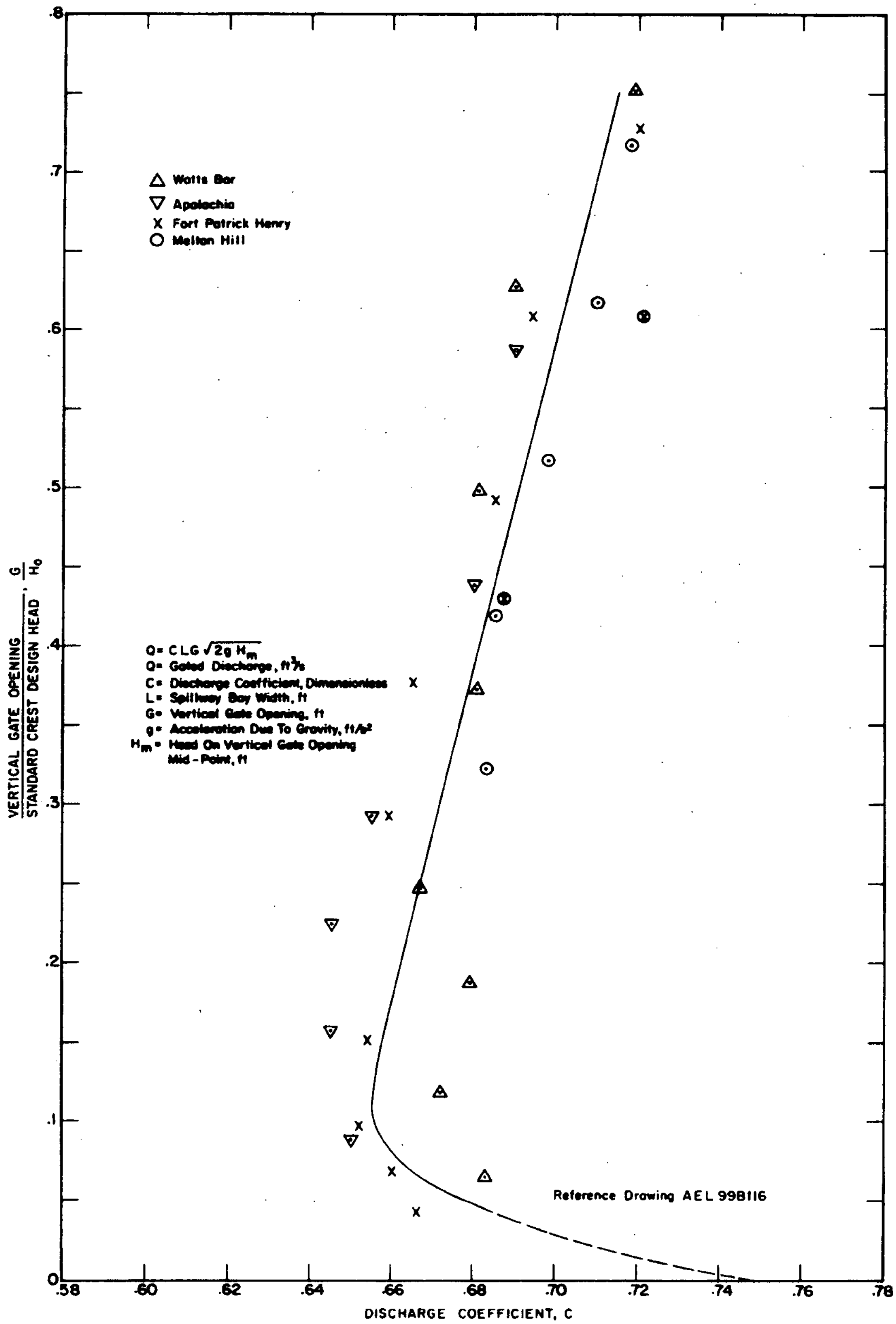


FIGURE A5: GATED DISCHARGE COEFFICIENTS FOR HEADWATER ELEVATION $HL_1 + 0.050 H_o$

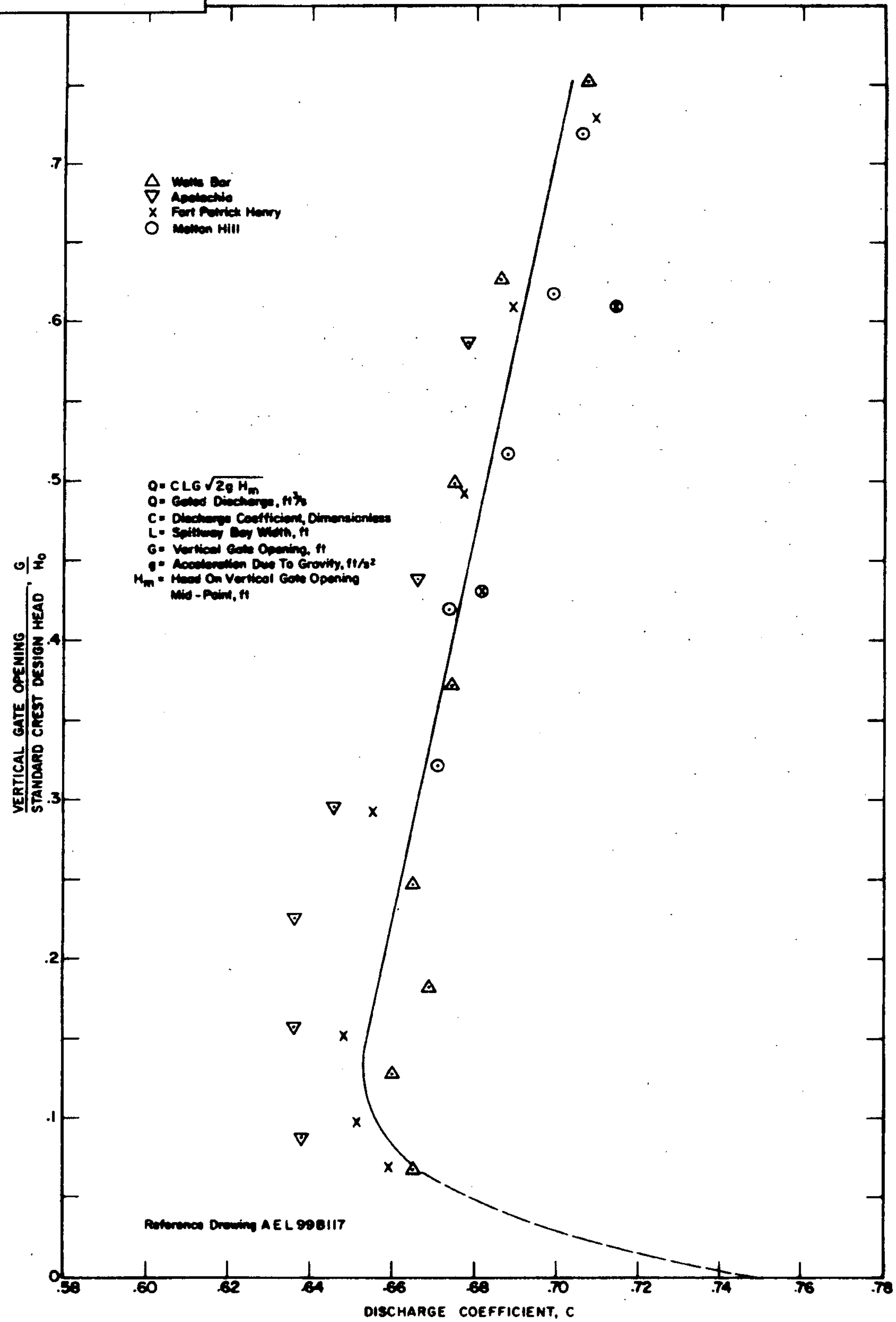


FIGURE A6: GATED DISCHARGE COEFFICIENTS FOR HEADWATER ELEVATION HL_1 +0.075 H_0

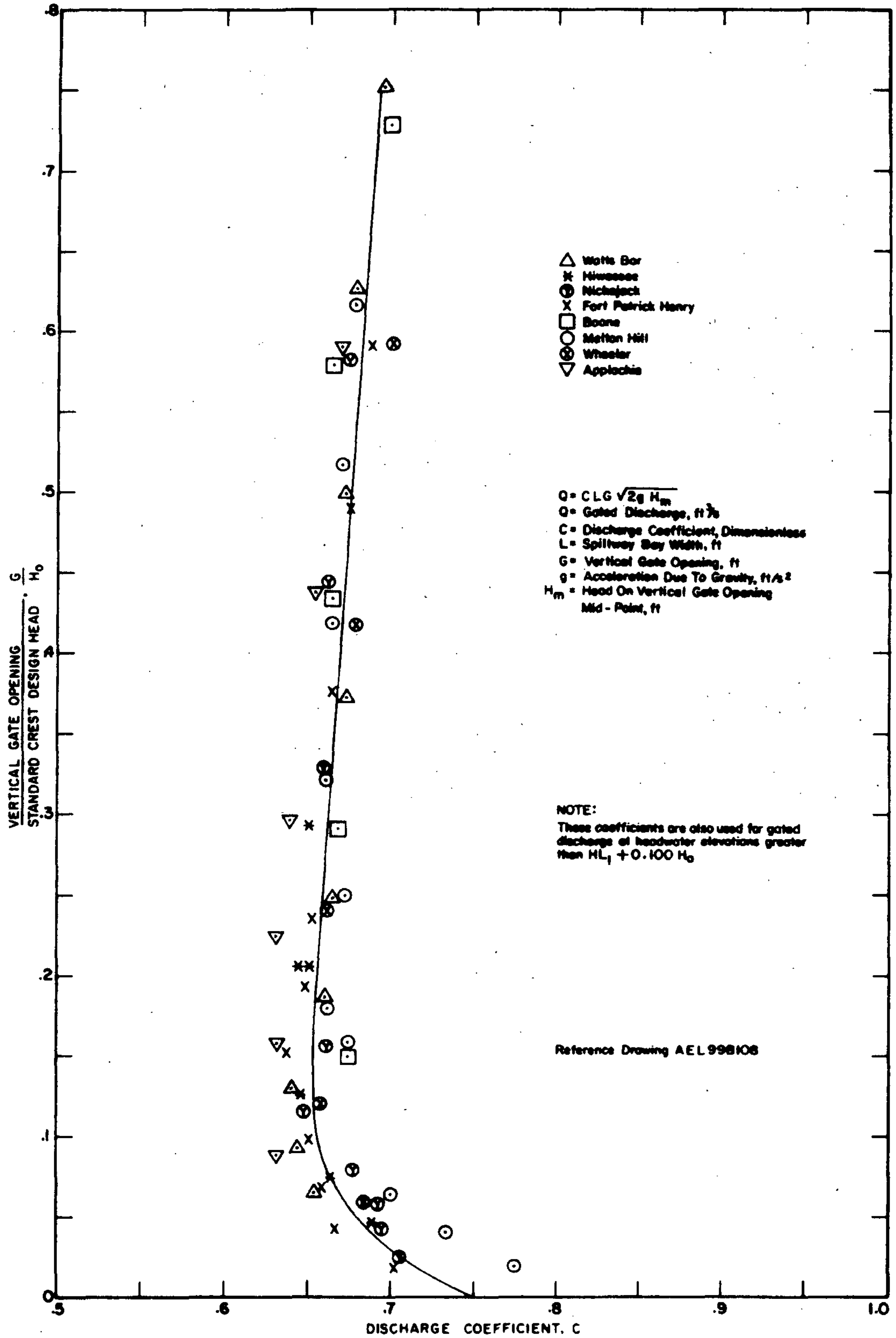


FIGURE A7: GATED DISCHARGE COEFFICIENTS FOR HEADWATER ELEVATION $HL_1 + 0.100 H_0$

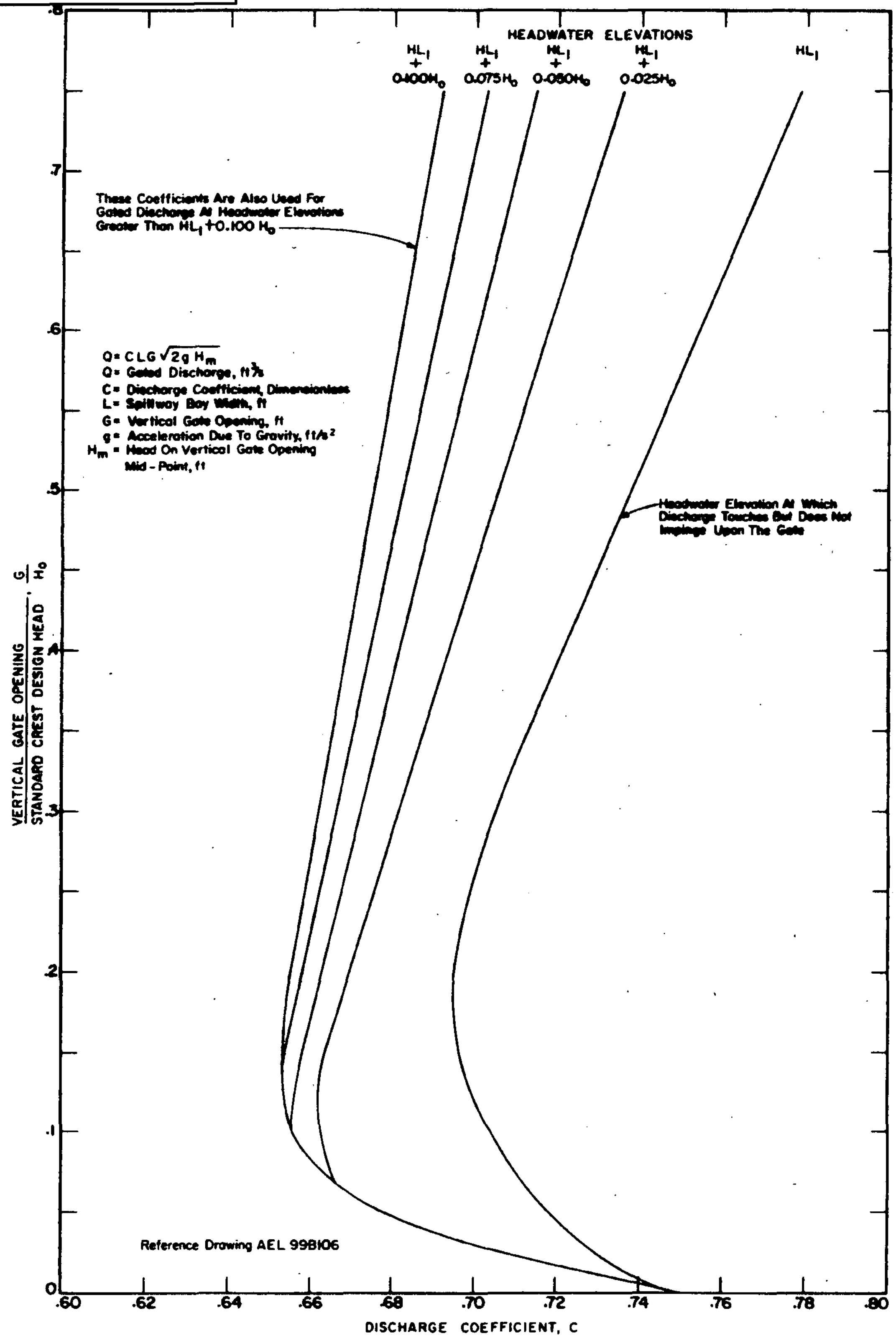


FIGURE A8: GATED DISCHARGE COEFFICIENTS-SUMMARY OF AVERAGE COEFFICIENTS AS A FUNCTION OF HEADWATER ELEVATION

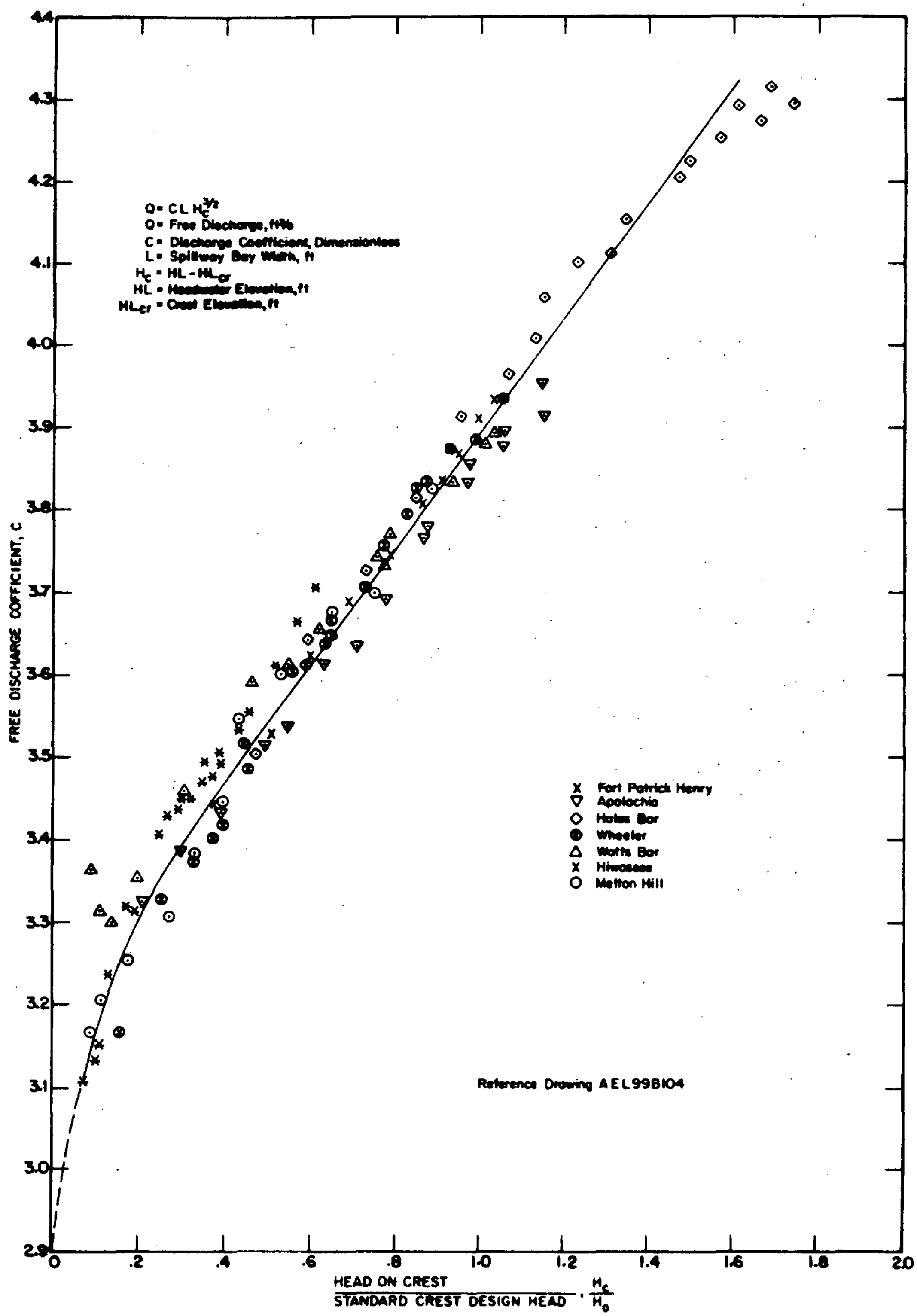


FIGURE A1: FREE DISCHARGE COEFFICIENTS

HYDRAULIC DESIGN CRITERIA

SHEETS 111-1 to 111-2/1

OVERFLOW SPILLWAY CREST

1. Previous Crest Shapes. Some early crest shapes were based on a simple parabola designed to fit the trajectory of the falling nappe. Bazin's experiments of the 19th century were the basis of many early designs. The Bureau of Reclamation conducted extensive experiments on the shape of the nappe over a sharp-crested weir (reference 2). Numerous crests have been designed using the coordinates of the lower surface of the nappe for the shape of the crest, without resort to an equation. The Huntington District has used an equation involving the 1.82 power of X and the Nashville District has used the 1.88 power of X.

2. Standard Shape, Downstream Quadrant. A comparison of the Bureau of Reclamation data with those of other experimenters was made by the Office, Chief of Engineers. On the basis of this study, Circular Letter No. 3281 was issued on 2 September 1944, suggesting the use of the 1.85 power of X. This equation is given in Hydraulic Design Charts 111-1 and 111-2 and was adopted to define the downstream quadrant shape.

3. Point of Tangency. The slope function graph of the tangents X and Y to the downstream quadrant is shown in Chart 111-1 to facilitate the location of the point of tangency α. Although it is realized that the tangent point will often be determined analytically for the final design, this graph should be of value in the preliminary layouts in connection with stability analyses and cost estimates. The downstream tangent points can be computed from

$$\frac{X}{H_d} = 1.096 \left(\frac{1}{\alpha}\right)^{1.176} \qquad (1)$$

and

$$\frac{Y}{H_d} = 0.592 \left(\frac{1}{\alpha}\right)^{2.176} \qquad (2)$$

where H_d is the design head.

4. Standard Shape, Upstream Quadrant. The upstream quadrant shape of circular arcs originally defined in Chart 111-1, dated 4-1-52 (revised 8-60), resulted in a surface discontinuity at the vertical spillway face. A third, short-radius arc ($R = 0.04H_d$) incorporated in this design has been model tested (reference 1) and found to result in

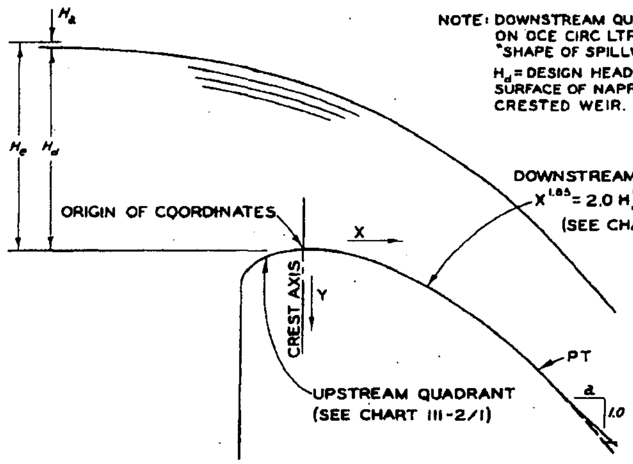
improved pressure conditions and discharge coefficients for heads exceeding the design head. Chart 111-2/1 (revised 9-70) presents this upstream crest quadrant design. A table of coordinates in terms of X/H_d and Y/H_d is included as Chart 111-2 for design convenience.

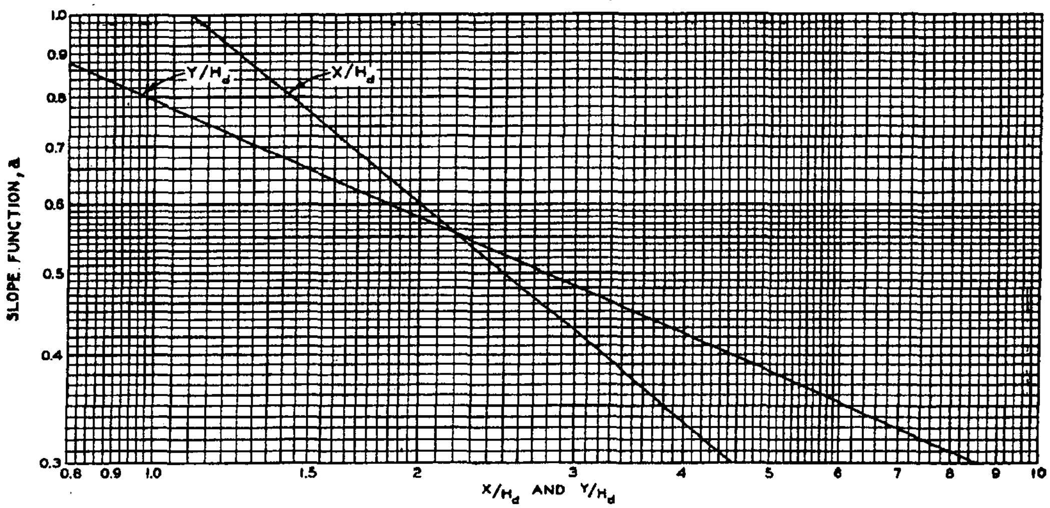
5. Recent model studies have verified the elliptical upstream quadrant design also presented in reference 1. This method, depicted in Hydraulic Design Charts 111-20 through 111-25/1, should be used for future spillway design. The Standard Shape Criteria will be retained for reference purposes.

6. References.

(1) U. S. Army Engineer Waterways Experiment Station, CE, Investigations of Various Shapes of the Upstream Quadrant of the Crest of a High Spillway; Hydraulic Laboratory Investigation, by E. S. Melsheimer and T. E. Murphy. Research Report H-70-1, Vicksburg, Miss., January 1970.

(2) U. S. Bureau of Reclamation, U. S. Department of the Interior, Boulder Canyon Project, Hydraulic Investigations; Studies of Crests for Overfall Dams. Part VI, Bulletin 3, Denver, Colo., 1948.





NOTE: COORDINATES OF TANGENT POINT FOR PRELIMINARY LAYOUTS AND ESTIMATES.

OVERFLOW SPILLWAY CREST
TANGENT ORDINATES

HYDRAULIC DESIGN CHART III-1

REV 8-60 WES 4-1-52

X	$X^{1.85}$	X	$X^{1.85}$	H_d	$2H_d^{0.85}$	H_d	$2H_d^{0.85}$	H_d	$2H_d^{0.85}$
0.10	0.0141	6	27.515	1	2.000	26	31.896	51	56.554
.15	.0299	7	36.596	2	3.605	27	32.937	52	57.495
.20	.0509	8	46.851	3	5.088	28	33.971	53	58.434
.25	.0769	9	58.257	4	6.498	29	35.000	54	59.370
.30	.1078	10	70.795	5	7.855	30	36.024	55	60.303
.35	.1434	12	99.194	6	9.172	31	37.041	56	61.234
.40	.1836	14	131.928	7	10.460	32	38.054	57	62.162
.45	.2283	16	168.897	8	11.713	33	39.063	58	63.088
.50	.2774	18	210.017	9	12.946	34	40.066	59	64.011
.60	.3887	20	255.215	10	14.159	35	41.067	60	64.932
.70	.5169	25	385.646	11	15.354	36	42.062	61	65.851
.80	.6618	30	540.349	12	16.532	37	43.053	62	66.767
.90	.8229	35	718.664	13	17.696	38	44.040	63	67.681
1.00	1.000	40	920.049	14	18.847	39	45.023	64	68.594
1.20	1.401	45	1144.045	15	19.985	40	46.002	65	69.503
1.40	1.864	50	1390.255	16	21.112	41	46.978	66	70.411
1.60	2.386	55	1658.330	17	22.229	42	47.950	67	71.317
1.80	2.967	60	1947.959	18	23.335	43	48.919	68	72.221
2.00	3.605	65	2258.863	19	24.433	44	49.884	69	73.123
2.50	5.447	70	2590.785	20	25.521	45	50.846	70	74.022
3.00	7.633	75	2943.496	21	26.602	46	51.807	71	74.920
3.50	10.151	80	3316.779	22	27.674	47	52.761	72	75.816
4.00	12.996	90	4124.285	23	28.741	48	53.714	73	76.710
4.50	16.160	100	5011.872	24	29.799	49	54.663	74	77.603
5.00	19.638			25	30.852	50	55.610	75	78.493

OVERFLOW SPILLWAY CREST EQUATIONS

$$X^{1.85} = 2H_d^{0.85}Y, \quad Y = \frac{X^{1.85}}{2H_d^{0.85}}; \text{ WHERE } H_d = \text{DESIGN HEAD}$$

NOTE: SEE CHART 111-2/1 FOR UPSTREAM QUADRANT COORDINATES.

OVERFLOW SPILLWAY CREST

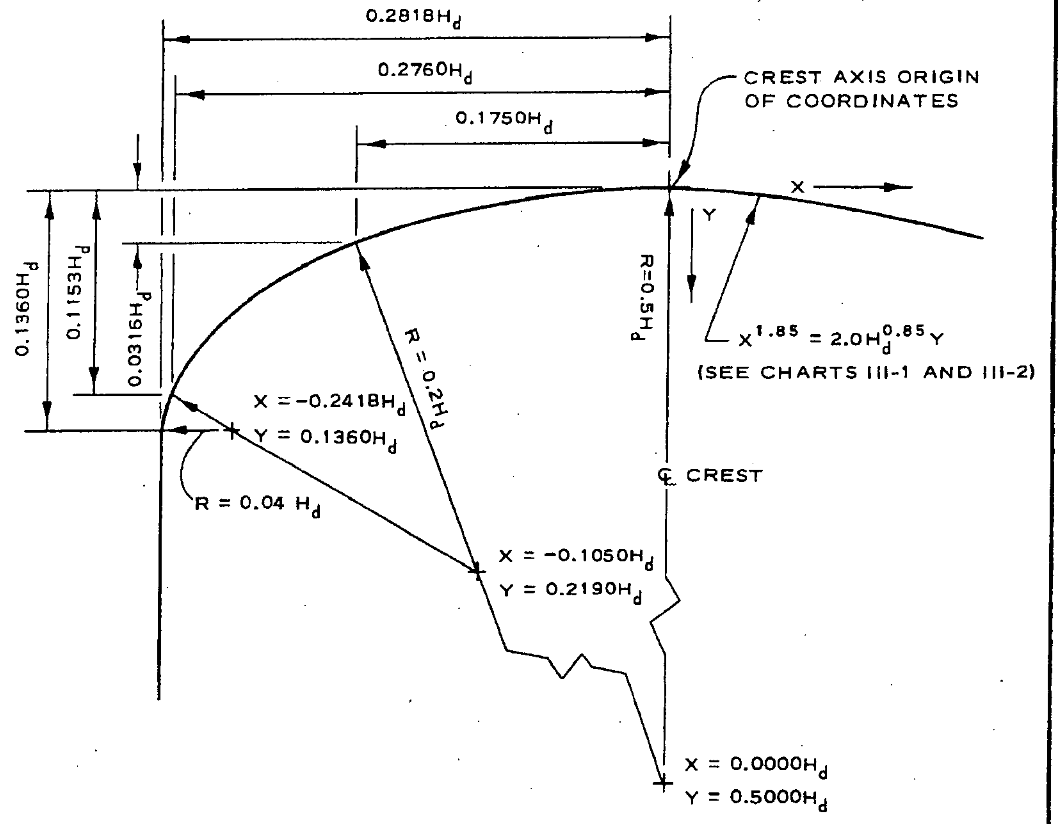
DOWNSTREAM QUADRANT

TABLE OF FUNCTIONS

HYDRAULIC DESIGN CHART 111-2

REV 9-60 WES 4-52

PREPARED BY U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MISSISSIPPI



COORDINATES FOR UPSTREAM QUADRANT

$\frac{X}{H_d}$	$\frac{Y}{H_d}$	$\frac{X}{H_d}$	$\frac{Y}{H_d}$
−0.0000	0.0000	−0.2200	0.0553
−0.0500	0.0025	−0.2400	0.0714
−0.1000	0.0101	−0.2600	0.0926
−0.1500	0.0230	−0.2760	0.1153
−0.1750	0.0316	−0.2780	0.1190
−0.2000	0.0430	−0.2800	0.1241
		−0.2818	0.1360

NOTE: H_d = DESIGN HEAD BASED ON LOWER SURFACE OF NAPPE FROM SHARP-CRESTED WEIR WITH NEGLIGIBLE VELOCITY OF APPROACH AND CREST AT X = −0.2818H_d, Y = 0.1259H_d.

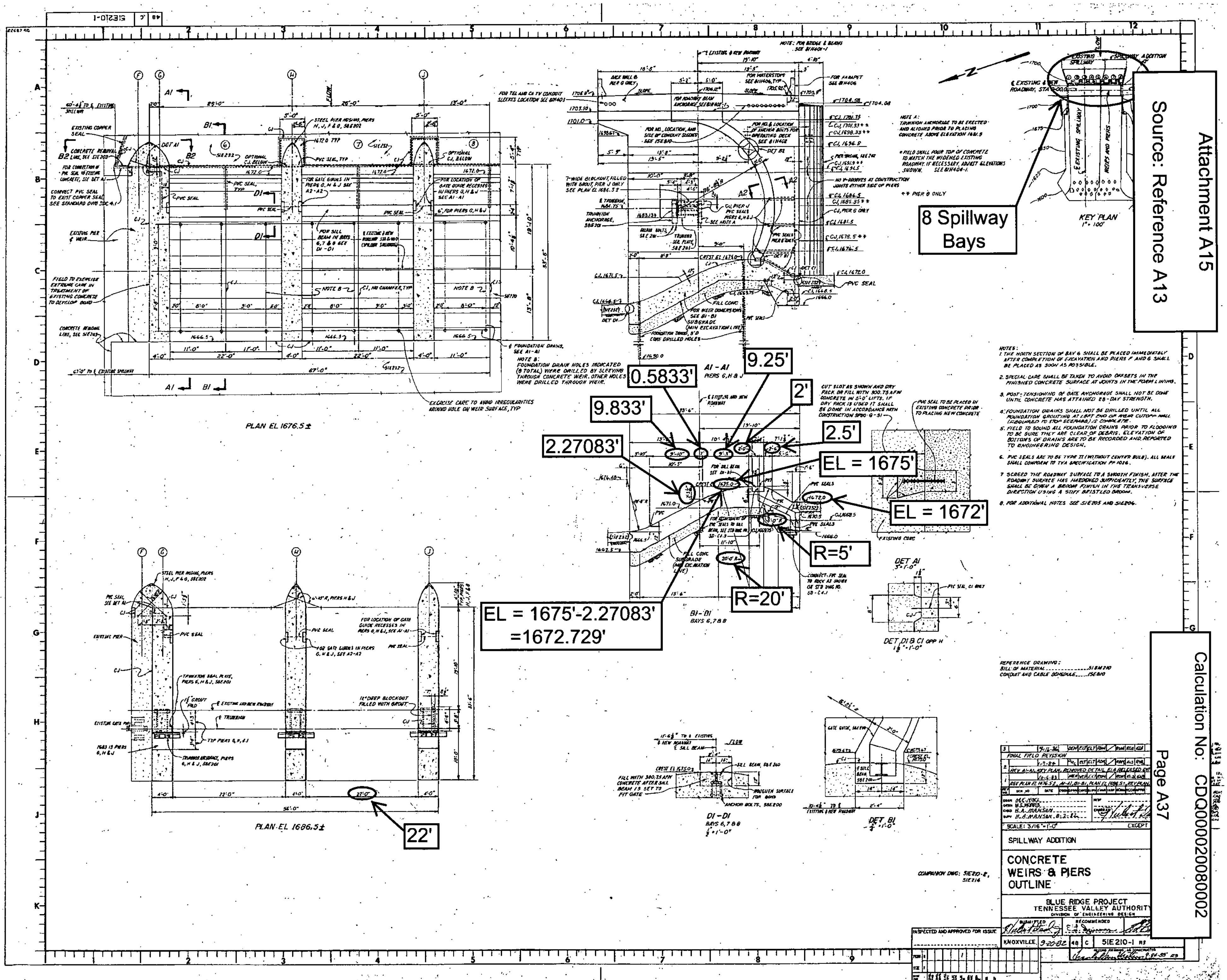
OVERFLOW SPILLWAY CREST
UPSTREAM QUADRANT

HYDRAULIC DESIGN CHART 111-2/1

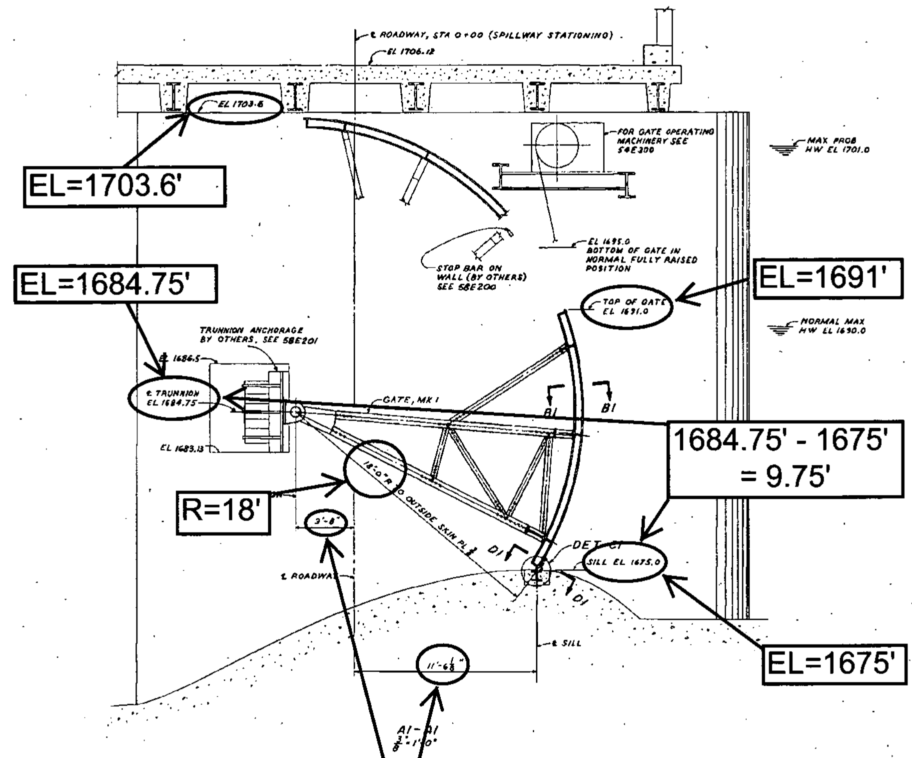
PREPARED BY U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MISSISSIPPI

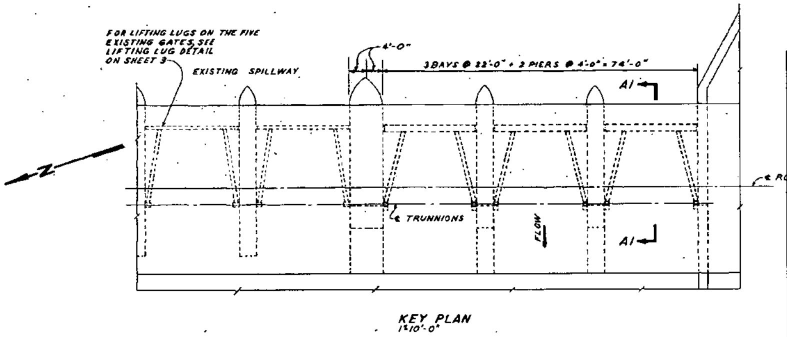
REV 9-70, 8-71

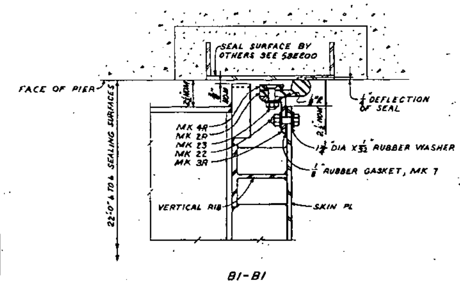
Attachment A15
Source: Reference A13

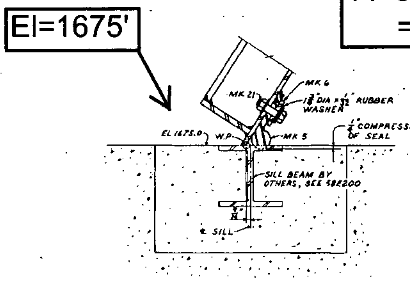


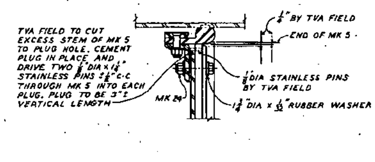
Calculation No: CDQ000020080002
Page A37

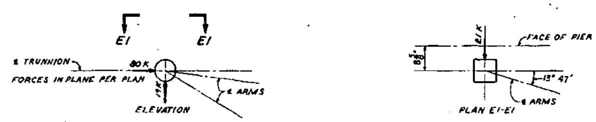












TRUNNION LOADING DIAGRAM
MAX LOADS FOR ONE TRUNNION WITH H.W. @ EL 1690.0
NTS

GENERAL NOTES:

1. MARK NUMBERS ON DRAWINGS HAVE PREFIX 54E200.
2. QUANTITIES OF ITEMS SHOWN ON DRAWINGS ARE FOR THREE GATES.
3. STRUCTURAL STEEL ASTM A441 OR A588 UNLESS NOTED. SEE SPECIFICATION FOR SPECIFIC MATERIAL LISTING.
4. THREADS ANSI COURSE-THREAD SERIES CLASS 2A FIT FOR BOLTS AND CLASS 2B FIT FOR NUTS UNLESS OTHERWISE NOTED.
5. GATE WATERTIGHT AGAINST HW PRESSURE.
6. WELD METAL AWS 5.1, E70 SERIES.
7. BOLT HEADS AND NUTS ANSI REGULAR SEMI FINISHED HEXAGON, UNLESS OTHERWISE NOTED

FIELD NOTES:

1. TVA FIELD TO FURNISH AND INSTALL ALL NORDBAK, ASPHALT FELT, FILLER PLATES MK 27, AND ALL STEEL BARS AND STRIPS SHOWN IN SECTIONS A5-A5, C5-C5, AND D5-D5.
2. TRUNNIONS SET ACCORDING TO SKIN PLATE CLEARANCE DIMENSIONS AND SIDE SEAL DEFLECTION SHOWN IN SECTION B1-B1.
3. STEEL STRIPS FOR RETAINING NORDBAK WELDED TO TRUNNION SHOE, MK 8, AS SHOWN IN SECTION C5-C5.
4. AFTER HARDENING OF NORDBAK FILLER, SETSCREWS (MK 9) TO BE BACKED OUT SLIGHTLY AND BOLTS (MK 15) RETIGHTENED TO ADJUST FOR NORDBAK SHRINKAGE.
5. FILLER PLATE, MK 27, TO BE AGITATED WHEN NORDBAK IS IN LIQUID STATE TO ELIMINATE FORMATION OF VOIDS.

FOR MANUFACTURERS DETAILS REFER TO LAKESIDE BRIDGE AND STEEL CO. FILE, TVA CONTRACT NO. 83K70-833540

COMPANION DWGS: 54E200-2 THRU -5

2 FINAL FIELD REVISIONS
1 NOTES 3 & 6 REVISED

SCALE: 3" = 1'-0" EXCEPT

SPILLWAY ADDITION

SPILLWAY GATE
GENERAL ARRANGEMENT

BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE 11-10-82 46 H 54E200-1

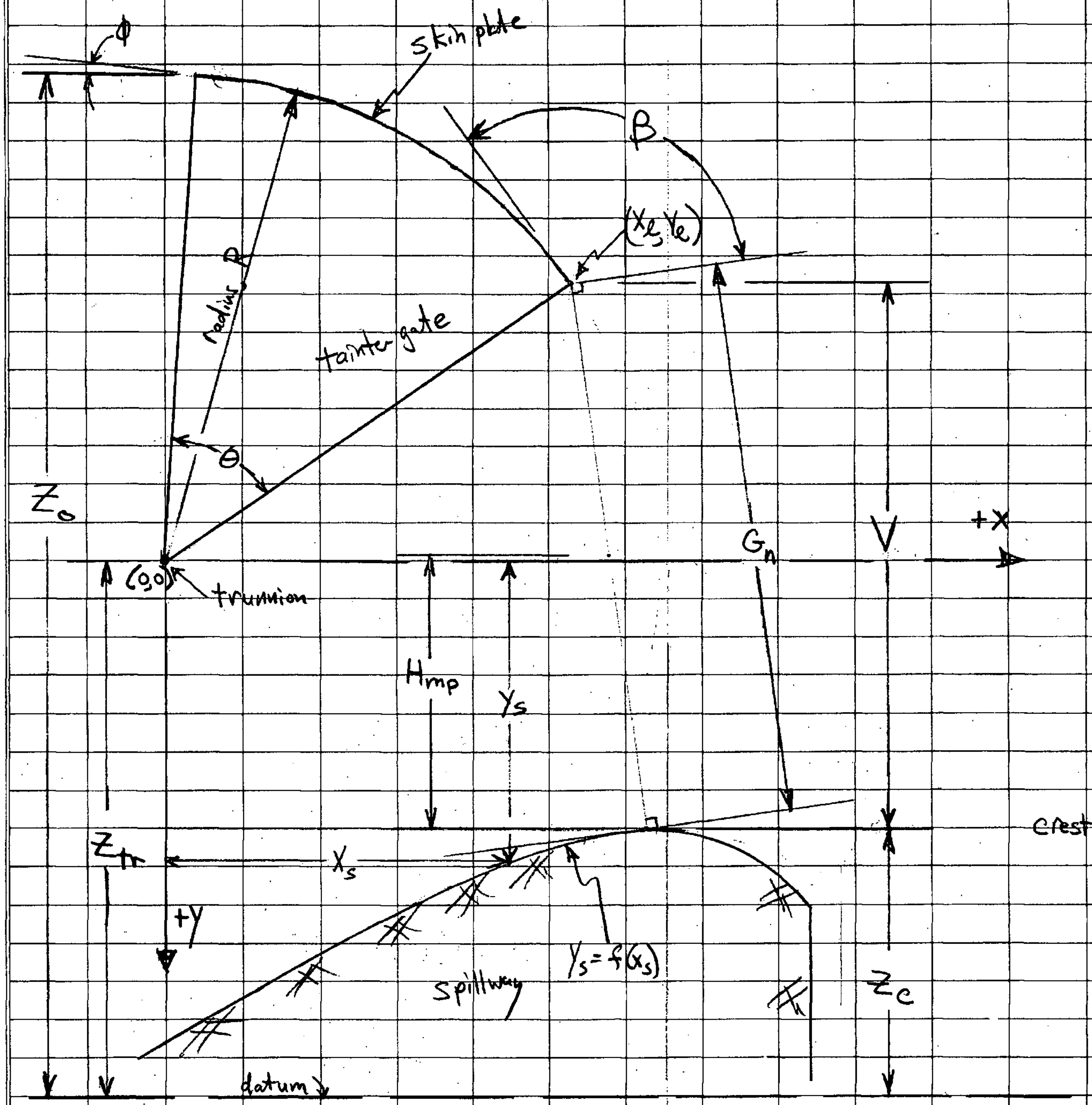
Spillway Discharge Calculations Geometry for Flow Under an Open Tainter Gate

Calculation No: CDQ000020080002
Page A39

COMPUTED GAS DATE 8/11/2008

CHECKED ___ DATE ___

Definition Sketch



Spillway Gate Geometry

Variables

V = vertical distance between the bottom of the open gate and the crest
Z_c = crest elevation
Z_{tr} = trunnion elevation
Z_o = overflow elevation
R = radius of the tainter gate
G_n = minimum distance between the gate lip and the crest
H_{mp} = vertical distance between the mid-point of G_n and the crest
β = angle formed by the tangent to the gate lip and the tangent to the crest curve at the nearest point of the crest curve
θ = angle of the sector of a circle formed by two lines connecting the trunnion axis to the bottom and top of the radial gate.
x, y = coordinates relative to trunnion axis (y positive downward)
~~x_s, y_s = coordinates of spillway surface defined by $y_s = f(x_s)$~~
x_e, y_e = coordinates of the gate lip relative to trunnion axis

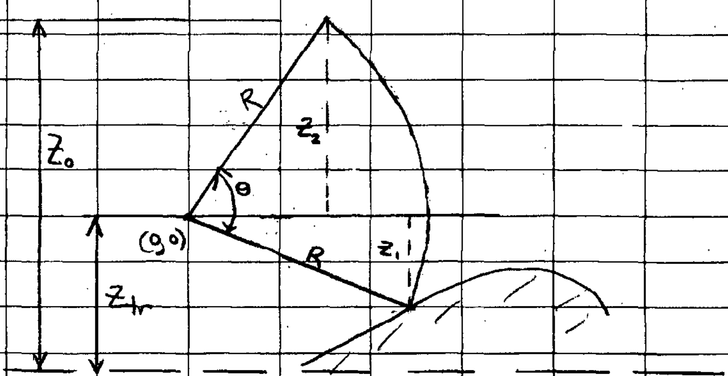
notes: { y positive downward for all coordinates; all coordinates relative to trunnion axis }

ϕ = angle formed by the tangent to the gate top and horizontal

Angle, θ

$$\theta = \sin^{-1}\left(\frac{z_2}{R}\right) + \sin^{-1}\left(\frac{z_1}{R}\right)$$

z_1 & z_2 are determined from drawings



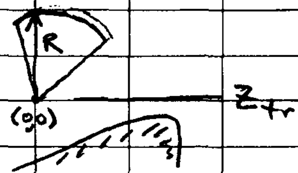
Closed Gate

Spillway Gate Geometry

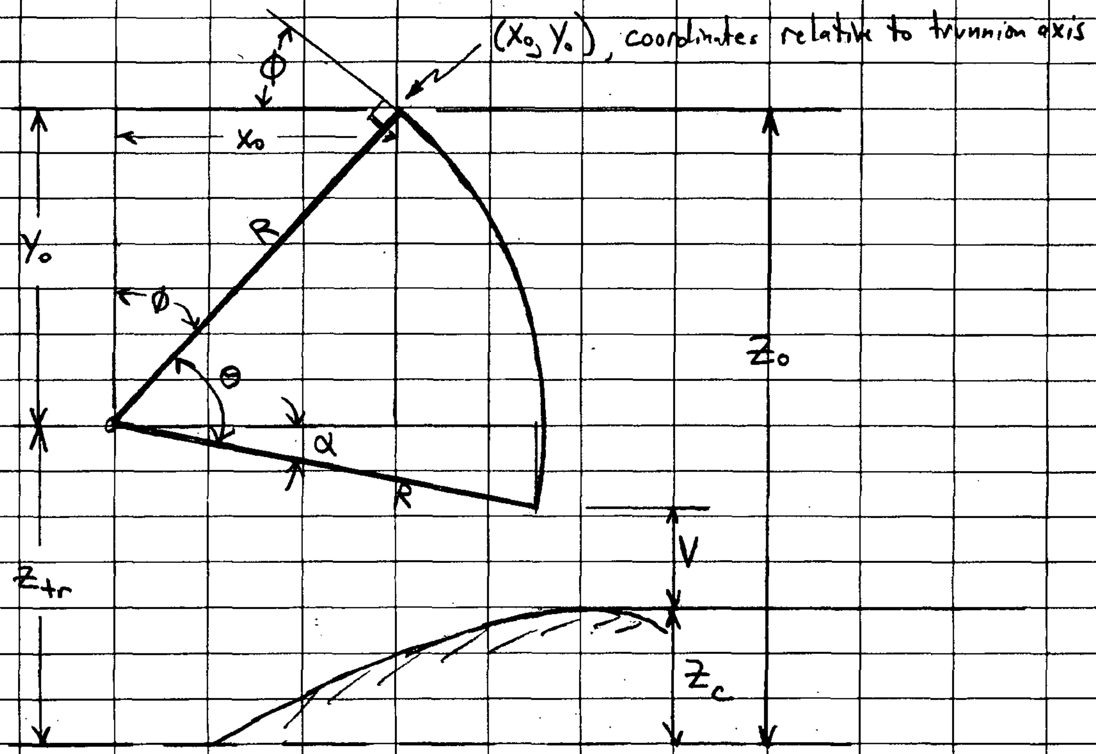
Overflow Elevation, Z_o and Angle, Φ

For a gate opened so far that its upper edge is downstream of the trunnion:

$$Z_o = Z_{tr} + R$$



For a gate opened less:



$$\alpha = \tan^{-1}\left(\frac{Z_{tr} - (Z_{cr} + V)}{\sqrt{R^2 - (Z_{tr} - Z_{cr} - V)^2}}\right)$$

V given

$$Z_o = Z_{tr} + R\sin(\theta - \alpha)$$

and $$\Phi = \tan^{-1}\left(\frac{X_o}{Y_o}\right)$$ with $$\begin{cases} Y_o = Z_o - Z_{tr} \\ X_o = R\cos(\theta - \alpha) \end{cases}$$

Spillway Gate Geometry

COMPUTED GAS DATE 8/11/2008
CHECKED ____ DATE ____

Gate Opening, G_n

Gate lip coordinates: $\begin{cases} Y_\ell = Z_{tr} - Z_{cr} - V \\ X_\ell = \sqrt{R^2 - Y_\ell^2} \end{cases}$

Distance between gate lip and any point on spillway surface is

$$\ell = \sqrt{(X_s - X_\ell)^2 + (Y_s - Y_\ell)^2} \equiv \sqrt{(X_s - X_\ell)^2 + [f(X_s) - Y_\ell]^2}$$

G_n is the minimum distance. ℓ is minimum when $\frac{d\ell}{dX_s} = 0$

$$\frac{d\ell}{dX_s} = \frac{1}{2}\left\{(X_{sn} - X_\ell)^2 + [f(X_{sn}) - Y_\ell]^2\right\}^{-1/2} \cdot \left\{2(X_{sn} - X_\ell) + 2[f(X_{sn}) - Y_\ell]\frac{df(X_{sn})}{dX_s}\right\} = 0$$

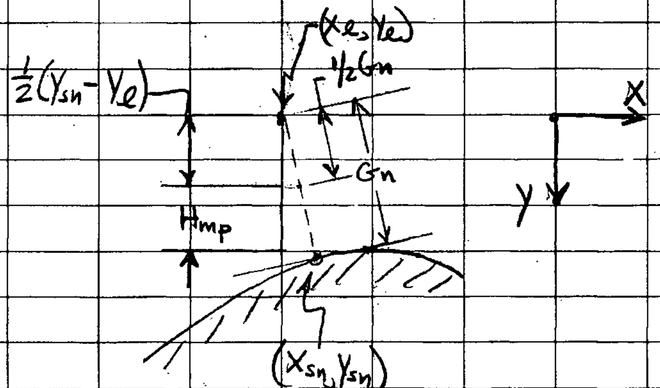
$$\Rightarrow 0 = \frac{(X_{sn} - X_\ell) + [f(X_{sn}) - Y_\ell]\frac{df(X_{sn})}{dX_s}}{\ell_{minimum}}$$

where $X_{sn} = X_s$ for minimum ℓ, $\ell_{minimum} \equiv G_n$.

Solve: $X_{sn} - X_\ell + [f(X_{sn}) - Y_\ell]\frac{df(X_{sn})}{dX_s} = 0$ for X_{sn}

Then: $Y_{sn} = f(X_{sn})$ and $\boxed{G_n = \sqrt{(X_{sn} - X_\ell)^2 + (Y_{sn} - Y_\ell)^2}}$

Mid-Point Head, H_{mp}



$$H_{mp} = Z_{tr} - Z_c - Y_\ell - \frac{1}{2}(Y_{sn} - Y_\ell)$$

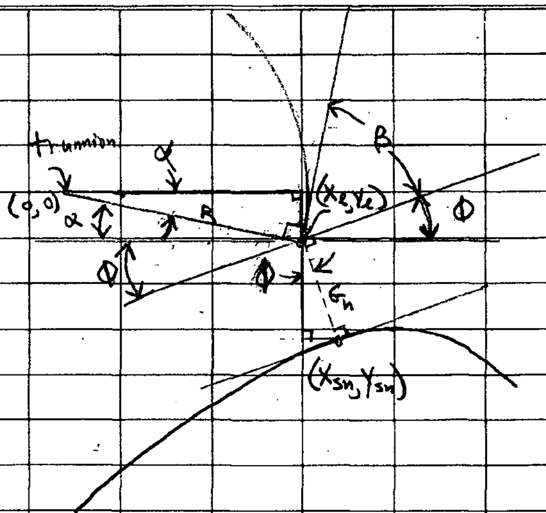
$$\Rightarrow \boxed{H_{mp} = V - \frac{1}{2}(Y_{sn} - Y_\ell)}$$

Spillway Gate Geometry

COMPUTED GAS DATE

CHECKED DATE

Angle, B



$$\beta + \frac{\pi}{2} + \alpha + \phi = \pi$$

$$\beta + \phi = \frac{\pi}{2} - \alpha$$

$$\beta = \frac{\pi}{2} - \alpha - \phi$$

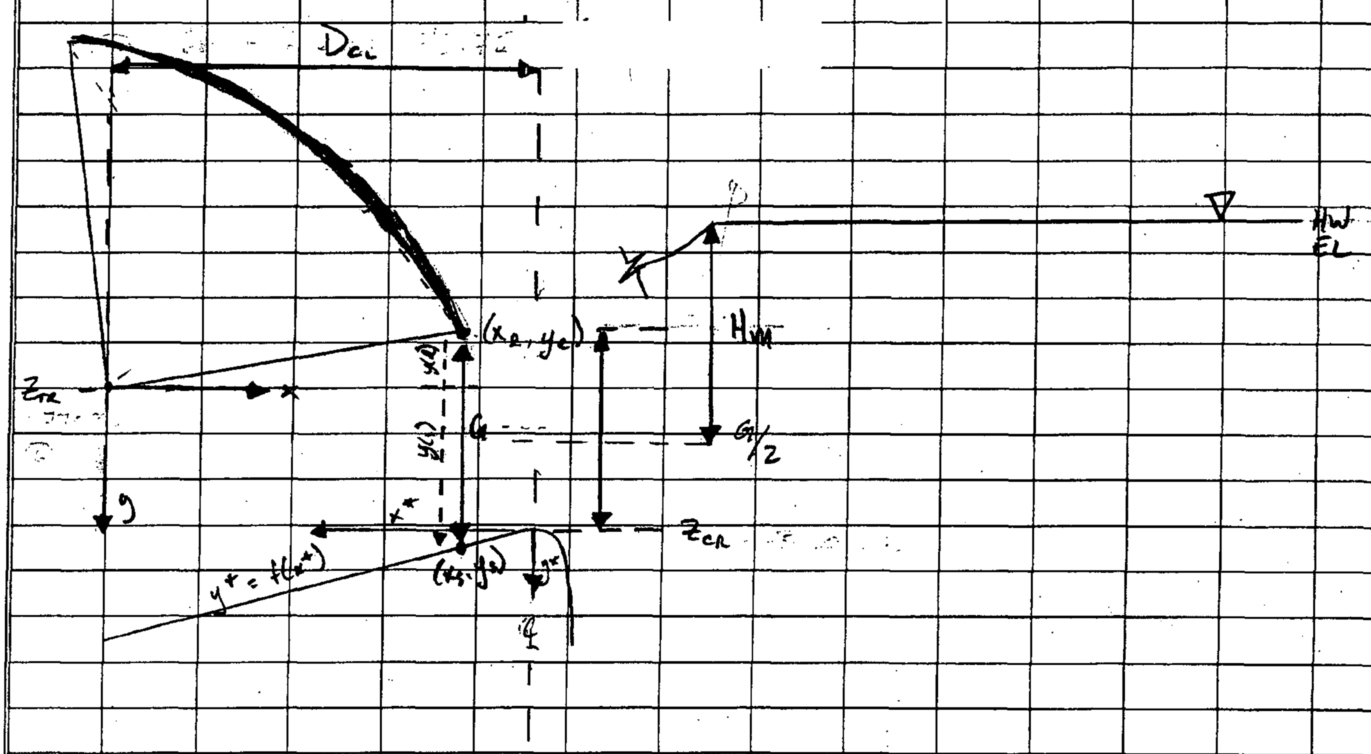
$$\alpha = \tan^{-1}\left(\frac{Y_e}{X_e}\right)$$

$$\phi = \tan^{-1}\left(\frac{X_{sn} - X_e}{Y_{sn} - Y_e}\right)$$

$$\beta = \frac{\pi}{2} - \tan^{-1}\left(\frac{Y_e}{X_e}\right) - \tan^{-1}\left(\frac{X_{sn} - X_e}{Y_{sn} - Y_e}\right)$$

DAM RATING CURVE –
– GATE GEOMETRY

COMPUTED CTS DATE 10/31/08
CHECKED DATE



$$y = y^* + Z_{TR} - Z_{CR} \Rightarrow y^* = y - (Z_{TR} - Z_{CR})$$

$$x = D_{CL} - x^* \Rightarrow x^* = D_{CL} - x$$

$$y^* = f(x^*) \Rightarrow y_s - (Z_{TR} - Z_{CR}) = f(D_{CL} - x)$$

Evaluate at $x = x_e$ to Determine y_s

$$G = y_e - y_s$$

$$H_M = H_W - (Z_{CR} + \nabla) + \frac{G}{2}$$

Attachment A18

Attachment A26 Blue Ridge Model Data For Headwater Ratings.xls, Hlmin Determination

Calculation No: CDQ000020080002

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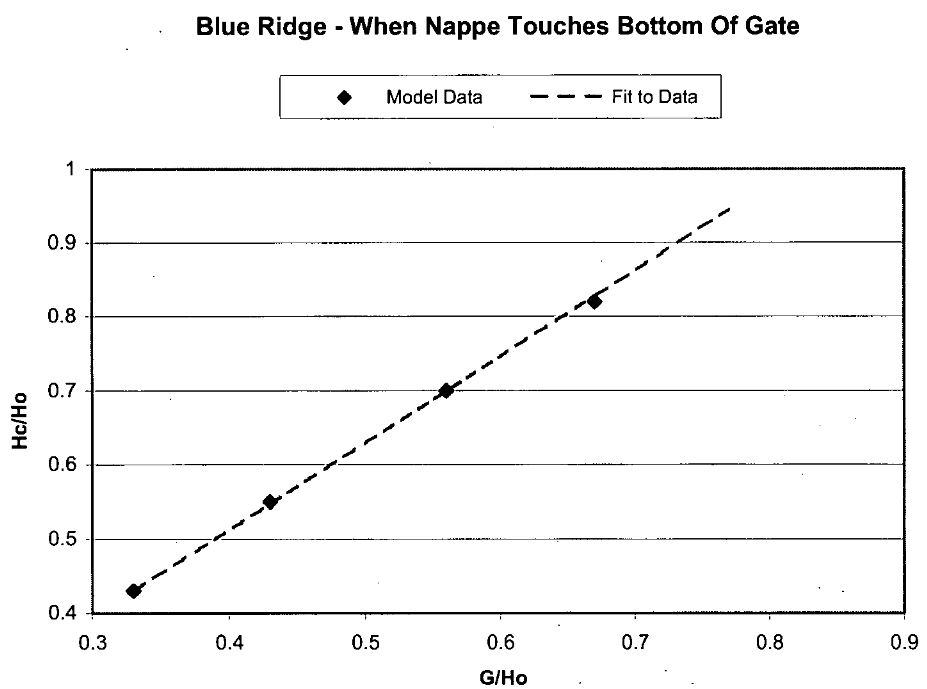
H_o = 34 ft
G = 19.195 ft

G/Ho	Hc/Ho (Data)		Hc/Ho (Fit)	Hc (feet)
0.33	0.43	From Drawing AEL99B105	0.43	14.64
0.43	0.55		0.55	18.61
0.56	0.7		0.70	23.78
0.5646	*		0.70	23.96
0.67	0.82		0.83	28.15
0.77	0.95		0.94	32.12

* Data point relevant to this calculation, not used to develop relationship between G/H_o and H_c/H_o



Hc/Ho = 1.1688*(G/Ho)+0.0448

Electronic version available in Attachment A26

Attachment A19
Source: Reference A2

Attachment A26 Blue Ridge Model Data For Headwater Ratings.xls, Free Discharge

Calculation No: CDQ000020080002

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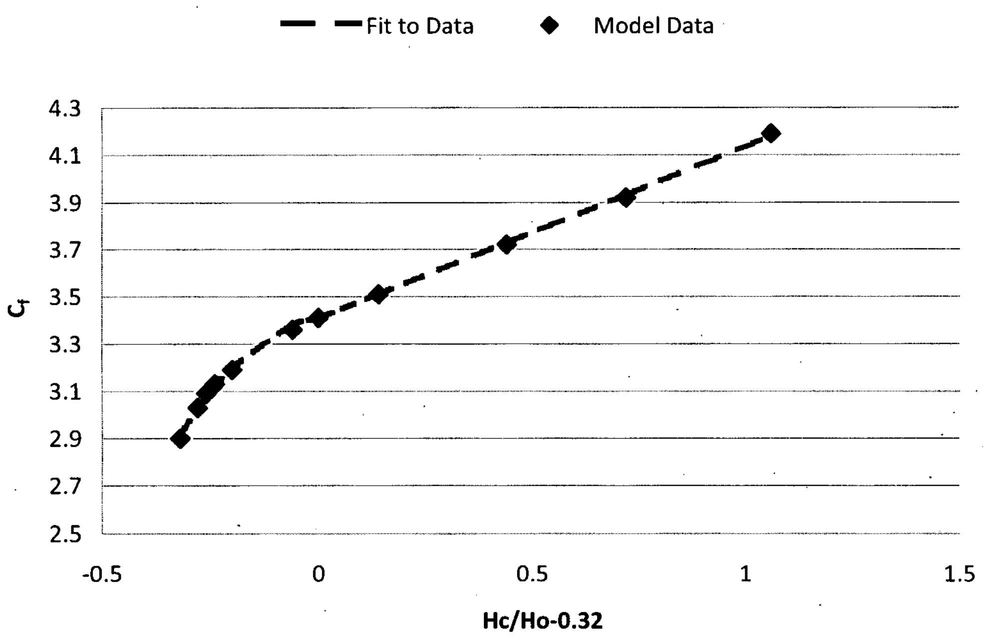
Ho = 37 feet

Hc/Ho	Hc/Ho-0.32	Cf (model data)		Cf (fit)	Hc (feet)
0	-0.32	2.9	From Drawing AEL99B104	2.92	0
0.04	-0.28	3.03		3.02	1.48
0.06	-0.26	3.09		3.07	2.22
0.08	-0.24	3.13		3.12	2.96
0.12	-0.2	3.19		3.20	4.44
0.26	-0.06	3.36		3.38	9.62
0.32	0	3.41		3.41	11.84
0.46	0.14	3.51		3.51	17.02
0.76	0.44	3.72		3.73	28.12
1.04	0.72	3.92		3.93	38.48
1.38	1.06	4.19		4.18	51.06

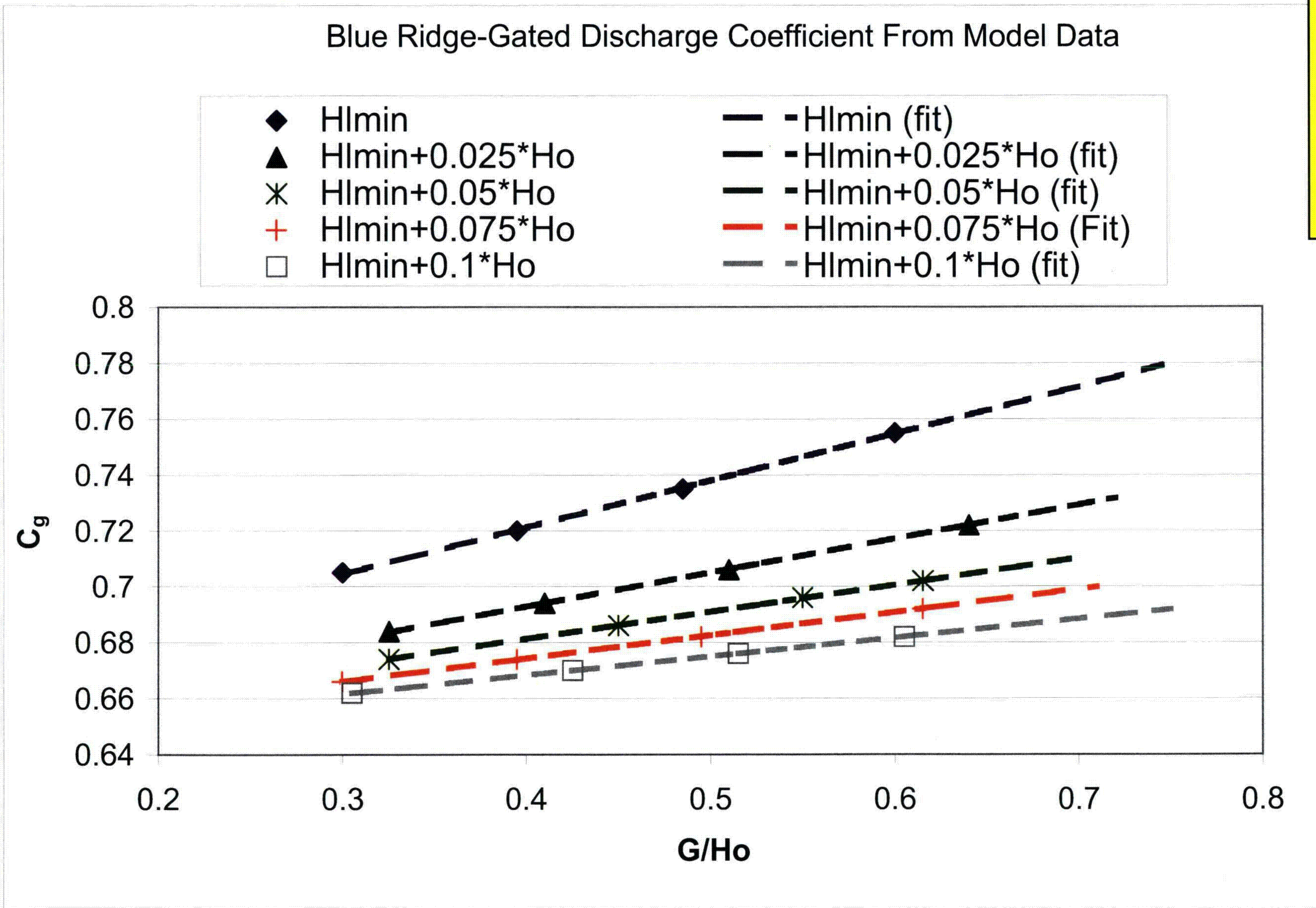


C_f=3.41+0.2437*(Hc/Ho-0.32)-4.0473*(Hc/Ho-0.32)^2 for 0<=Hc/Ho<=0.32

C_f = 0.7247*(Hc/Ho-0.32) + 3.41 for Hc/Ho > 0.32

Electronic version available in Attachment A26

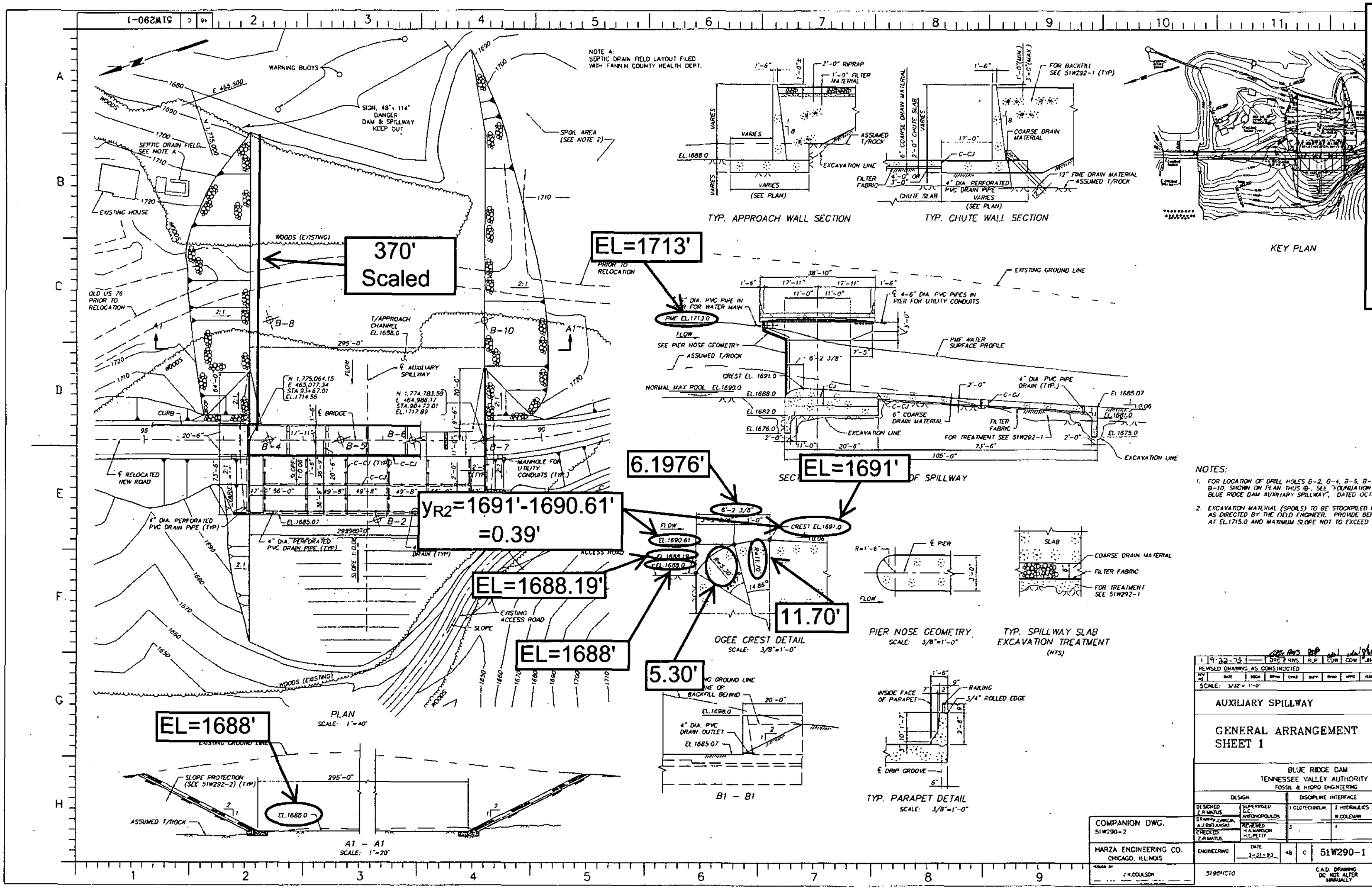
	G/Ho	(Model Data)	(Fit to Data)	Fit Eqn	Ref.
Hc = Hlmin	0.3	0.705	0.704	Cg = 0.1676 (G/Ho) +0.6542	From Drawing AEL99B107
	0.395	0.72	0.720		
	0.485	0.735	0.735		
	0.519		0.741		
	0.6	0.755	0.755		
	0.75	0.78	0.780		
Hc = Hlmin+0.025*Ho	0.325	0.684	0.684	Cg = 0.1216 (G/Ho) +0.6442	From Drawing AEL99B115
	0.41	0.694	0.694		
	0.51	0.706	0.706		
	0.519		0.707		
	0.64	0.722	0.722		
	0.72	0.732	0.732		
Hc = Hlmin+0.05*Ho	0.325	0.674	0.674	Cg = 0.0963 (G/Ho) +0.6428	From Drawing AEL99B116
	0.45	0.686	0.686		
	0.519		0.693		
	0.55	0.696	0.696		
	0.615	0.702	0.702		
	0.7	0.71	0.710		
Hc = Hlmin+0.075*Ho	0.3	0.666	0.666	Cg = 0.0827 (G/Ho) +0.6412	From Drawing AEL99B117
	0.395	0.674	0.674		
	0.495	0.682	0.682		
	0.519		0.684		
	0.615	0.692	0.692		
	0.71	0.7	0.700		
Hc = Hlmin+0.1*Ho	0.305	0.662	0.662	Cg = 0.0672 (G/Ho) +0.6414	From Drawing AEL99B118
	0.425	0.67	0.670		
	0.515	0.676	0.676		
	0.519		0.676		
	0.605	0.682	0.682		
	0.75	0.692	0.692		



Electronic version available in Attachment A26

Attachment A22A

Source: Reference A15



Calculation No: CDQ000020080002

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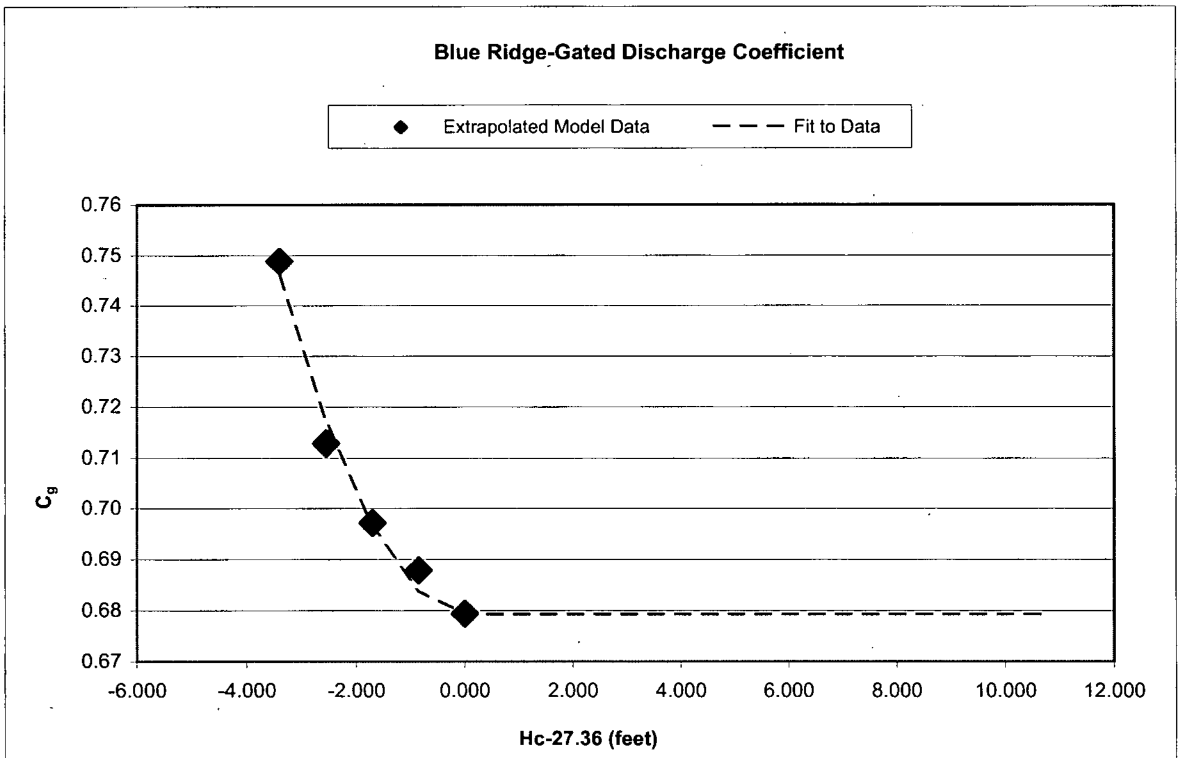
Attachment A26 Blue Ridge Model Data For Headwater Ratings.xls, Determination of Cg from Model Data

H_{lmin} 23.96 feet
H_o 34 feet

$H_{lmin} + C_1*H_o$		$H_c-(H_{lmin} + 0.1*H_o)$		
C_1	H_c (feet)	(feet)	C_g	C_g (fit)
0	23.960	-3.400	0.7488	0.7461
0.025	24.810	-2.550	0.7129	0.7172
0.05	25.660	-1.700	0.6972	0.6965
0.075	26.510	-0.850	0.6879	0.6839
0.1	27.360	0.000	0.6793	0.6793
	38	10.640		0.6793



C_g= 0.0056*(Hc-27.36)^2-0.0006*(Hc-27.36)+0.6793 for 0<=Hc<=27.36

C_g=0.6793 for Hc>27.36 ft

Electronic version available in Attachment A26

ɔd trees 8 to 10 years old, inter- ɪe of the vegetation in foliage, ·n 2 ft, and (*c*) growing season— ı with some weeds in full foliage ɪn along channel bottom, where

·ble to the following: (*a*) turf is less than one-half the height · willows about 1 year old, inter- side slopes, or dense growth of value of hydraulic radius up to ɪtergrown with weeds and brush, ıulic radius up to 10 or 15 ft.
ː of meandering depends on the ht length of the channel reach. ːatios of 1.0 to 1.2, *appreciable* ɔs of 1.5 and greater.
ːermining the *n* value, several oes not consider the effect of en in Table 5-5 were developed small and moderate channels. hen applied to large channels The method applies only to lrainage channels and shows a ɜuch channels. The minimum low as 0.012 in lined channels ɜ.
ːs Coefficient. Table 5-6 gives ds.[1] For each kind of channel ɪes of *n* are shown. The nor- ɪe table are recommended only ɪe boldface figures are values he case in which poor mainte- ɔuld be increased according to ːound very useful as a guide to used in a given problem. A Horton [34] from an examina- ː time.[2] Table 5-6 is compiled

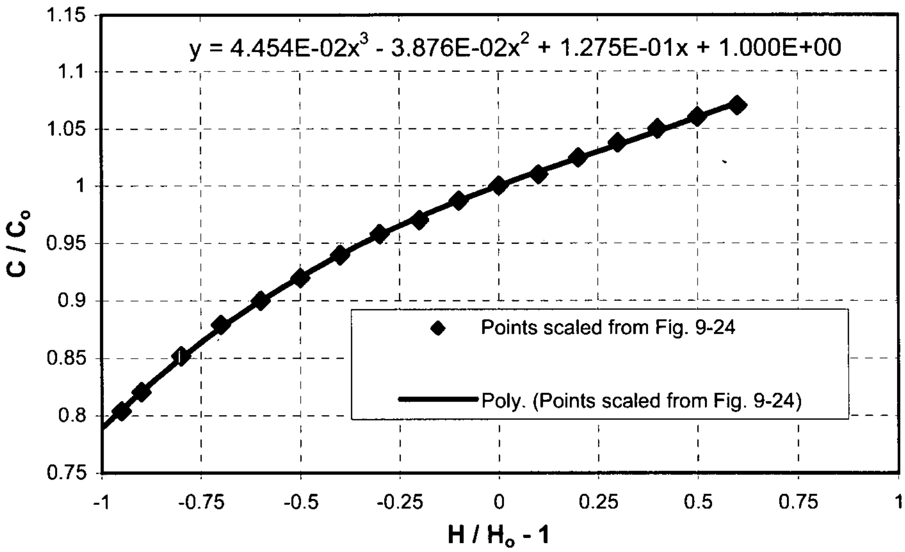
the Hydraulic Engineering Labora- ɾ *n* value may perhaps be obtained ns have yet been reported.
om 269 observations made on many ·5].

TABLE 5-5. VALUES FOR THE COMPUTATION OF THE ROUGHNESS COEFFICIENT BY EQ. (5-12)

Channel conditions			Values
Material involved	Earth	n_0	0.020
	Rock cut		0.025
	Fine gravel		0.024
	Coarse gravel		0.028
Degree of irregularity	Smooth	n_1	0.000
	Minor		0.005
	Moderate		0.010
	Severe		0.020
Variations of channel cross section	Gradual	n_2	0.000
	Alternating occasionally		0.005
	Alternating frequently		0.010–0.015
Relative effect of obstructions	Negligible	n_3	0.000
	Minor		0.010–0.015
	Appreciable		0.020–0.030
	Severe		0.040–0.060
Vegetation	Low	n_4	0.005–0.010
	Medium		0.010–0.025
	High		0.025–0.050
	Very high		0.050–0.100
Degree of meandering	Minor	m_5	1.000
	Appreciable		1.150
	Severe		1.300

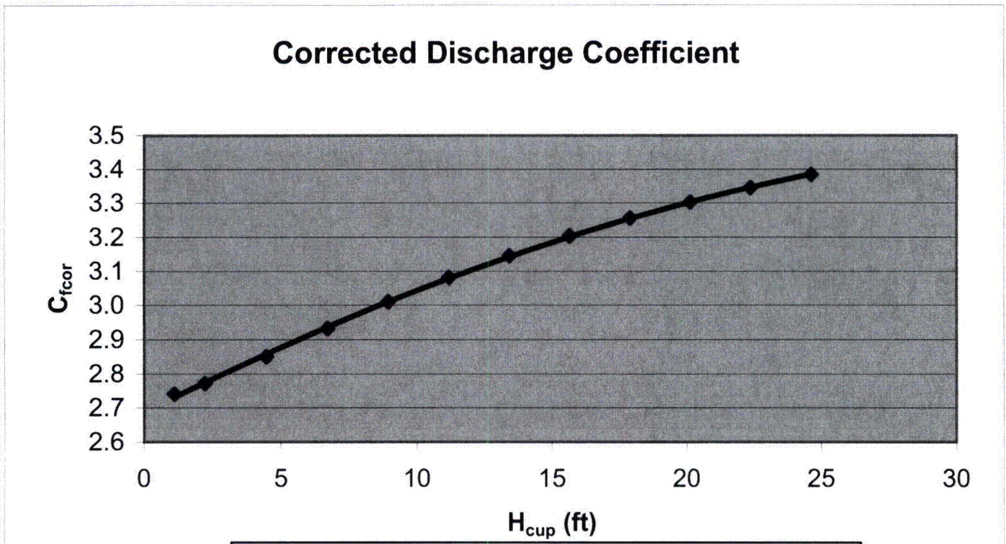
Points scaled from Fig. 9-24 in Design of Small Dams, Bureau of Reclamation, 1987

H/H_o	H/H_o-1	C/C_o
0	-1	
0.05	-0.95	0.804
0.1	-0.9	0.821
0.2	-0.8	0.852
0.3	-0.7	0.879
0.4	-0.6	0.9
0.5	-0.5	0.92
0.6	-0.4	0.94
0.7	-0.3	0.958
0.8	-0.2	0.97
0.9	-0.1	0.987
1	0	1
1.1	0.1	1.01
1.2	0.2	1.025
1.3	0.3	1.038
1.4	0.4	1.05
1.5	0.5	1.06
1.6	0.6	1.07



Blue Ridge Dam
Free Discharge Corrected for Frictional Losses in Approach Channel

Hc	C_f	q	y	ΔE	H_{cup}	Calulcated	fit
feet		cfs/ft	feet	feet	feet	C_{fcor}	C_{fcor}
1.1	2.764	3.188	4.091	0.006	1.106	2.740	2.731
2.2	2.817	9.194	5.151	0.024	2.224	2.772	2.775
4.4	2.917	26.921	7.182	0.068	4.468	2.851	2.859
6.6	3.006	50.975	9.114	0.110	6.710	2.933	2.937
8.8	3.087	80.581	10.961	0.148	8.948	3.011	3.011
11	3.159	115.251	12.726	0.184	11.184	3.081	3.079
13.2	3.224	154.619	14.413	0.219	13.419	3.146	3.142
15.4	3.283	198.388	16.018	0.253	15.653	3.203	3.201
17.6	3.336	246.316	17.536	0.289	17.889	3.256	3.254
19.8	3.385	298.212	18.959	0.326	20.126	3.303	3.303
22	3.430	353.934	20.263	0.368	22.368	3.346	3.346
24.2	3.472	413.393	21.412	0.418	24.618	3.384	3.385



$C_{fcor} = -0.000498(H_{cup})^2 + 0.040623(H_{cup}) + 2.687$

Electronic version available in Attachment A27

Appendix B: Overflow Parameters

Reference Drawings
1. TVA drawing no. 81W200, R1 (Ref. 11, Att 10)
2. TVA drawing no. 81W300-1, R1 (Ref. 12, Att 11)
3. TVA drawing no. 51E200, R2 (Ref. 13, Att 12)

Although Dam Safety Modifications raised the level of embankments to an elevation of 1713' and installed retaining walls to the same elevation along the roadway leading to and from Blue Ridge Dam (Attachments 10 and 11), the bridge over the dam itself could be overtopped during a PMF event. According to Attachment 12, the retaining walls on the bridge above the dam rise to an elevation of 1710', which could be overtopped during a PMF event.

Refer to Hydraulic Design Chart 711 (Attachment 14-1) for values of free flow discharge coefficient, C_f. The maximum headwater elevation used in this rating is 1713'.

<u>Flow Over the Tops of the Bridge Retaining Walls</u>

The width of the overflow section is taken as the width of the roadway over the spillway. Therefore, from Attachment 12, B = 36'. The effects of the railings across the top of the dam have been neglected.

$$0 \le \frac{H_c}{B} \equiv \frac{H_1}{B} \le \frac{1713'-1710'}{36}$$

$$0 \le \frac{H_c}{B} \le 0.0833$$

$$C_f = 2.65$$

And

L = 200' (The entire length of the main spillway)

Appendix C: Hydrostatic Loads on the Spillway Tainter Gates

The hydrostatic loads on the spillway tainter gates for Watts Bar Dam can be found in the following calculations.

C1 References

C1. "Watts Bar Dam – Flood and Earthquake Analysis on Radial Spillway Gates, pages 76-100" Tennessee Valley Authority, HEPE3WBHSQN-WBNBLNBFN.

C2. Calculations

Reference C1 evaluates the structural capacity of the radial spillway gates at Watts Bar Dam. This reference was used as a basis for evaluating the margin between the forces on the closed gates (FR_{closed}) when the headwater elevation is at the top of the gate (1691 feet) and when the gates are completely open (FR_{open}) and the headwater elevation is at 1707.0 feet at Blue Ridge Dam. The margin is defined as the ratio of FR_{open} to FR_{closed}. The calculation of these forces and the results of this comparison are shown in Figure C1.

Comparison of forces when gates are closed and HW is at 1691 feet (top of gate) vs. when gates are fully open and HW at an elevation of 1707 feet.

Attribute	Symbol	Value	Unit
top elev	Zo	1691	ft
trun elev	Ztr	1684.75	ft
sill elev	Zsill	1675.00	ft
radius	R	18	ft
length	L	22	ft
angle up	α2	20.32	deg
angle lwr	α	32.80	deg
angle tot	θ	53.11	deg
area of lower slice	Aslice1	150.18	ft^2
proj area	AProjected	352.00	ft^2
Desgn LdH	FRx	175718.40	lbs
Result elv	Z1	1680.33	ft
Result ang deg		14.20	deg
Result ang rad		0.25	rad
Result Dsgn	Horiz	170346.58	lbs
Area slice upper	Aslice2	57.45	ft^2
Area triangle	Atriangle	52.75	ft^2
project vert	x1	1.12	ft
vert weight water	FRy	3161.99	lbs
Resultant load - Gates Closed	FR_{closed}	**175746.85**	lbs
vert open fm calc	calc App A	19.20	ft
max hw	calc	1707.00	ft
lwr lip elev	Z2	1694.20	ft
bot angle	α3	31.67	deg
top elev	Zo	1702.68	ft
project area for h ld	AProjected	186.46	ft^2
Flood LdH	FRx	99622.80	lbs
Height over gate	y1	4.32	ft
Height ratio to orig		2.00	(ratio)
project vert	x2	13.68	ft
Flood LdV1		81233.43	lbs
Flood lLdV2		51316.29	lbs
Total Flood LdV	FRy	132549.73	lbs
Resultant load - Gates Fully Open	FR_{open}	**165813.55**	lbs
Margin	FR_{open}/FR_{closed}	**0.94**	(ratio)

Figure C1: Blue Ridge Spillway Gate Margin Evaluation

BWSC Barge Waggoner Sumner & Cannon, Inc.

Project: Hydrostatic Force on Gate
Description: Diagram
Project No. ______ Sheet No. ______ of ______
Designer: ______ Date: ______
Checker: ______ Date: ______

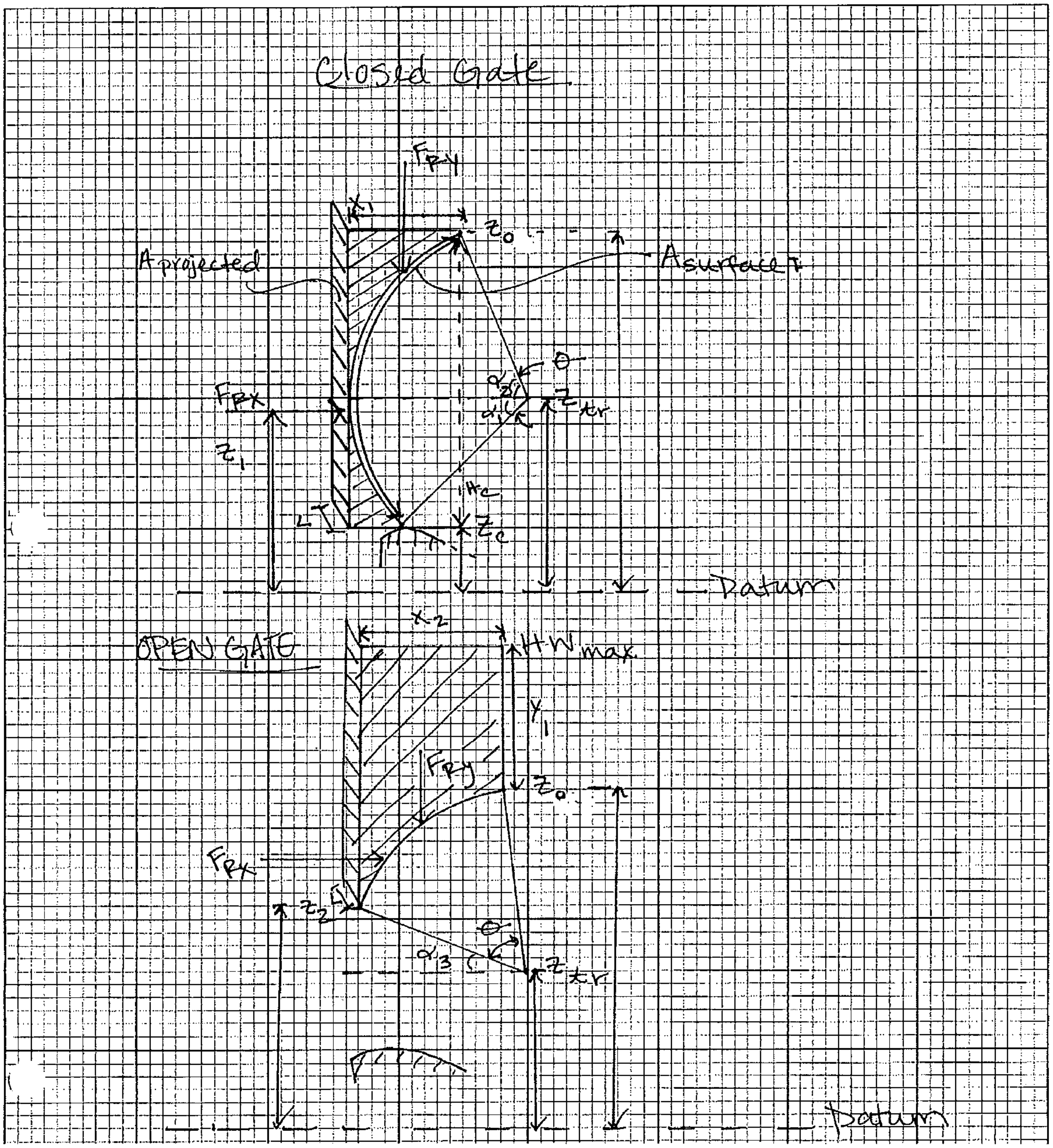
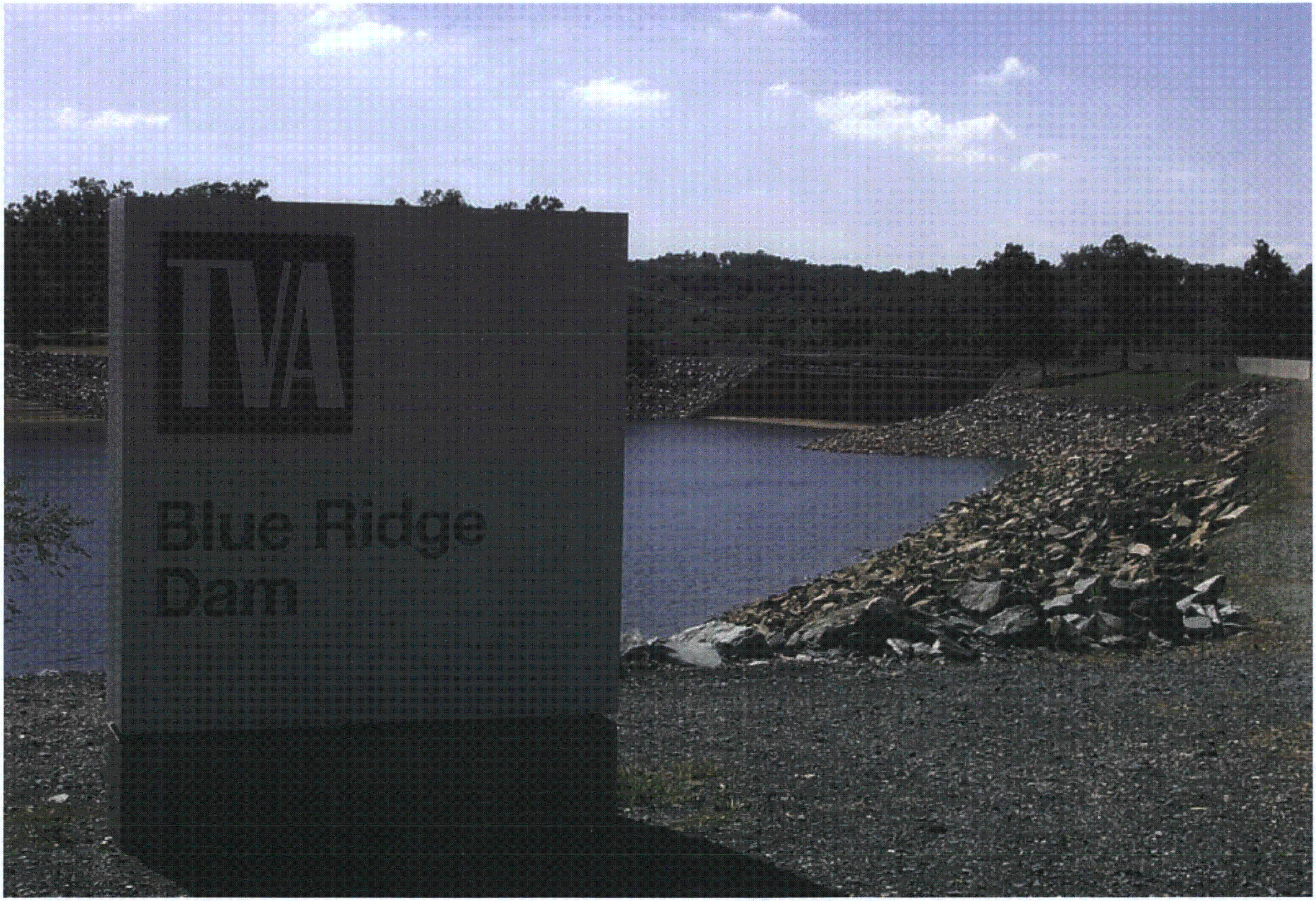


Figure C2: Diagram of Hydrostatic Forces

BLUE RIDGE DAM



RESERVOIR OPERATION OVERVIEW

Blue Ridge is a tributary project located on the Toccoa River in Fannin County, Georgia. It is the uppermost TVA project on the Ocoee River system. Blue Ridge was acquired from the Tennessee Electric Power Co. in 1939. TVA purchased Blue Ridge as a single purpose power project (only power funds were used to finance the purchase and operation of the project); but it is operated for many purposes including flood control, hydroelectric power generation, water supply, water quality, recreation, and aquatic ecology. It is an earthfill dam with one primary generating unit and a second small unit for providing minimum flows.

Blue Ridge Reservoir has an annual pool variation of 30 to 35 feet during normal years. This fluctuation is primarily for power economics and also provides limited seasonal flood storage. Once every five years, the reservoir is lowered an additional 30 feet (to about elevation 1620) for dam safety inspections.

Table of Contents

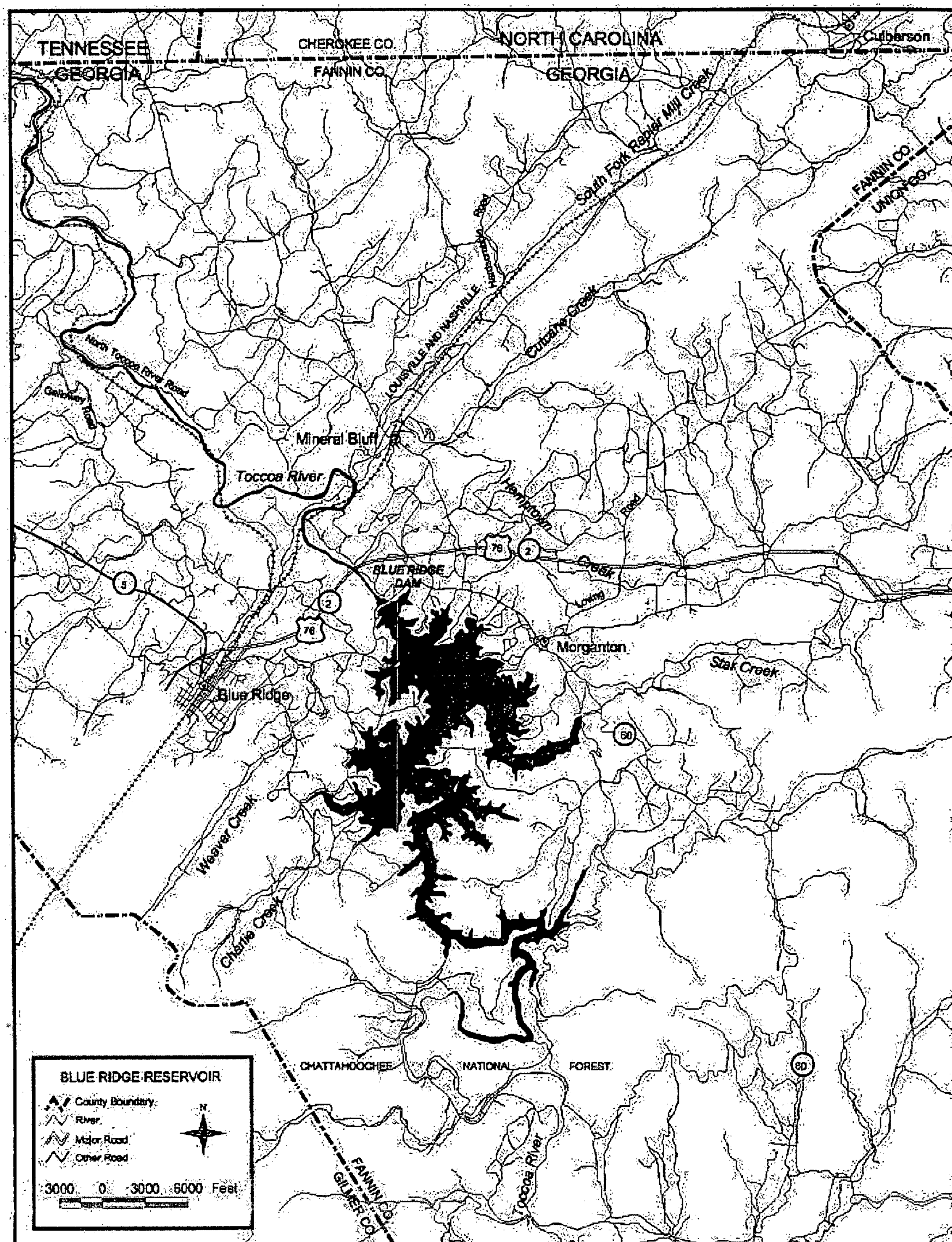

TENNESSEE
GEORGIA
CHEROKEE CO.
FANNIN CO.
NORTH CAROLINA
GEORGIA
Culberson
South Fork Rapier Mill Creek
FANNIN CO.
UNION CO.
LOUISVILLE AND NASHVILLE
Cutcane Creek
North Toccoa River Road
Mineral Bluff
Toccoa River
Hemptown
Creek
Road
BLUE RIDGE DAM
Morganton
Star Creek
Blue Ridge
Weaver Creek
Charlie Creek
CHATTAHOOCHEE
NATIONAL
FOREST
Toccoa River
FANNIN CO.
GILMER CO.
BLUE RIDGE RESERVOIR
County Boundary
River
Major Road
Other Road
N
3000 0 3000 6000 Feet

Figure 1

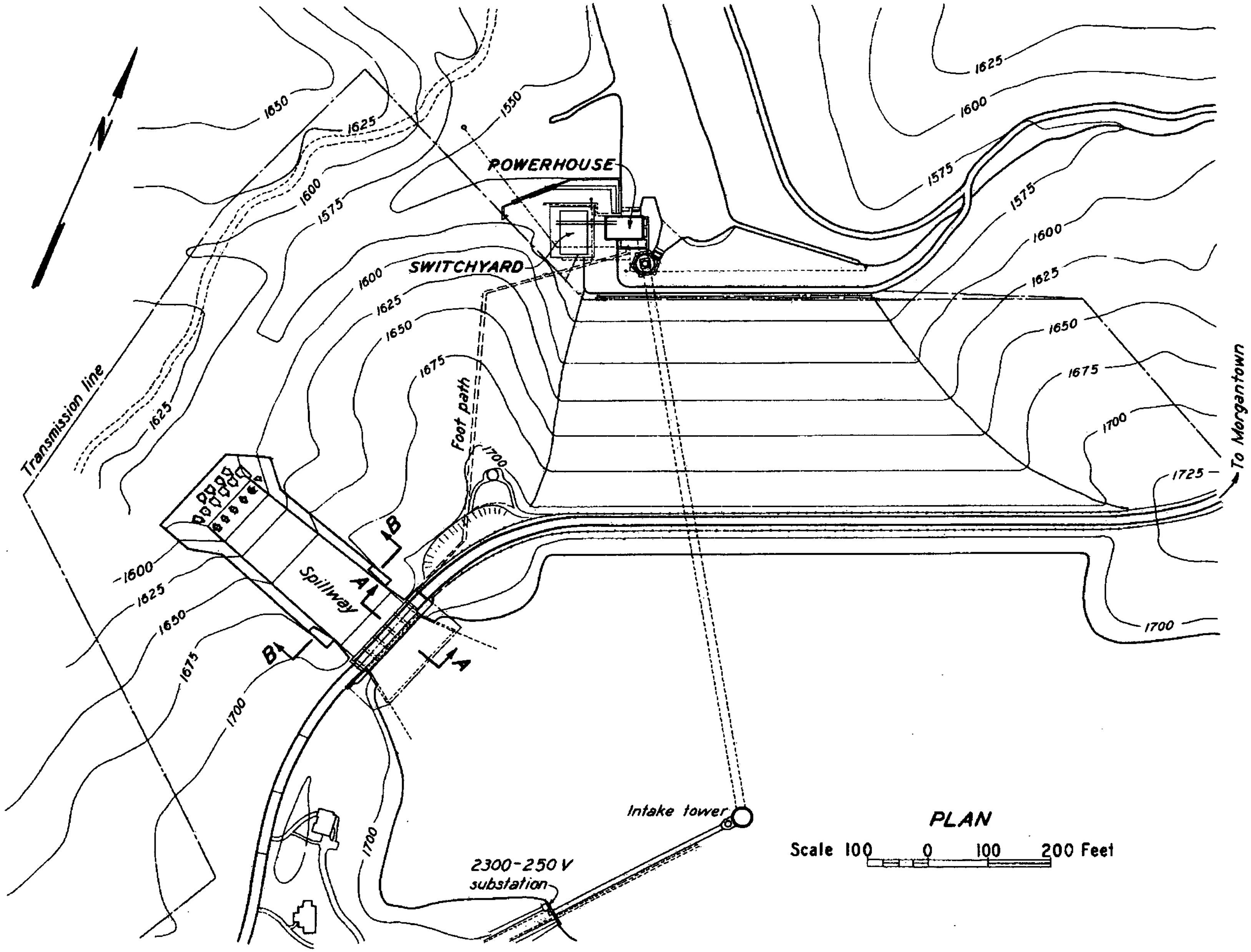
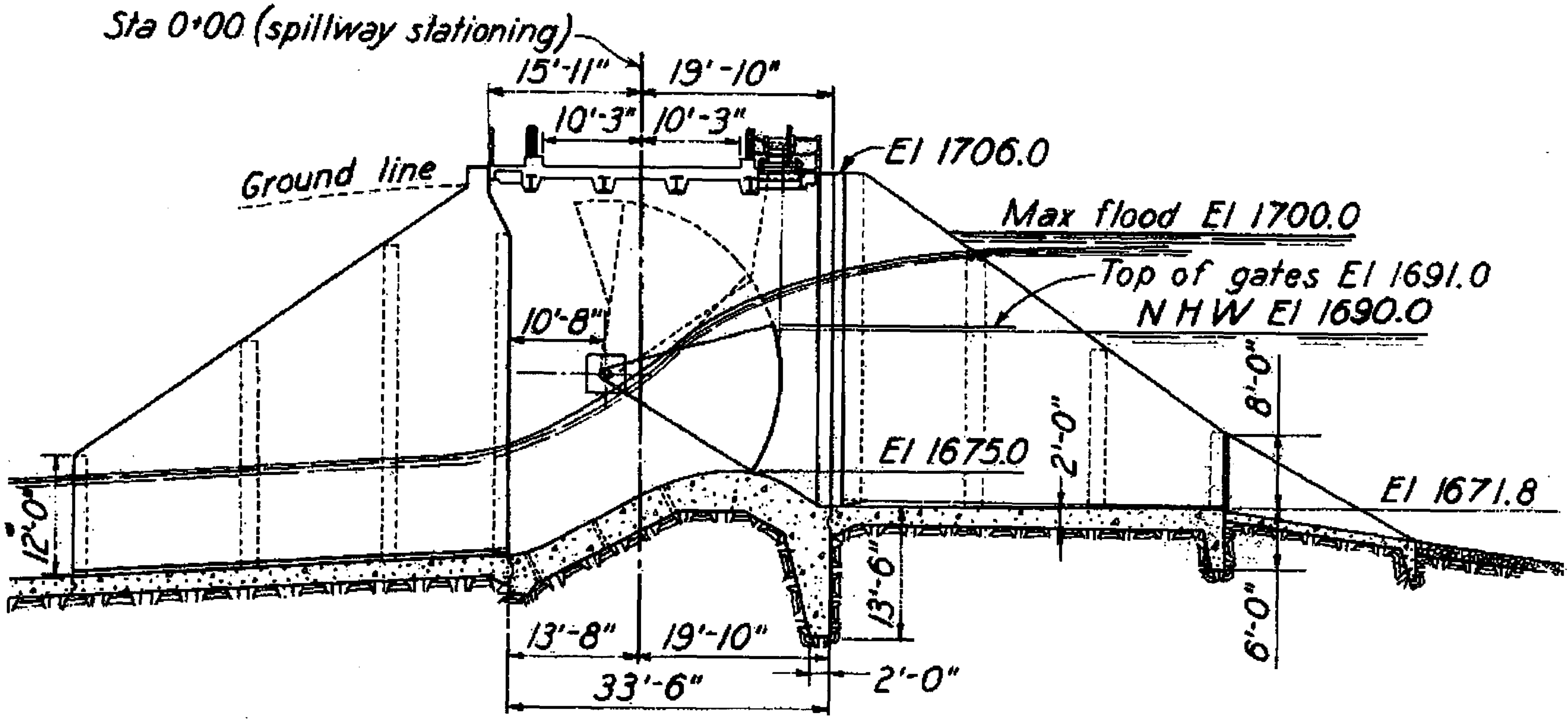
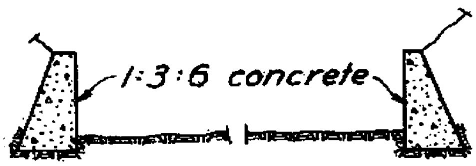

POWERHOUSE
SWITCHYARD
Transmission line
Foot path
Spillway
To Morgantown
Intake tower
2300-250 V substation
PLAN
Scale 100 0 100 200 Feet
N

Figure 2



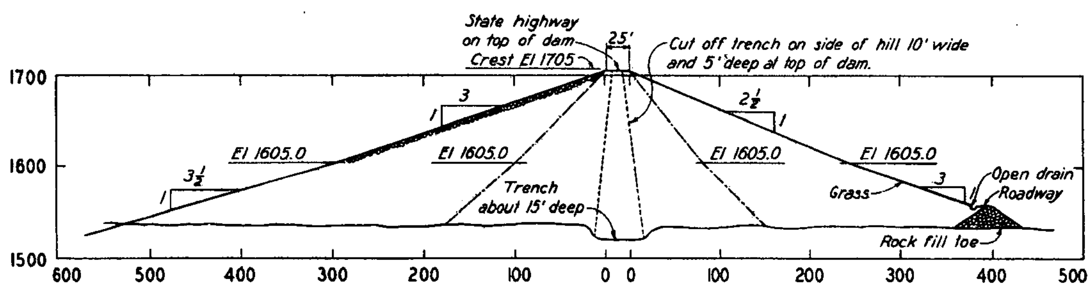
SECTION A-A

Figure 3



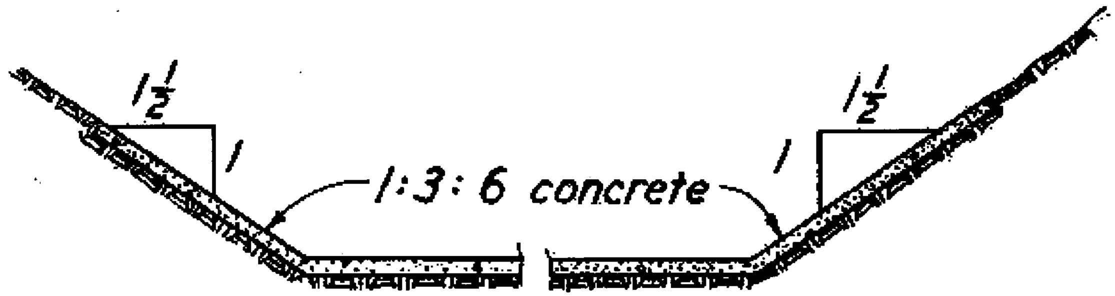
SECTION B-B
Not to scale

Figure 4



TYPICAL SECTION
Scale 100 0 100 Feet

Figure 5



SPILLWAY CHANNEL SECTION
SHOWING PAVING
Not to scale

NOTE:

Elevations are based on TEP Co. datum. To correct to USC & GS

BLUE RIDGE

SUMMARY OF PRINCIPAL FEATURES

LOCATION

On Toccoa (Ocoee) River at river mile 53.0; in Fannin County, Georgia; on Georgia State Highway No. 2; 2 miles west of Morganton, Georgia; 2-1/2 miles east of Blue Ridge, Georgia; 23.8 river miles upstream from Ocoee No. 3 Dam.

CHRONOLOGY

Construction started	November 1925
Construction discontinued	Early in 1926
Construction resumed	March 1929
Closure effected	December 6, 1930
Placed in commercial operation	July 1931
Acquired from Tennessee Electric Power Co	August 15, 1939
Spillway addition (added three bays/gates)	May 1986
Safety Modifications for Probable Maximum Flood completed	September 22, 1995
Reservoir releases improvements completed	February 1995

PROJECT COST

Initial project acquired, including 1 unit and switchyard	$ 5,040,042
Spillway addition	10,708,000
PMF modifications	6,850,000
Reservoir releases improvements	4,000,000
Total, including switchyard	$26,598,042

STREAMFLOW

Drainage area at dam	232 sq. miles
Maximum known flood at dam site, natural (1906)	34,000 cfs
Average unregulated flow at dam site, estimated (1903-2000)	608 cfs
Minimum daily natural flow at dam site (1999), approx	60 cfs

RESERVOIR

Counties affected:	
State of Georgia	Fannin
Reservoir land at May 31, 1996:	
Fee simple	2,851 ac.
Easements	885 ac.
Total	3,736 ac.
Transferred	4,082 ac.
Operating levels at dam:	
Probable maximum flood elevation	el. 1712.6
500-year flood elevation	el. 1691.0
100-year flood elevation	el. 1691.0
Winter flood guide level	el. 1668.0
Summer flood guide level	el. 1687.0
Maximum probable flood elevation	el. 1701.8
Maximum used for design	el. 1700.0
Top of gates (area 3,330 ac.)	el. 1691.0
Backwater, length at normal maximum pool level	11 miles
Shoreline, length at normal maximum pool level:	
Main shore	63 miles
Islands	2 miles
Total	65 miles
Original river area (to el. 1690 crossing)	182 ac.
Storage (flat pool assumption):	
Total volume:	
At top of gates (el. 1691)	195,900 ac.-ft
At normal minimum pool (el. 1590)	12,000 ac.-ft
Useful controlled storage (el. 1691-1590)	183,900 ac.-ft

TAILWATER

Full plant operating (11 unit)	el. 1544.5
One unit operating at best efficiency	el. 1543.9
Minimum level	el. 1540.0

HEAD (Gross)

Maximum static (el. 1691-1540)	151 ft
Normal maximum operating (el. 1690-1544)	146 ft
Average operating	129 ft
Minimum operating (el. 1605-1543)	62 ft

DAM

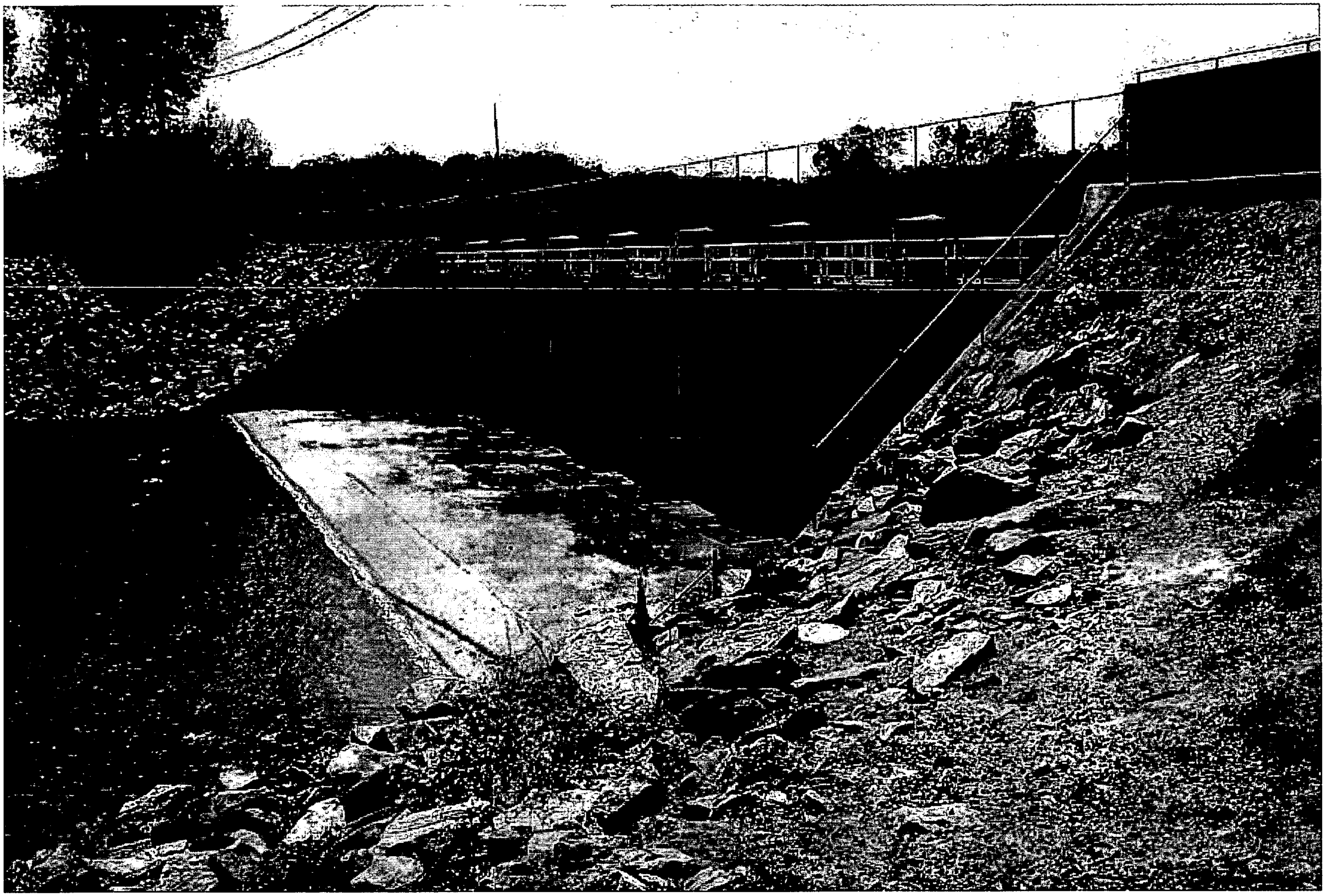
Material and type	Earth, semi-hydraulic fill with puddled core; gate-controlled saddle spillway
Length (approx.)	1,000 ft
Maximum height (approx.)	167 ft
Maximum width at base (approx.)	950 ft
Crest of earth embankment	el. 1705
Sluices	Turbine intakes and penstock used for sluices; 6-ft Dow valve controls turbine bypass
Roadway	State highway on top of dam

SPILLWAY

Location	Through saddle 300 ft south of west end of dam
Length	110 ft clear; 126 ft total
Crest	el. 1675.0
Gates	Eight 16- by 22-ft Tainter gates, operated by electric hoist or gasoline auxiliary hoist
Discharge capacity	55,000 cfs
Channel:	
Upstream	70-ft riprap and 58-ft concrete paving
Downstream	396-ft concrete paving
Energy dissipation	Splitter and baffle piers at el. 1580.0

Figure 6

Blue Ridge Spillway

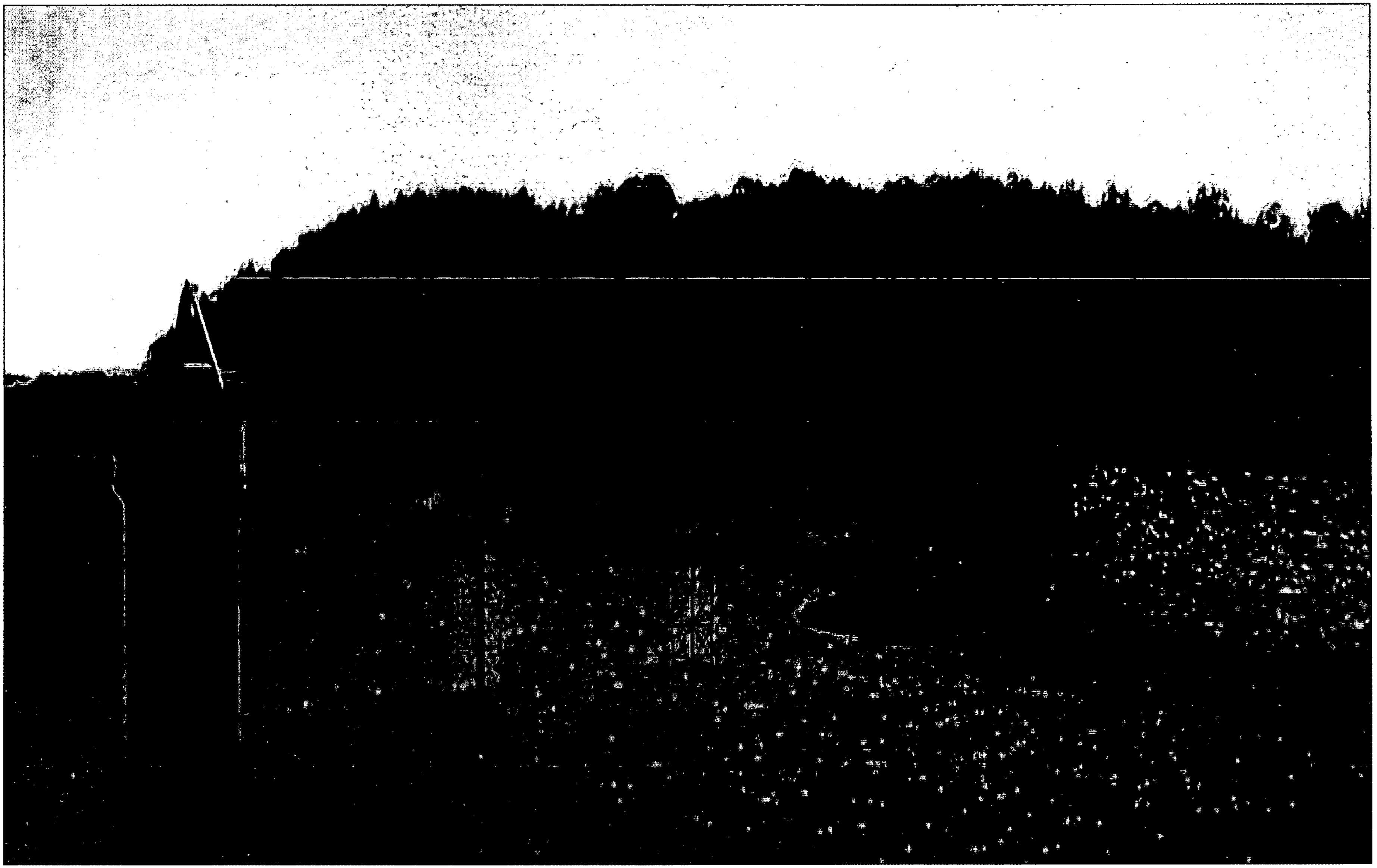


POWER FACILITIES

INTAKE AND CONDUIT

Intake tower	One reinforced concrete tower, 26-ft dia., 192 ft high
Floor of intake	el. 1534
Top of intake tower	el. 1720
Gates	2 electrically operated 7- by 14-ft caterpillar-type Broome gates
Hoists	Two 75-ton gate hoists and one stiffleg derrick
Penstock	Under dam, 14-ft dia., 1,050 ft long
Surge tank	Steel, nonoverflow differential type, 30-ft dia., 180 ft high

Figure 7



POWER FACILITIES (Continued)

POWERHOUSE

Generating capacity (1 unit)	20,000 kW
Type of construction	Concrete substructure, brick and steel superstructure
Principal outside dimensions	64 ft long by 43 ft wide
Erecting crane	One 240-ton Whiting

HYDRAULIC TURBINE

Number	1
Manufacturer	S. Morgan Smith Co. (now Allis-Chalmers Manufacturing Co.)
Type	Vertical Francis
Rated capacity	30,000 hp at 147-ft head
Efficiency at rated head and horsepower	91.2 percent
Discharge (estimated overall use at 120-ft head):	
1/2 load	1,100 cfs
3/4 load	1,600 cfs
Full load	2,100 cfs
Normal speed	163.6 rpm
Governor	Woodward, cabinet actuator type
Elevation of centerline of distributor	el. 1555
Elevation of draft tube floor	el. 1532.3

GENERATOR

Number	1
Manufacturer	Westinghouse Electric Corp.
Type	Open, air-cooled, vertical-shaft
Rating	25,000 Kva, 20,000 Kw, 1175 A, 60 degrees C rise, 0.8 PF, 12.5 Kv, 3 ph, 60 Hz
Efficiency (guaranteed):	
At 75% Kva, 0.8 pf	96.5 percent
Flywheel effect	8,500,000 Lb-ft2
Thrust bearing	Kingsbury type, capacity 288 tons
Neutral	Solidly grounded through breaker
Exciters:	
Main	150 Kw, 250 V
Pilot	15 Kw, 250 V

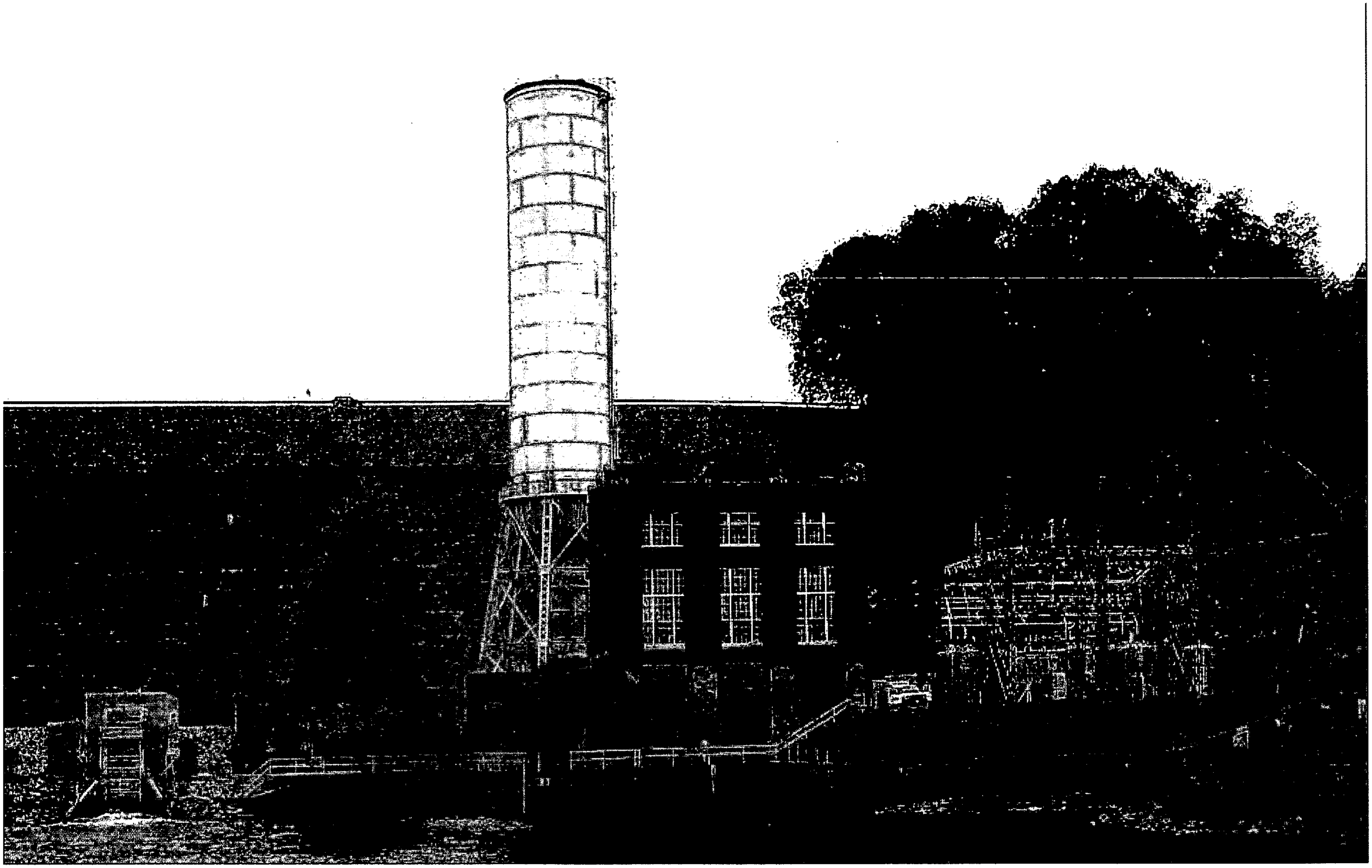
GENERATOR (Continued)

Weight of heaviest crane lift, rotor.......................... 140 tons
The stator winding was replaced 1987
The existing rating is ....27,500 Kva, 22,000 KW,
....................................1270 A, 60 degrees C rise,
.... 0.8 PF, 12.5 kv, 3 phase, 60 Hz

GENERATOR AND TURBINE MODERNIZATION

This project, scheduled to start in March 2012 and complete in July 2012, will modernize the turbine and upgrade the electrical power train.

Figure 8



ELECTRIC CONTROLS

Generation and switching are normally controlled from Ocoee No. 2 powerhouse by means of supervisory control equipment. Pertinent data such as electrical quantities and turbine flow are telemetered via a tone channel to Ocoee No. 2, when initiated by the operator. Integrated turbine flows and water levels are telemetered on demand via the supervisory control equipment. Annunciation of trouble condition is transmitted by the supervisory equipment in the form of status indications and is grouped, generally, in two categories, emergency and non-emergency. Provision is also made for local control of the plant.

TRANSMISSION PLANT

Transformer bank 1:

4 single-phase including one spare, 3-winding, 6667/8333 kVA OA/FA, 69-wye-12.5 delta-12.47 kV wye, 55 degrees C rise, Penn

Structures:

1 transformer and 69-kV structure

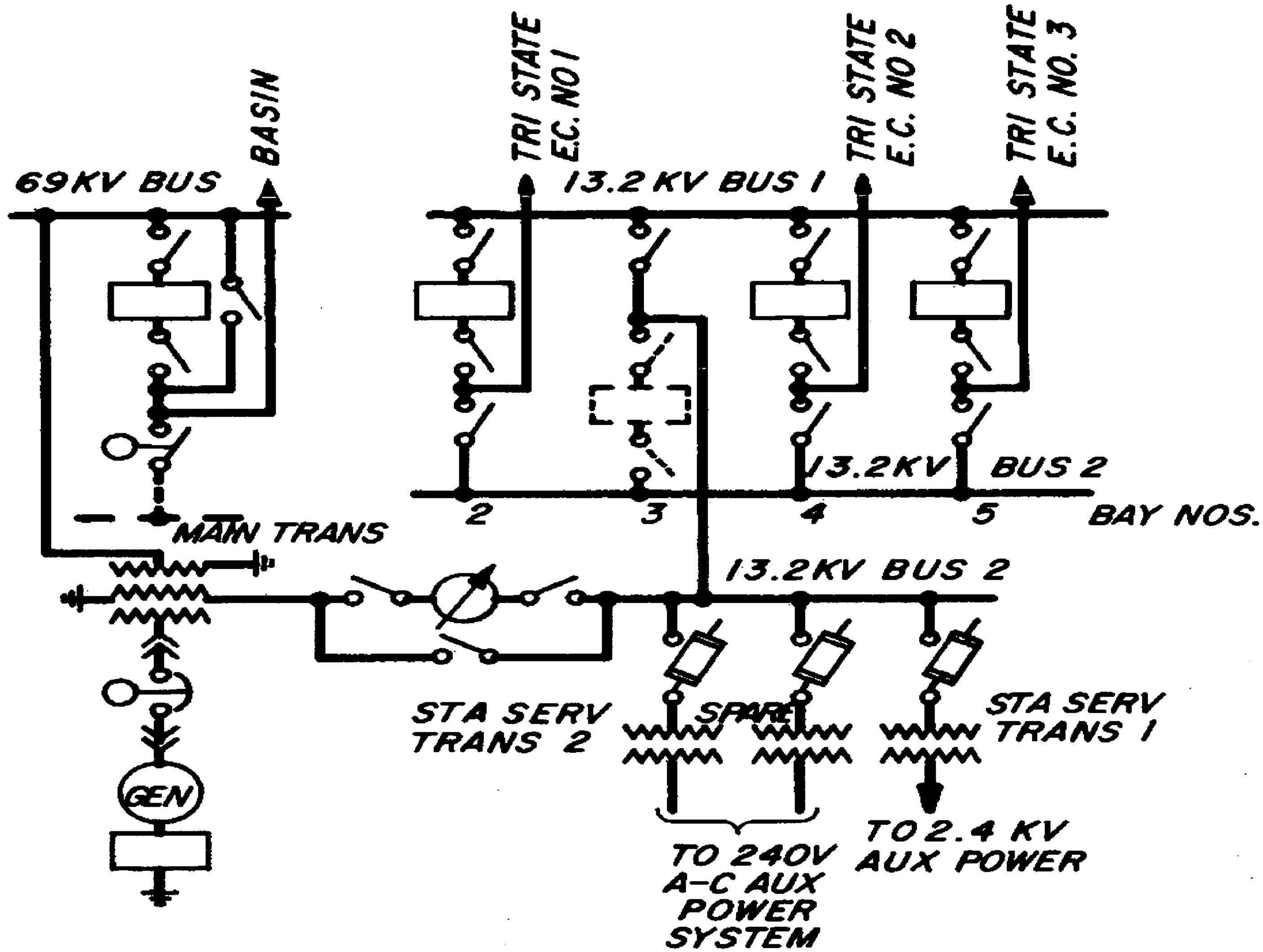
4 12.5-kV switchyard bays

69-kV oil circuit breaker:

1 600-A, 750-MVA, 15/40-Hz, Westinghouse

Figure 9

SINGLE LINE DIAGRAM OF MAIN CONNECTIONS



TRANSMISSION PLANT DATA

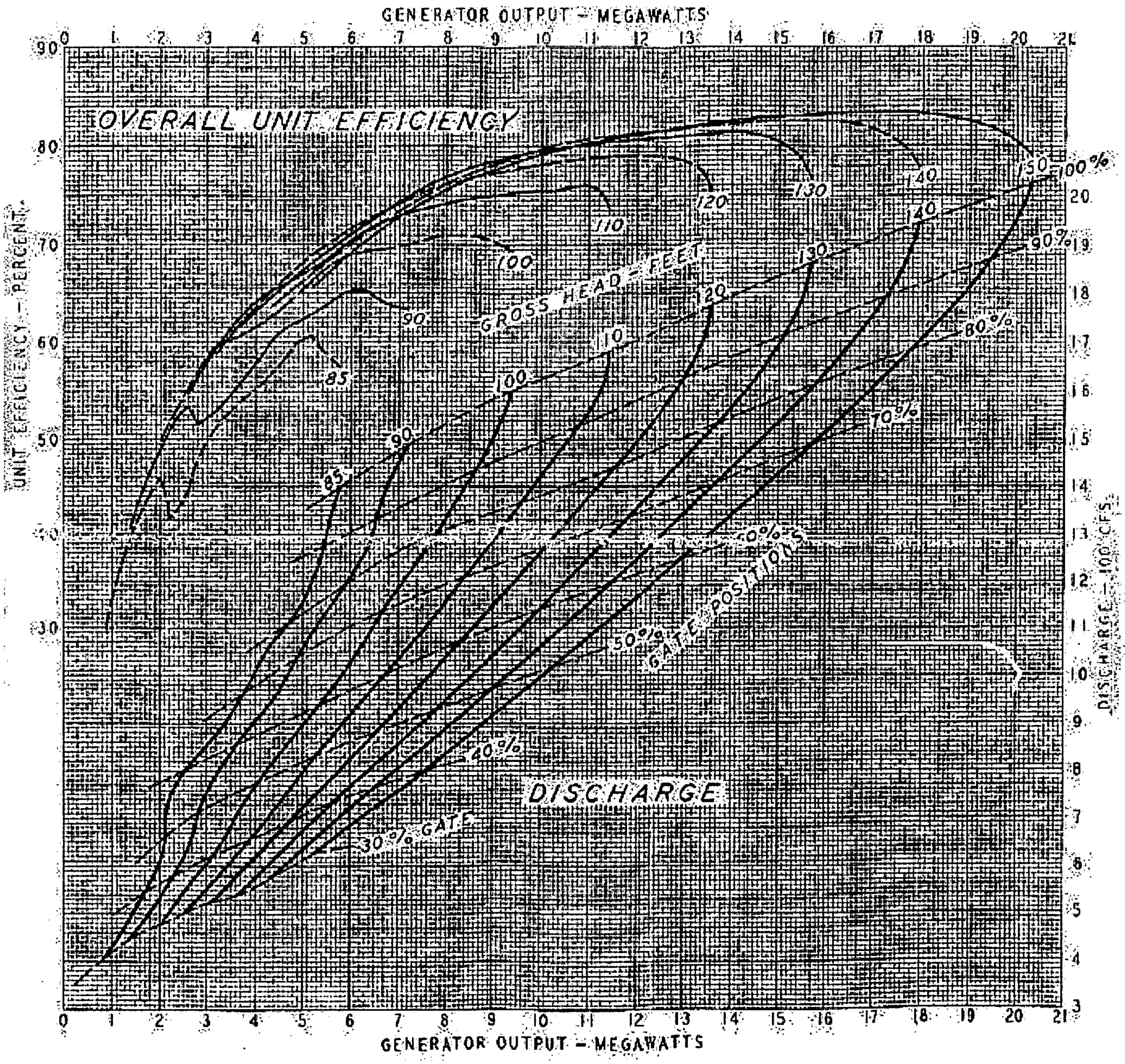
Plant	Location	Phase	Serial Number	MVA Rating		Voltage kV	Cooling	Tap Changer	Oil Preservation System	Oil Volume Gal.	Configuration	Impedance %			Contract Number	Manufacturer	Year of Manuf
				55 deg	65 deg							H-X	H-Y	X-Y			
Blue Ridge Hydro	Bank 1	A	C-01951-5-1	8.333	9.333	69/12.5/12.47	OA/FA	DETC	Gas-Blanketed	2100	Wye/Delta/Wye	6.50	10.2	2.9	64P2-60404	Pennsylvania	1964
Blue Ridge Hydro	Bank 1	B	C-01951-5-2	8.333	9.333	69/12.5/12.47	OA/FA	DETC	Gas-Blanketed	2100	Wye/Delta/Wye	6.39	10.13	2.9	64P2-60404	Pennsylvania	1964
Blue Ridge Hydro	Bank 1	C	C-01951-5-3	8.333	9.333	69/12.5/12.47	OA/FA	DETC	Gas-Blanketed	2100	Wye/Delta/Wye	6.47	10.27	2.89	64P2-60404	Pennsylvania	1964
Blue Ridge Hydro	Bank 1	Spare	C-01951-5-4	8.333	9.333	69/12.5/12.47	OA/FA	DETC	Gas-Blanketed	2100	Wye/Delta/Wye	6.51	10.17	2.85	64P2-60404	Pennsylvania	1964

Note: H=High voltage winding
Y=Tertiary winding
X=Low voltage winding

Elevation (feet)	Area (acre*1000)	Volume (ac-ft*1000)	Potential Eis (gWh)	Gross Head (feet)	Best Efficiency Plant Output (mW)	Best Efficiency Turbine Discharge (cfs)	Best Efficiency kW/CFS	Maximum Sustainable Plant Output (mW)	Maximum Sustainable Turbine Discharge (cfs)	Maximum Sustainable kW/CFS
1691	3.34	195.9	162.7	145.0	16.5	1,600	10.33	18.0	1,750	10.29
1690	3.31	192.6	159.4	144.0	16.5	1,610	10.27	18.0	1,760	10.23
1689	3.28	189.3	156.2	143.0	16.5	1,620	10.21	18.0	1,770	10.17
1688	3.25	186.0	153.0	141.9	16.5	1,620	10.15	18.0	1,780	10.11
1687	3.22	182.8	149.9	140.9	16.5	1,630	10.10	18.0	1,790	10.05
1686	3.19	179.6	146.8	139.9	16.5	1,640	10.03	18.0	1,800	9.99
1685	3.16	176.4	143.6	138.9	16.3	1,640	9.94	17.8	1,800	9.88
1684	3.13	173.3	140.5	137.9	16.1	1,630	9.84	17.6	1,800	9.77
1683	3.10	170.1	137.4	136.9	15.9	1,630	9.75	17.4	1,800	9.65
1682	3.07	167.1	134.3	135.9	15.7	1,630	9.65	17.2	1,800	9.54
1681	3.04	164.0	131.3	134.9	15.5	1,620	9.55	17.0	1,800	9.43
1680	3.00	161.0	128.3	133.9	15.3	1,620	9.46	16.8	1,800	9.32
1679	2.97	158.0	125.4	132.9	15.1	1,610	9.36	16.6	1,800	9.20
1678	2.94	155.1	122.4	131.9	14.9	1,610	9.27	16.4	1,800	9.09
1677	2.91	152.1	119.6	130.9	14.7	1,600	9.17	16.2	1,800	8.98
1676	2.88	149.2	116.7	129.9	14.5	1,600	9.08	16.0	1,800	8.87
1675	2.84	146.4	114.0	128.9	14.3	1,590	9.04	15.8	1,780	8.83
1674	2.81	143.5	111.4	128.0	14.2	1,580	9.00	15.6	1,770	8.80
1673	2.77	140.8	108.7	127.0	14.0	1,570	8.96	15.4	1,750	8.76
1672	2.74	138.0	106.1	126.0	13.9	1,560	8.92	15.2	1,740	8.72
1671	2.70	135.3	103.6	125.0	13.8	1,550	8.88	15.0	1,730	8.69
1670	2.67	132.6	101.0	124.0	13.6	1,540	8.83	14.8	1,710	8.65
1669	2.63	130.0	98.5	123.1	13.5	1,530	8.79	14.6	1,700	8.61
1668	2.59	127.3	96.1	122.1	13.3	1,520	8.75	14.4	1,680	8.58
1667	2.55	124.8	93.7	121.1	13.2	1,510	8.71	14.2	1,670	8.54
1666	2.52	122.2	91.3	120.1	13.0	1,500	8.67	14.0	1,650	8.50
1665	2.48	119.7	88.9	119.1	12.8	1,490	8.61	13.8	1,640	8.46
1664	2.44	117.3	86.6	118.2	12.7	1,480	8.54	13.6	1,620	8.41
1663	2.41	114.8	84.3	117.2	12.5	1,470	8.48	13.4	1,610	8.36
1662	2.37	112.5	82.1	116.2	12.3	1,460	8.41	13.2	1,590	8.31

Elevation (feet)	Area (acre*1000)	Volume (ac-ft*1000)	Potential Eis (gWh)	Gross Head (feet)	Best Efficiency Plant Output (mW)	Best Efficiency Turbine Discharge (cfs)	Best Efficiency kW/CFS	Maximum Sustainable Plant Output (mW)	Maximum Sustainable Turbine Discharge (cfs)	Maximum Sustainable kW/CFS
1661	2.33	110.1	79.8	115.2	12.1	1,450	8.35	13.0	1,580	8.26
1660	2.29	107.8	77.7	114.2	12.0	1,440	8.28	12.8	1,560	8.21
1659	2.26	105.5	75.5	113.3	11.8	1,430	8.22	12.7	1,550	8.16
1658	2.22	103.3	73.4	112.3	11.6	1,420	8.15	12.5	1,530	8.11
1657	2.19	101.1	71.3	111.3	11.4	1,410	8.09	12.3	1,520	8.06
1656	2.16	98.9	69.3	110.3	11.3	1,400	8.02	12.1	1,500	8.02
1655	2.13	96.7	67.3	109.3	11.1	1,390	7.97	11.9	1,490	7.96
1654	2.11	94.6	65.3	108.4	10.8	1,370	7.92	11.7	1,480	7.90
1653	2.08	92.5	63.3	107.4	10.6	1,350	7.87	11.5	1,460	7.85
1652	2.06	90.5	61.4	106.4	10.4	1,330	7.82	11.3	1,450	7.79
1651	2.04	88.4	59.5	105.4	10.2	1,310	7.77	11.1	1,430	7.73
1650	2.02	86.4	57.6	104.4	10.0	1,290	7.72	10.9	1,420	7.68
1649	2.00	84.4	55.8	103.5	9.8	1,270	7.67	10.7	1,400	7.62
1648	1.97	82.4	53.9	102.5	9.5	1,250	7.62	10.5	1,390	7.56
1647	1.95	80.4	52.1	101.5	9.3	1,230	7.58	10.3	1,370	7.50
1646	1.92	78.5	50.3	100.5	9.1	1,210	7.53	10.1	1,360	7.45
1645	1.90	76.6	48.5	99.6	8.9	1,190	7.46	9.9	1,340	7.38
1644	1.87	74.7	46.8	98.6	8.7	1,180	7.38	9.7	1,330	7.31
1643	1.84	72.9	45.1	97.6	8.5	1,170	7.30	9.5	1,310	7.24
1642	1.81	71.0	43.4	96.6	8.4	1,150	7.22	9.3	1,300	7.16
1641	1.77	69.3	41.7	95.6	8.2	1,140	7.14	9.1	1,280	7.09
1640	1.73	67.5	40.1	94.7	8.0	1,120	7.06	8.9	1,270	7.02
1639	1.70	65.8	38.5	93.7	7.8	1,110	6.97	8.7	1,260	6.94
1638	1.66	64.1	37.0	92.7	7.6	1,100	6.89	8.5	1,240	6.87
1637	1.63	62.5	35.4	91.7	7.4	1,080	6.81	8.3	1,230	6.80
1636	1.60	60.8	34.0	90.8	7.2	1,070	6.73	8.2	1,210	6.72
1635	1.56	59.3	32.5	89.8	7.1	1,050	6.65	8.0	1,200	6.65
1634	1.53	57.7	31.1	88.8	6.9	1,030	6.57	7.8	1,180	6.55
1633	1.51	56.2	29.7	87.8	6.6	1,010	6.50	7.6	1,170	6.46
1632	1.48	54.7	28.3	86.9	6.4	990	6.42	7.4	1,150	6.37

Elevation (feet)	Area (acre*1000)	Volume (ac-ft*1000)	Potential Eis (gWh)	Gross Head (feet)	Best Efficiency: Plant Output (mW)	Best Efficiency: Turbine Discharge (cfs)	Best Efficiency: kW/CFS	Maximum Sustainable: Plant Output (mW)	Maximum Sustainable: Turbine Discharge (cfs)	Maximum Sustainable: kW/CFS
1631	1.45	53.2	27.0	85.9	6.2	970	6.34	7.2	1,140	6.27
1630	1.43	51.8	25.7	84.9	6.0	950	6.26	7.0	1,120	6.18
1629	1.40	50.4	24.4	83.9	5.8	930	6.19	6.8	1,110	6.08
1628	1.38	49.0	23.1	83.0	5.6	910	6.11	6.6	1,090	5.99
1627	1.36	47.6	21.9	82.0	5.4	890	6.03	6.4	1,080	5.90
1626	1.33	46.3	20.6	81.0	5.2	870	5.95	6.2	1,070	5.80
1625	1.31	45.0	19.4	80.0	5.0	850	5.88	6.0	1,050	5.71
1624	1.29	43.7	18.3	79.1	4.6	810	5.72	5.6	1,010	5.58
1623	1.26	42.4	17.1	78.2	4.3	760	5.56	5.3	960	5.45
1622	1.24	41.1	16.0	77.3	3.9	710	5.40	4.9	910	5.32
1621	1.22	39.9	14.8	76.4	3.5	670	5.24	4.5	870	5.19
1620	1.19	38.7	13.8	75.4	3.2	620	5.08	4.2	820	5.06
1619	1.17	37.5	12.6	74.6	2.2	520	4.10	3.1	760	3.95
1618	1.15	36.4	11.7	76.7	3.7	680	5.29	4.7	880	5.23
1617	1.13	35.2	10.7	75.7	3.3	630	5.11	4.3	830	5.09
1616	1.11	34.1	9.6	74.7	2.4	530	4.26	3.2	770	4.13



NOTE:

These curves are based on field test data taken at headwater elevations of 1687, 1672, 1657, 1649.5, 1635, and 1625.5.

Discharges were obtained from current meter measurements made in the river below the plant by the U.S. Geological Survey. These were correlated with readings of the Winter - Kennedy scroll case piezometer taps at each five percent gate opening between 30 and 100 percent.

HYDRO GENERATING UNIT
OPERATING CHARACTERISTIC CURVES
BLUE RIDGE PROJECT TENNESSEE VALLEY AUTHORITY DIVISION OF WATER CONTROL PLANNING ENGINEERING LABORATORY
NORRIS 4-28-66 48 97 B100

YEAR	MAXIMUM AVERAGE DAILY DISCHARGE (TURBINE + SPILL)	DATE	NUMBER OF PERIODS	TOTAL DAYS	Volumes are average daily in day-second-feet, except as shown. Maximum spill, date of maximum, and number of days of spill in each spill period, in this order. "Total Days" is for calendar years and does not always equal the sum of the days in periods because of extension of periods into adjacent years. Water may be spilled through the spillway and/or the bypass valve. All unmarked spill was through the bypass valve. Maximum hourly average discharge to date was 10,860 cfs at 11 a.m. and 1 p.m. on 5/28/73. *Spillway #Spillway and valve simultaneously
1939	1500	10/24	2	5	800---12/22---3; 400---12/26---2
1940	1422	9/27	2	36	1000---1/11---4; 800---1/19---32
1941	1103	9/12	0	0	
1942	1720	2/2	0	0	
1943	1665	2/5	0	0	
1944	1446	10/30	0	0	
1945	1128	9/6	0	0	
1946	4868	2/12	7	19	#3512---2/12---8; 599---3/9---2; *330---3/16---1; #1010---3/17---2; 1440---3/29---3; #2434---5/16---2; 530---5/26---1
1947	1500	9/3	0	0	
1948	1323	9/29	0	0	
1949	2080	4/14	0	0	
1950	4765	3/13	1	3	*3325---3/13---3
1951	1225	7/10	0	0	
1952	4745	3/23	2	8	#2500---3/23---5; 1415---8/3---3
1953	1219	3/31	0	0	
1954	1796	5/26	1	4	800---1/14---4
1955	1181	10/5	1	4	928---12/29---4
1956	1707	10/6	2	31	890---1/1---29; 276---1/31---2
1957	1844	4/26	0	0	
1958	1841	5/12	2	20	1110---12/5-7---14; 455---12/26---6
1959	1082	1/29	0	0	
1960	1740	9/1	0	0	

YEAR	MAXIMUM AVERAGE DAILY DISCHARGE (TURBINE + SPILL)	DATE	NUMBER OF PERIODS	TOTAL DAYS	Volumes are average daily in day-second-feet, except as shown. Maximum spill, date of maximum, and number of days of spill in each spill period, in this order. "Total Days" is for calendar years and does not always equal the sum of the days in periods because of extension of periods into adjacent years. Water may be spilled through the spillway and/or the bypass valve. All unmarked spill was through the bypass valve. Maximum hourly average discharge to date was 10,860 cfs at 11 a.m. and 1 p.m. on 5/28/73. *Spillway #Spillway and valve simultaneously
1961	1764	6/29	0	0	
1962	2023	4/11	0	0	
1963	1932	7/1	0	0	
1964	3077	3/26	2	78	*1194---3/26---3; 1296---10/20---75
1965	1249	7/17	0	0	
1966	1531	5/28	0	0	
1967	3254	8/27	2	3	106---6/1---2; 1368---8/27---1
1968	1878	1/13	0	0	
1969	1438	11/8	0	0	
1970	1431	10/25	2	33	915---11/18&19---18; 966---11/24&25---15
1971	1890	8/3	0	0	
1972	1405	4/11	0	0	
1973	6213	5/28	1	3	*4333---5/28---3
1974	1930	4/6	1	29	1380---2/7-2/10---29
1975	1884	4/7	0	0	
1976	1967	5/16	0	0	
1977	1913	4/8	0	0	
1978	1368	2/21	0	0	
1979	2340	4/13	1	1	*457---4/13---1
1980	1937	4/6	0	0	
1981	1191	9/15	2	25	1070---12/1-4---23; 15---12/21---2 (bypass valve)
1982	1310	10/18	0	0	

YEAR	MAXIMUM AVERAGE DAILY DISCHARGE (TURBINE + SPILL)	DATE	NUMBER OF PERIODS	TOTAL DAYS	Volumes are average daily in day-second-feet, except as shown. Maximum spill, date of maximum, and number of days of spill in each spill period, in this order. "Total Days" is for calendar years and does not always equal the sum of the days in periods because of extension of periods into adjacent years. Water may be spilled through the spillway and/or the bypass valve. All unmarked spill was through the bypass valve. Maximum hourly average discharge to date was 10,860 cfs at 11 a.m. and 1 p.m. on 5/28/73. *Spillway #Spillway and valve simultaneously
1983	1904	4/17	1	3	900---11/3---3
1984	1940	5/9	0	0	
1985	1035	7/22	0	0	
1986	1020	12/27	0	0	
1987	1118	8/2	3	71	212---10/31---59; 54---12/19---11; 54---12/31---1
1988	1380	9/9	1	37	42---10/30---37
1989	2930	6/22	1	3	*1230---6/22---3
1990	4720	3/19	2	23	*1121---2/21---5; 1400---2/24-26, 28---12; 1430---3/18---3; *2950---3/18---5; 1430----3/23-25---5
1991	1800	5/1	1	1	94---10/7---1
1992	1650	12/15	1	10	*120---4/14-21---10
1993	1680	2/4 thru 5	4	46	14---3/9---1; 1073---10/31---19; 778---11/28---1
1994	1490	4/18, 19, 21-28	2	7	150---12/20 & 23---5; 150---12/30---2
1995	1803	3/13	2	4	44---1/4---1; 150---1/10---3
1996	1700	3/22 thru 24	0	0	
1997	1580	4/30	2	5	33---9/15---3; 70---9/19---2
1998	1720	4/21 thru 25	1	47	1130---11/12---47
1999	1100	11/21	0	0	
2000	1249	6/26	0	0	
2001	1157	9/12	0	0	
2002	1344	10/31	1	2	*192---12/31---21

RIVER SCHEDULING

TVA OPERATED RESERVOIR SYSTEM
ANNUAL MAXIMUM AND MINIMUM ELEVATIONS, IN ORDER OF MAGNITUDE
FROM DATE OF ACQUISITION BY TVA THROUGH 2002

BLUE RIDGE

	MAXIMUM					MINIMUM			
RDER	ELEVATION	YEAR	MONTH	DAY	ORDER	ELEVATION	YEAR	MONTH	DAY
1	1691.54	1946	FEB.	11	1	1587.75	1956	JAN.	16
2	1690.97	1973	MAY	28	2	1594.21	1940	FEB.	6
3	1690.89	1962	JUNE	12	3	1599.34	1959	JAN.	15
4	1690.83	1964	APR.	9	4	1599.40 #	1955	DEC.	31
5	1690.68	1966	JUNE	1	5	1600.87	1954	JAN.	15
6	1690.57	1952	MAY	15	6	1602.62	1953	DEC.	9
7	1690.55	1976	JULY	5	7	1604.62	1941	DEC.	3
8	1690.54	1961	JUNE	28	8	1606.13	1958	DEC.	27
9	1690.48	1963	JULY	1	9	1606.20	1944	DEC.	20
10	1690.40	1950	MAR.	13	10	1610.47	1947	NOV.	6
11	1690.28	1971	APR.	5	11	1611.06	1981	OCT.	16
12	1690.26	1972	APR.	11	12	1612.50	1948	JAN.	30
13	1690.23	1989	JUNE	21	13	1613.70	1945	JAN.	1
14	1690.16	1979	JUNE	5	14	1615.79	1943	DEC.	15
15	1690.09	1965	APR.	25	15	1615.98 %	1993	OCT.	31
16	1690.08	1949	APR.	24	16	1618.97	1961	FEB.	18
17	1690.06	1958	MAY	25	17	1619.69	1968	DEC.	21
18	1690.04	1967	AUG.	27	18	1620.17	1988	OCT.	18
19	1689.60	1944	MAY	15	19	1621.38 %	1998	NOV.	19
20	1689.57	1997	MAY	4	20	1624.84	1969	JAN.	18
21	1689.48	1968	FEB.	8	21	1624.94	1966	FEB.	7
22	1689.38	1977	APR.	26	22	1626.62 %	1942	JAN.	1
23	1689.26	1974	MAY	28	23	1627.53	1957	JAN.	22
24	1689.25	1957	APR.	22	24	1629.85	1976	NOV.	15
25	1689.15	1990	MAR.	18	25	1629.85	1979	DEC.	29
26	1689.07	1998	APR.	20	26	1629.94	1980	JAN.	1
27	1689.02	1943	MAY	17	27	1630.00	1964	DEC.	22
28	1688.99	1975	MAY	18	28	1630.37	1960	DEC.	30
29	1688.95	1954	MAY	23	29	1630.79	1963	JAN.	11
30	1688.93	1942	JUNE	17	30	1630.91	1946	DEC.	19
31	1688.85	2001	JUNE	11	31	1632.65	1982	JAN.	1
32	1688.76	1980	MAY	9	32	1633.59	1994	JAN.	1
33	1688.72	1991	APR.	30	33	1633.95	1952	DEC.	30
34	1688.71	2002	MAY	29	34	1634.05	1962	DEC.	28
35	1688.49	1951	MAY	7	35	1634.86	1973	NOV.	26
36	1688.36	1992	JUNE	17	36	1636.16	1999	JAN.	1
37	1688.16	1982	MAY	24	37	1636.59	1970	DEC.	7
38	1688.15	1993	MAY	15	38	1637.06	1965	DEC.	31
39	1688.02	1984	MAY	4	39	1637.81 %	1974	DEC.	24
40	1687.99	1994	JUNE	29	40	1638.76	1989	JAN.	1
41	1687.95	1978	JUNE	15	41	1641.52	1975	JAN.	3
42	1687.91	1956	MAY	21	42	1643.02	1971	JAN.	4
43	1687.57	1996	JUNE	11	43	1643.05	1951	DEC.	31
44	1687.55	1999	JULY	16	44	1643.05	1978	DEC.	22
45	1687.52	1953	MAY	25	45	1646.04	1985	JAN.	30
46	1687.35	1983	MAY	20	46	1646.20	1977	FEB.	17
47	1687.11	1970	JUNE	16	47	1646.97	2000	JAN.	11
48	1686.50	1960	MAY	20	48	1647.94	1950	DEC.	30
49	1686.24	1969	MAY	28	49	1648.89	1984	DEC.	31

RIVER SCHEDULING

TVA OPERATED RESERVOIR SYSTEM
ANNUAL MAXIMUM AND MINIMUM ELEVATIONS, IN ORDER OF MAGNITUDE
FROM DATE OF ACQUISITION BY TVA THROUGH 2002

BLUE RIDGE

MAXIMUM					MINIMUM				
RDER	ELEVATION	YEAR	MONTH	DAY	ORDER	ELEVATION	YEAR	MONTH	DAY
50	1685.92	2000	JUNE	21	50	1649.40	1972	NOV.	3
51	1685.77	1987	JUNE	8	51	1650.28	1997	DEC.	21
52	1685.35	1995	JUNE	7	52	1650.64	1986	FEB.	13
53	1685.03	1985	JUNE	19	53	1651.00	1983	NOV.	23
54	1683.78	1947	JUNE	2	54	1652.02	1967	JAN.	7
55	1683.38	1988	MAY	30	55	1653.35	1987	OCT.	20
56	1682.19	1948	APR.	19	56	1654.33	2001	JAN.	4
57	1682.09	1940	JULY	25	57	1656.59	2002	NOV.	3
58	1677.08	1945	MAY	29	58	1656.82	1990	DEC.	21
59	1676.01	1955	JUNE	11	59	1657.89	1996	NOV.	25
60	1674.45	1981	JUNE	16	60	1658.34	1995	JAN.	4
61	1674.12	1986	JUNE	12	61	1658.84	1992	JAN.	22
62	1666.74 %	1941	AUG.	12	62	1660.42	1991	JAN.	9
63	1663.36	1959	JUNE	25	63	1662.06	1949	JAN.	1

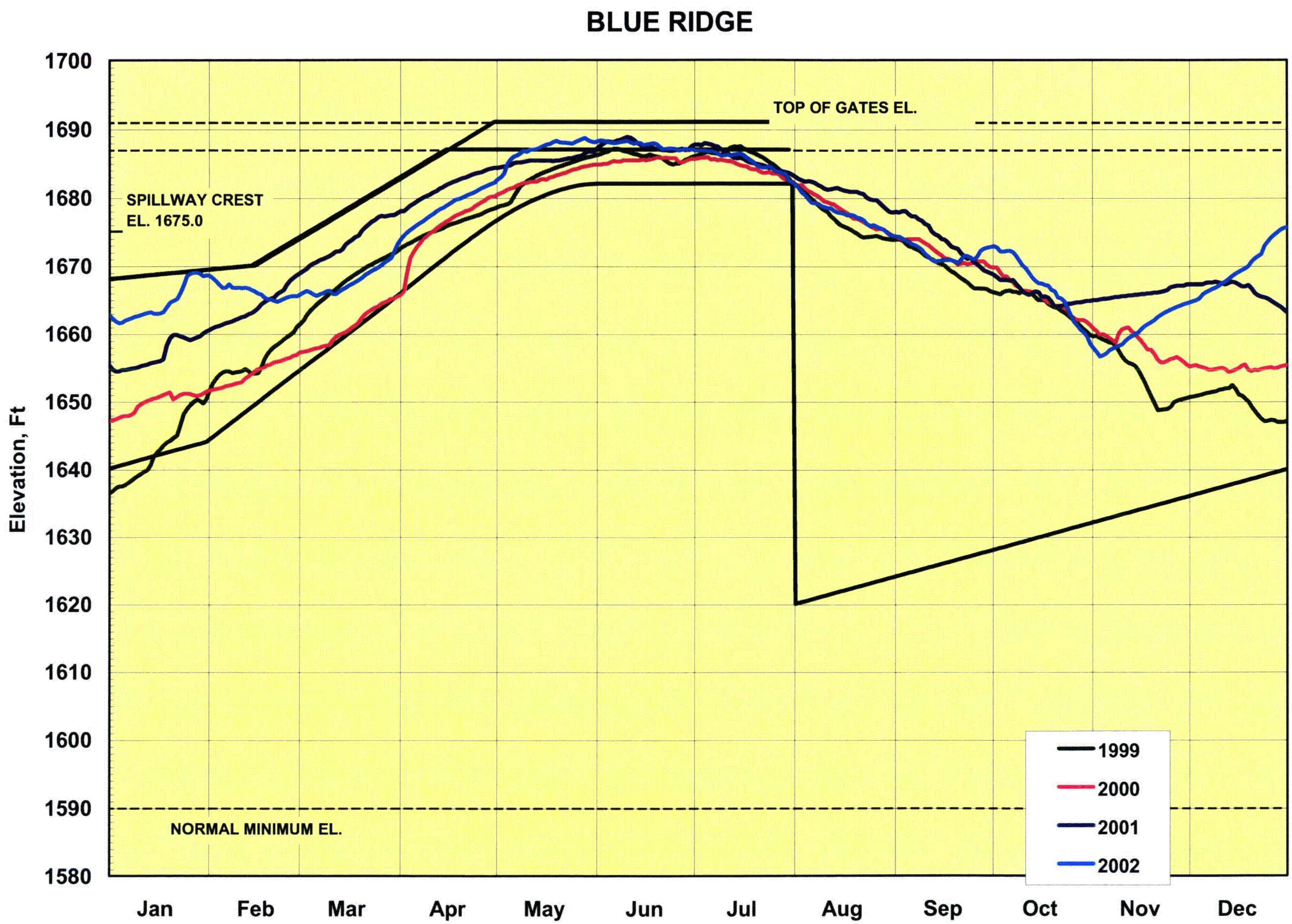
* CLOSURE DECEMBER 6, 1930
# ESTIMATED
% MIDNIGHT ELEVATION
TOP-OF-GATES ELEVATION 1691

MAXIMUM, MINIMIUM, MEDIAN, AND MEAN
Adjusted Flow by Weeks
Blue Ridge
Years=1903-2002

WEEK ENDING	WEEK NO.	AVERAGE WEEKLY CFS MAXIMUM	YR	MINIMUM	YR	MEDIAN	MEAN
JAN 7	1	1,940	1982	196	1940	619	700
JAN 14	2	2,490	1946	182	1956	615	685
JAN 21	3	2,630	1947	220	1914	634	724
JAN 28	4	2,190	1996	185	1940	743	773
FEB 4	5	2,530	1957	201	1940	747	800
FEB 11	6	3,000	1921	230	1934	744	826
FEB 18	7	3,200	1990	260	1934	761	861
FEB 25	8	2,580	1961	278	1941	782	867
MAR 4	9	3,140	1903	268	1988	807	911
MAR 11	10	2,280	1979	290	1986	842	931
MAR 18	11	3,720	1909	356	1981	781	974
MAR 25	12	2,670	1980	311	1988	828	946
APR 1	13	2,760	1913	320	1988	827	1,030
APR 8	14	4,260	1920	347	1986	871	1,010
APR 15	15	2,300	1979	291	1986	833	909
APR 22	16	1,640	1998	284	1986	821	847
APR 29	17	1,560	1912	261	1986	782	807
MAY 6	18	1,950	1929	227	1986	727	809
MAY 13	19	2,210	1929	227	1986	747	758
MAY 20	20	1,880	1976	236	1986	660	691
MAY 27	21	1,700	1910	180	1941	627	696
JUN 3	22	2,530	1973	191	1941	578	657
JUN 10	23	1,760	1909	162	1988	549	620
JUN 17	24	1,270	1906	158	1988	529	570
JUN 24	25	1,910	1989	149	1986	477	524
JUL 1	26	1,670	1929	141	1988	438	522
JUL 8	27	1,530	1976	124	1986	423	510
JUL 15	28	6,890	1916	114	1986	425	556
JUL 22	29	1,700	1938	89	2002	396	485
JUL 29	30	1,700	1938	154	1986	397	466
AUG 5	31	1,600	1971	-25	2002	380	431
AUG 12	32	1,170	1920	76	1999	371	410
AUG 19	33	2,640	1920	67	1999	367	429
AUG 26	34	3,430	1967	96	1925	326	409
SEP 2	35	1,600	1967	82	1925	305	369
SEP 9	36	1,380	1928	52	1999	305	345
SEP 16	37	1,180	1920	9	1999	277	313
SEP 23	38	1,020	1906	-35	1999	290	329
SEP 30	39	1,390	1929	87	1947	290	339
OCT 7	40	2,640	1964	61	1993	285	367
OCT 14	41	1,150	1906	52	1993	265	317
OCT 21	42	1,340	1975	71	1941	261	320
OCT 28	43	893	1997	63	2002	284	314
NOV 4	44	1,650	1918	94	2000	282	345
NOV 11	45	1,420	1977	69	1999	300	350
NOV 18	46	2,260	1929	61	1999	324	382
NOV 25	47	4,440	1906	157	1956	337	437
DEC 2	48	1,850	1948	126	1956	352	438
DEC 9	49	1,460	1983	150	1987	430	509
DEC 16	50	2,250	1961	145	1939	426	544
DEC 23	51	2,410	1918	168	1965	447	560
DEC 31	52	3,400	1932	170	1955	552	653

AVERAGE FLOW 1903 - 2002 = 603 CFS

RIVER SYSTEM OPERATIONS


BLUE RIDGE
1700
1690
1680
1670
1660
1650
1640
1630
1620
1610
1600
1590
1580
Elevation, Ft
TOP OF GATES EL.
SPILLWAY CREST
EL. 1675.0
NORMAL MINIMUM EL.
1999
2000
2001
2002
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

RESERVOIR RELEASES IMPROVEMENTS

The aeration and minimum flow equipment at Blue Ridge Dam is part of the implementation of TVA's Lake Improvement Plan (LIP) approved by the Board of Directors in 1991. One of the goals of the Lake Improvement Plan is to improve the dissolved oxygen (DO) levels and minimum flows of the releases of 16 dams. Minimum flow releases of 115 cfs at Blue Ridge were obtained by the installation of a 2,000 hp small hydroturbine unit which is operated whenever the main unit is off. At Blue Ridge testing showed the target minimum DO content of the release (6 mg/L) to be best achieved by the installation of oxygen injection equipment. Oxygen is supplied from a 9,000 gallon liquid oxygen storage tank. Four line diffusers are deployed upstream of the main turbine intake and are 1,800 feet long and include 14,400 feet of diffuser hoses. Also, a turbine venting system for the small turbine was added that includes draft-tube baffles with 4-valved air passages.

SAFETY MODIFICATIONS FOR PROBABLE MAXIMUM FLOOD

Chronology

Safety analysis studies for Blue Ridge Dam for the Probable Maximum Flood (PMF) were completed in early 1990. Onsite construction began in February 1993 and was completed on September 22, 1995.

Cost of Modification

Design costs for the capital safety modifications to Blue Ridge Dam were approximately $600,000. This did not include costs for dam safety evaluation studies, which resulted in the modifications. Construction costs were approximately $6.25 million. The total project cost was approximately $6.85 million.

Controlling Features

The existing embankment was raised 4.1 feet with compacted earthfill starting at elevation 1706.5. Also, a cast-in-place 7 foot tall concrete wall, with a 1′-3″ thick footing, was placed upstream of the existing roadway across the dam. And an ungated spillway along the left rim with a 320-foot Ogee Crest was added. These PMF modifications will prevent overtopping and subsequent erosion of the Blue Ridge embankment.

LOW LEVEL DISCHARGE OUTLET

At Blue Ridge Dam the present penstock is the only outlet that provides low level discharge. The penstock is in need of repairs. Consequently, TVA plans to construct a new low level outlet at Blue Ridge in order to have an alternate means of low level discharge control for the reservoir while the penstock is being repaired. The proposed location of the outlet/tunnel is being investigated. Further, TVA's hydraulic analysis has determined that an approximate 8-foot inside diameter conduit will satisfy the preliminary maximum flow criteria of 1800 cfs assigned to the low level outlet. The tunnel length, depending on the alignment selected, will be somewhere between 600 and 1000 feet long. The estimated cost of this project is $14 million and is expected to be completed in the fall of 2004.

WR28-2-900-123

METHOD FOR ESTIMATING DISCHARGE AT OVERFLOW SPILLWAYS WITH CURVED CRESTS AND RADIAL GATES

TENNESSEE VALLEY AUTHORITY
OFFICE OF NATURAL RESOURCES AND ECONOMIC DEVELOPMENT
DIVISION OF AIR AND WATER RESOURCES
WATER SYSTEMS DEVELOPMENT BRANCH
NORRIS, TENNESSEE

Tennessee Valley Authority
Office of Natural Resources and Economic Development
Division of Air and Water Resources
Water Systems Development Branch

METHOD FOR ESTIMATING DISCHARGE AT OVERFLOW SPILLWAYS WITH CURVED CRESTS AND RADIAL GATES

Report No. WR28-2-900-123

Prepared by
E. Dean Harshbarger,
Billy J. Clift,
and
James W. Boyd

Norris, Tennessee
January 1985

CONTENTS

LIST OF FIGURES

INTRODUCTION

The discharge at overflow spillways is determined by the spillway width, spillway gate position, a representative head (or water depth), and a discharge coefficient. For rating purposes, the spillway width and head are usually specified and the discharge coefficient is determined from scale model tests. Most of the spillways for the Tennessee Valley Authority (TVA) dams were model tested at the TVA Engineering Laboratory.

The original development of specific TVA spillway discharge coefficients (Kirkpatrick, 1957; TVA, 1962) did not establish an orderly connection between the discharge characteristics of various spillways, and therefore, the data could not be directly applied to other installations. However, revised discharge coefficient curves which did establish usable relationships were developed (TVA, 1972) and were later augmented by additional model tests. Presently data from Apalachia, Boone, Fort Patrick Henry, Hales Bar, Hiwassee, Melton Hill, Nickajack, Watts Bar and Wheeler model tests are used to define discharge coefficients with respect to gate openings, headwater elevations and crest shapes. Using these relationships, the coefficients for installations of similar design may be obtained without model testing. Discharge coefficients for Normandy Dam (TVA, 1984) were determined in this manner.

This report describes the discharge coefficient relationships established by TVA and how they are used to compute spillway rating tables for similar spillway installations in lieu of model testing.

DISCHARGE CRITERIA

The major factors which influence the discharge coefficient are the position of the gate seal point with respect to the highest point of the spillway crest, the curvature (or shape) of the crest and the curvature of the gate. Although no systematic attempt has been made to determine the quantitative effect of these factors individually, the basic trend of the coefficient data has been established with respect to crest shape. The crest shapes were identified by their relative similarity to standard crests (Creager, 1950; Corps of Engineers, 1954; Bureau of Reclamation, 1960) which approximate closely the lower portion of a free jet issuing from a sharp-crested weir.

For each standard crest shape there is a corresponding head at which flow over the crest will not separate from the surface of the crest, but will conform exactly to the crest contours. This head is termed the "standard crest design head." The TVA spillway discharge coefficient relationships are based on normalized data from the nine spillway models tested, together with standard crest design heads determined by comparing the model crest shape with standard crests.

In given situations, if the flow over the spillway crest touches or impinges upon the gate, the discharge is computed using a formula for gated discharges. If the flow does not impinge upon the gate, the discharge is computed using a formula for free discharge.

Discharge coefficients were determined for gated and free discharge using spillway models consisting of three spillway bays placed across an open channel with uniform flow. The width of the channel corresponded to the distance between the centerlines of the end piers to include the effect of flow contraction around piers. These spillway crests approximate standard crests from a point near the upstream face of the spillway to a point downstream near the gate seal point. The gate seal point is usually located below the crest elevation on the downstream portion of the crest to prevent discharge jets from overshooting the spillway for small gate openings under high heads.

The discharge nappe was unrestricted due to low tailwater elevations in the model tests. Therefore, the spillway discharge coefficient relationships do not include the effects of tailwater submergence.

GATED DISCHARGE

At multipurpose reservoirs, spillway discharge is used to regulate reservoir water levels and downstream water flowrates.

Therefore various spillway gate positions are needed to provide a range of discharge rates for each headwater elevation. To release water, the gate is raised to a predetermined position which allows a prescribed discharge to pass over the spillway crest.

The gated discharge shown in Figure 1 is determined by the area of the opening under the gate, by the water velocity through the gate opening and by the discharge coefficient of the gate opening. The area is based on the vertical distance, G, between the gate bottom point and the spillway point directly below. The water velocity is a function of the acceleration due to gravity and the mean water depth over the gate opening, H_m, defined as the distance from the surface of the headwater to the gate opening mid-point.

The equation for gated discharge through one spillway bay is:

$$Q = C\ L\ G \sqrt{2g\ H_m} \qquad (1)$$

where

Q = discharge, ft^3/s

C = discharge coefficient, dimensionless

L = spillway bay width, ft

G = vertical gate opening, ft

g = acceleration due to gravity, ft/s^2

H_m = head on the vertical gate opening mid-point measured from the reservoir headwater elevation, ft

The discharge coefficients were developed as a function of vertical gate opening, standard crest design head, and headwater elevation as shown in Figures 2a and 2b. The general uncertainty of the gated discharge coefficient relationship is considered to be within ± 2 percent based on the maximum deviation from the average trend. At small vertical gate openings (i.e., less that two feet) the error may be greater (Kirkpatrick, 1972).

To use Figure 2a, the headwater elevation, HL_1, at which the spillway discharge touches, but does not impinge upon the spillway gate must be determined. Starting with the desired gate opening, G, and the standard crest design head, H_o, the ratio H_c/H_o can be determined from Figure 2b. Then HL_1 can be determined by using the equation:

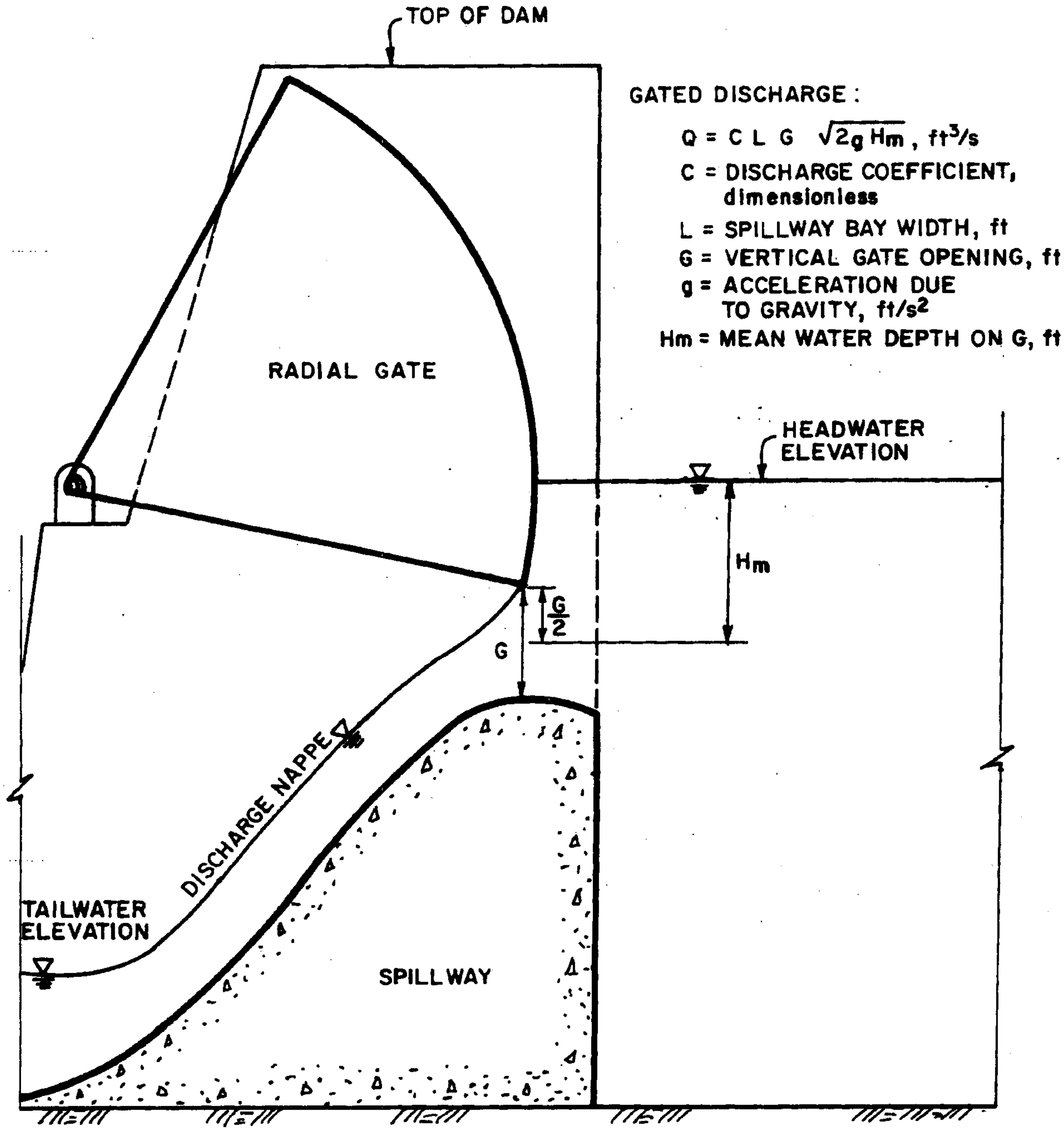


Figure 1: Gated Spillway Discharge

COEFFICIENTS

1. FOR $HL_1 \leq HL \leq HL_5$
   $C = f(G/H_o, HL)$
2. FOR $HL > HL_5$
   $C = f(G/H_o, HL_5)$

TRANSITION HEADWATER ELEVATIONS

$HL_1 = HL_{cr} + (H_c/H_o) H_o$
$HL_2 = HL_1 + 0.025 H_o$
$HL_3 = HL_1 + 0.050 H_o$
$HL_4 = HL_1 + 0.075 H_o$
$HL_5 = HL_1 + 0.100 H_o$

NOTE

HL_1 = HEADWATER ELEVATION AT WHICH SPILLWAY DISCHARGE TOUCHES BUT DOES NOT IMPINGE UPON THE GATE, ft
HL = HEADWATER ELEVATION, ft
H_o = STANDARD CREST DESIGN HEAD, ft
H_c = HEAD ON CREST, ft
HL_{cr} = CREST ELEVATION, ft
H_m = HEAD ON MID-POINT OF GATE OPENING, ft
G = VERTICAL GATE OPENING, ft
L = SPILLWAY BAY WIDTH, ft
g = ACCELERATION DUE TO GRAVITY, ft/s²

REFERENCE DRAWINGS AEL 99 B105
AEL 99 B106

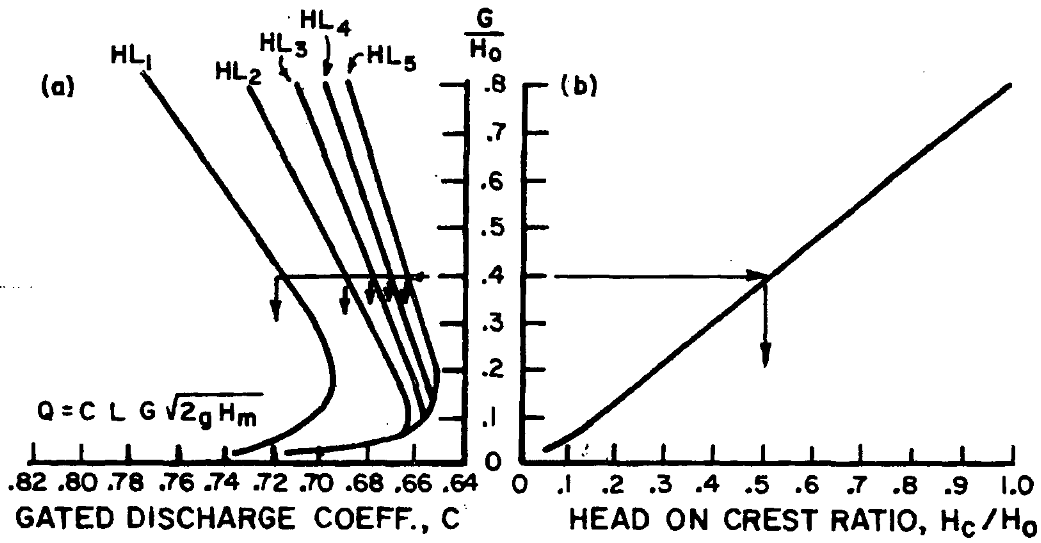


Figure 2: Gated Discharge Coefficients and Associated Headwater Elevations for Specified Gate Openings and Standard Crest Design Heads at Curved Spillways with Radial Gates

$$HL_1 = HL_{cr} + \frac{H_c}{H_o} H_o \qquad (2)$$

Where:

HL_1 = headwater elevation at which spillway discharge touches but does not impinge upon the gate, ft
HL_{cr} = spillway crest elevation, ft
H_c = head on crest, ft
H_o = standard crest design head, ft
H_c/H_o = dimensionless ratio specified by G/H_o in Figure 2b

Once HL_1 is known, the discharge coefficients for higher headwater elevations can be determined as shown in Figure 2a. For transition headwater elevations HL_1 through HL_5 in Figure 2a, increased headwater elevation may not cause increased discharge and may even cause decreased flow because of flow contraction losses and friction losses resulting from increased water impingement upon the gate. At headwater elevations greater than HL_5 there is no significant increase in the various flow losses, and therefore the discharge coefficient is constant and equal to the discharge coefficient for headwater elevation HL_5. At small gate openings (say less than a foot), there may be little, or no transition and the discharge coefficients may be constant at some headwater elevation less than headwater elevation HL_5. The general uncertainty of the H_c/H_o vs G/H_o relationship is within ± 10 percent at small vertical gate openings and ± 2 percent at large openings based on the maximum deviations from the trend.

At headwater elevation HL_1, gated discharge is equal to free discharge described later in this report. However, due to the uncertainties of the discharge coefficient relationship and the H_c/H_o relationship to headwater elevation HL_1, either the gated discharge coefficient for headwater elevation HL_1 at large vertical gate openings or the headwater elevation HL_1 at small vertical gate openings may require adjustment as described later in this report to mathematically ensure gated discharge equivalent to free discharge.

In some cases, headwater elevation HL_1 may be the headwater elevation for maximum spillway discharge at the maximum vertical gate opening. This maximum spillway discharge elevation is critical in extreme flood control situations. Although the relationship between headwater HL_1 and the ratio H_c/H_o in Figures 2a and 2b is satisfactory for most spillway operations, deviations from the average trend are inherent due to variations in gate designs and locations. Other computation methods may have the same uncertainty because they require friction factors, kinetic energy factors, etc., that are best evaluated through individual model or prototype tests.

FREE DISCHARGE

Free spillway discharge occurs when water discharges freely through the vertical gate opening, as shown in Figure 3, without impinging on the gate. For each vertical gate opening, free discharge is limited by headwater elevation HL_1 previously described. The equation for free spillway discharge through a single spillway bay is:

$$Q = C\ L\ H_c^{3/2} \qquad (3)$$

in which

Q = discharge, ft^3/s
C = discharge coefficient, dimensionless
L = spillway bay width, ft
H_c = head on crest measured from the reservoir headwater elevation, ft

This equation is similar to the general equation for weirs across open channels. The free discharge coefficient varies with the head on crest, H_c, shown in Figure 3, and with the standard crest design head. The relationship between discharge coefficients, head on crest, and the standard crest design head is shown in Figure 4. The uncertainty of the discharge coefficient relationship is within ± 1 percent based on the maximum deviation from the average trend (Kirkpatrick, 1972).

GATE ARRANGEMENTS AND IDENTIFICATION

Gate opening arrangement, or the pattern of open gates across the spillway is important at installations with several spillway bays and

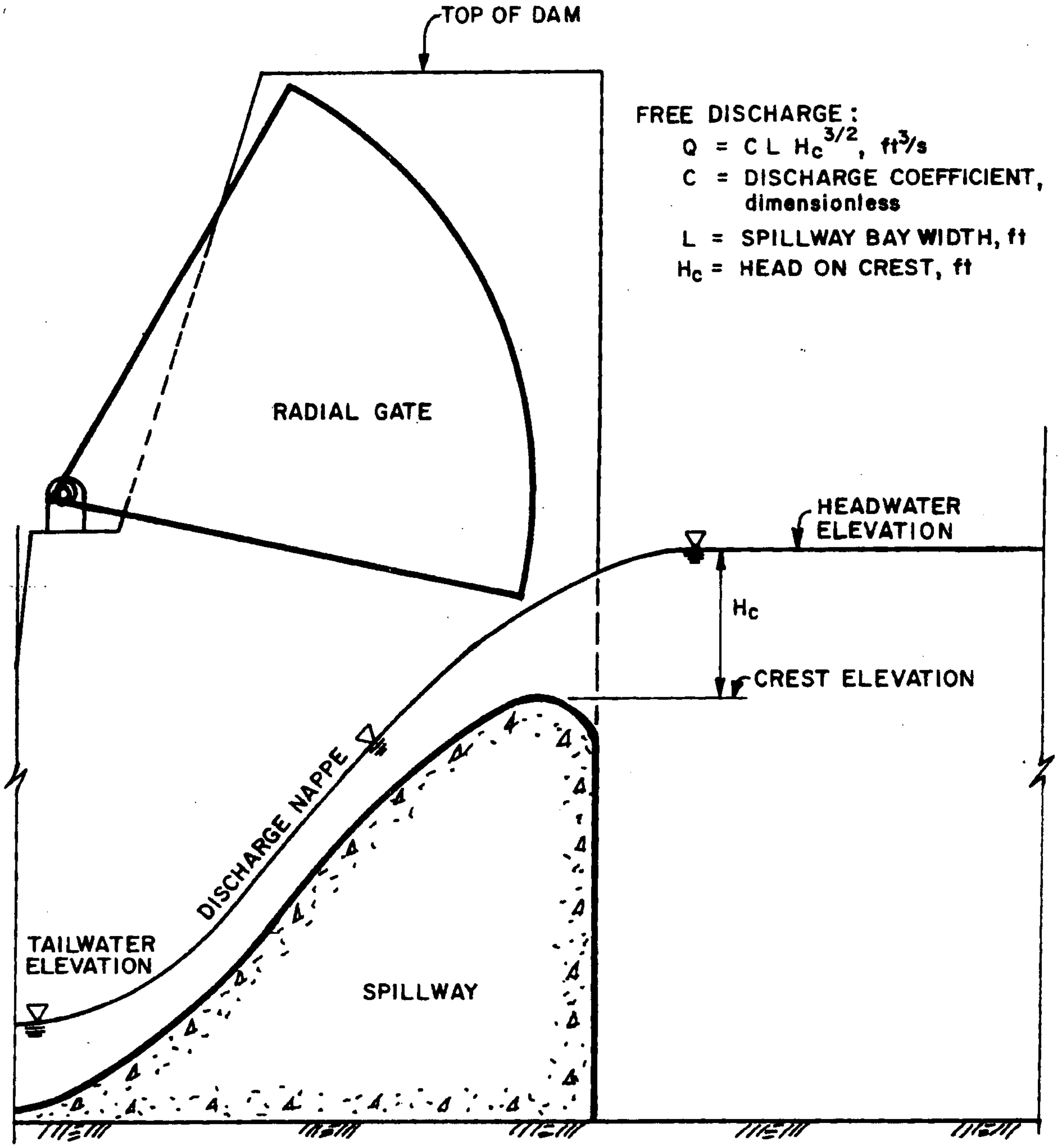


Figure 3: Free Spillway Discharge

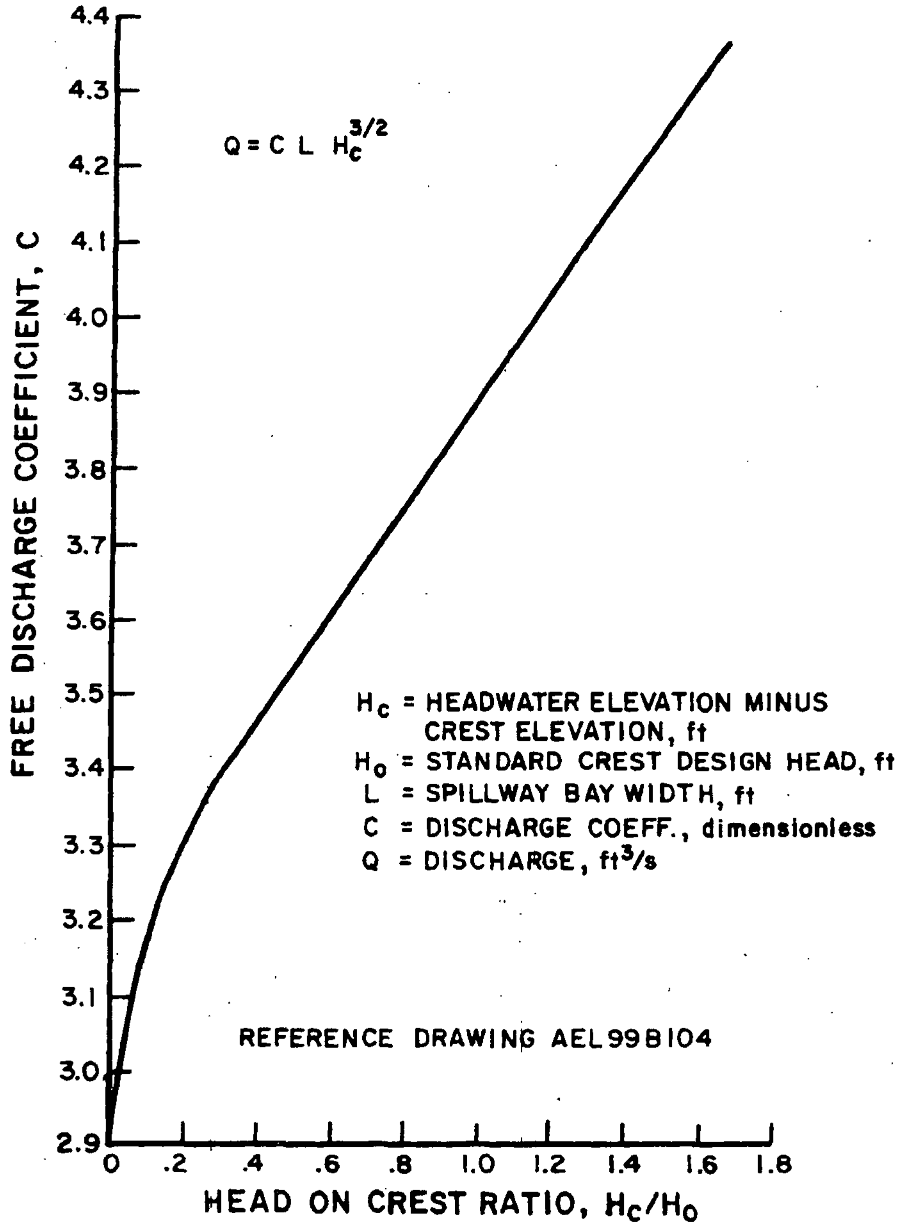


Figure 4: Free Discharge Coefficients for Specified Headwater Elevations and Standard Crest Design Heads at Curved Spillways

gates. Some gate opening arrangements will produce flow patterns in the stilling basin that are hazardous to the structural stability of the dam and stilling basin and to navigation downstream.

In practice, each gate is assigned an identification number and a diagram showing the spillway gate number and location is included in the spillway rating tables. For a given flow and headwater elevation, the gates to be opened and the required amount of opening to obtain the given flow are identified by a specific gate arrangement number. Increasing gate arrangement number indicates increasing flow.

RATING TABLES

Spillway rating tables are used for daily water control operations and water control planning. For each gate arrangement number, discharge rates are listed as a function of headwater elevation. At multiple gate spillways, the listed discharge represents the total discharge for the gate positions prescribed in the table of gate arrangements. The primary purpose of the spillway rating table is to determine the appropriate gate opening arrangements required to pass the listed discharge for the given headwater elevation. The alternate use is to determine the discharge for a given gate arrangement and headwater elevation.

Only discrete discharge rates are listed in the rating table. In the event that a preferred rate is not listed, the rate nearest to it should be used to minimize gate arrangement adjustments and to avoid using gate arrangements not authorized in the rating table.

The TVA discharge coefficient relationships can be used in lieu of calibration data to prepare rating tables for spillways that meet conditions of geometric similitude and have an established table of gate arrangements. Seven major parameters must be evaluated for each spillway rating.

1. Standard crest design head: determined by crest shape.
2. Vertical gate openings: determined by gate positions.
3. Gated discharge headwater elevations: determined for each gate opening by the relationships in Figures 2a and 2b for

transitional headwater elevations based on headwater elevation HL_1. Note adjustment listed in (4) below for headwater elevation HL_1.

4. Gated discharge coefficients: with minor adjustments, they are determined for each vertical gate opening and headwater elevation by the relationships in Figure 2a. At headwater elevation HL_1, the gated discharge must be equivalent to free discharge. However, due to the uncertainties of the discharge relationships, the gated and free discharge equations may not converge. In this case, the gated discharge coefficient is adjusted so that the gated discharge from equation (1) is equal to the free discharge from equation (3). Also the adjusted gated discharge coefficient at headwater elevation HL_1 must not be less than the constant gated discharge coefficient at headwater elevation HL_5. If the coefficient must be readjusted to be equal to the constant coefficient, headwater elevation HL_1 must be adjusted also by using equations (1) and (3) which are solved iteratively to establish headwater elevation HL_1 for equivalent discharges.

   After adjustment, the coefficients are plotted as a function of transitional headwater elevation. An average, monotonically-decreasing curve is drawn to pass through the maximum and minimum coefficient points to define interpolated coefficients in the transitional headwater range. For headwaters greater than the transitional headwaters, the discharge coefficient is constant and equal to the minimum coefficient. At small gate openings, the interpolated coefficients may be equal or they may become equal at some headwater within the transitional headwater range.

5. Free discharge coefficients: determined for each crest elevation and headwater elevations less than, or equal to headwater elevation HL_1, by the relationship in Figure 4.
6. Adjacent gate effect: the discharge coeffieients include the effect of flow contraction around spillway piers when the gate

openings for adjacent bays are equal. Although reduced discharge occurs due to contractions at piers between adjacent gates with dissimilar gate openings (Kirkpatrick, 1957), the reduction is not significant when compared with the accuracy of discharge coefficient relationships where interior adjacent gate openings do not vary more than one position. At end gates, the dam abutment may have the same effect as a closed gate. Where the abutment approximates one gate, the estimated end gate discharge reduction varies from one percent at median gate positions to three percent at the maximum gate position. If the approach channel corresponds to the spillway end piers, there is no discharge reduction.

7. Overtopping discharge: the spillway discharge coefficent relationships cannot be used to estimate discharge over the gates or over the dam. At small gate openings, the top of the gate elevation may be lower than the top of the dam elevation and, therefore, gated discharge headwater elevations must not exceed the top of the gate elevation in discharge calculations for small gate openings.

A representative discharge rating curve for one gate is shown in Figure 5. Some, or all, gates at a particular dam may have identical discharge characteristics at all gate positions and will have duplicate discharge rating curves. Discharge rates for each gate arrangement are determined by summing individual rates according to the prescribed gates, gate positions, and headwater elevations for each gate arrangement number. The spillway rating table normally lists discharge rates to the nearest 10 cubic feet per second for rates less than 100,000 and to the nearest 100 cubic feet per second at higher rates.

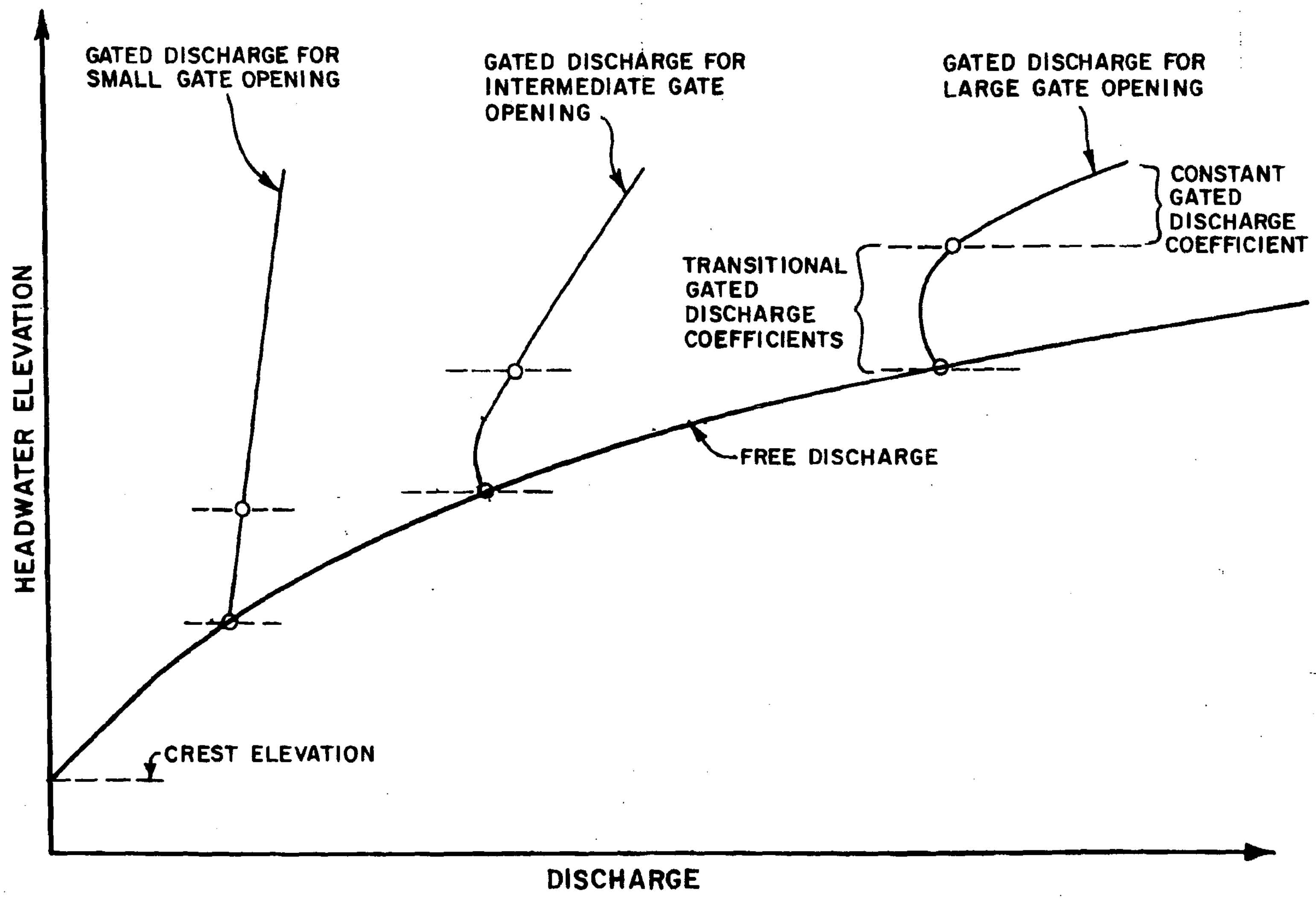


Figure 5: Representative Discharge Curve for a Radial Gate Over a Curved Spillway

REFERENCES

Bureau of Reclamation, 1960, Design of Small Dams, United States Department of the Interior.

Corps of Engineers, 1954, "Overflow Spillway Crests," Hydraulic Design Criteria, Waterways Experiment Station, Vicksburg, Mississippi.

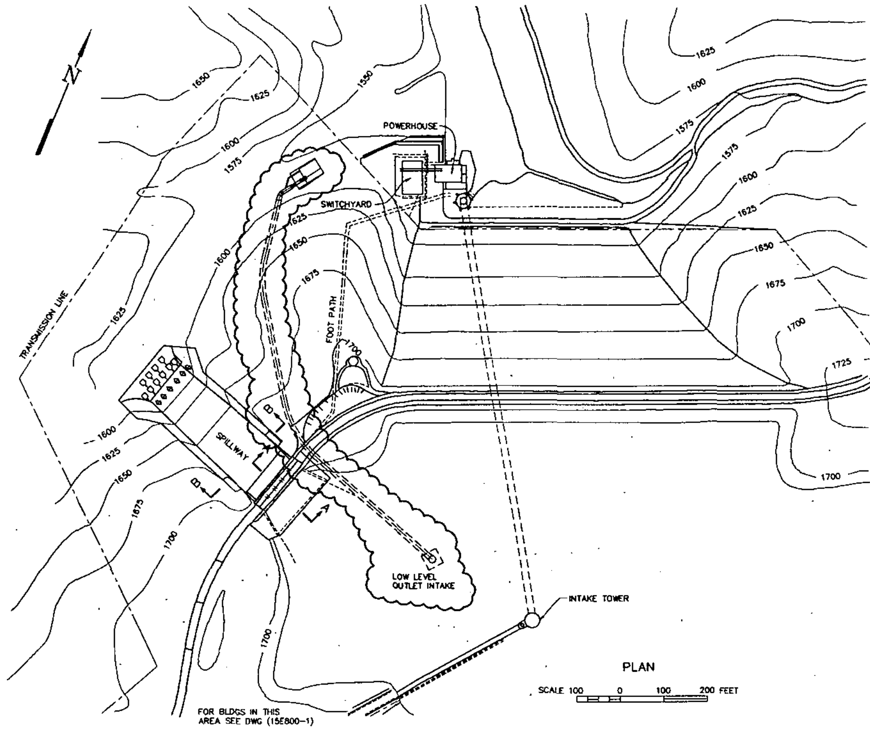
Creager, W. P., and J. D. Justin, 1950, Hydroelectric Handbook, John Wiley and Sons, Inc., New York, New York, Second Edition.

Kirkpatrick, K.W., 1957, "Discharge Coefficients for Spillways at TVA Dams," ASCE Paper No. 2855, Reprinted from Transactions, Vol. 122, page 190.

TVA, March 1962, "Tainter Gate Rating Data Determined from Eight TVA Model Studies," Division of Water Control Planning, Engineering Laboratory.

TVA, June 1972, "Spillway Discharge Rating," Division of Water Control Planning, Engineering Laboratory, Normandy Project Advance Report No. 4, Report No. 65-11.

TVA, April 1984, "Normandy Dam Spillway and Sluice Discharge Tables," Division of Air and Water Resources, Water Systems Development Branch.



PLAN

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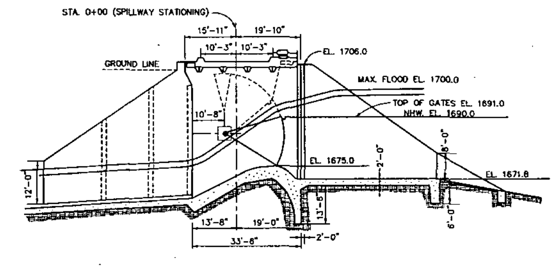
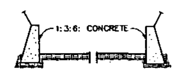


SECTION A–A

NTS

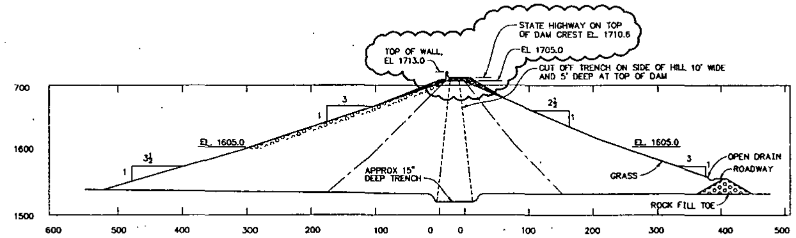


SECTION B–B

NTS

TAKEN FROM TEP. CO. DWGS. 17-C-48 & 17-C-50

NOTE:
ELEVATION ARE BASED ON TEP CO. DATUM. TO CORRECT TO USC & GS 1936 SUPPLEMENTARY ADJUSTMENT, SUBTRACT 0.18 FEET.



TYPICAL SECTION

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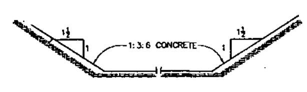


SPILLWAY CHANNEL SECTION

SHOWING PAVING

NTS

REFERENCE DRAWINGS:
10W200------SITE LOCATION PLAN

FOR PROBABLE MAXIMUM FLOOD MODIFICATIONS, SEE DRAWINGS:
51W290-SERIES ------ AUXILIARY SPILLWAY DETAILS
81W200-81W203 ------ ROADWAY OVER DAM MODIFICATIONS
81W300-SERIES ------ CONCRETE RETAINING WALL DETAILS
81W307-SERIES ------ SLOPE PROTECTION-CONCRETE DETAILS

R 1 JAN 08 2007 KGK LBO CBD RWT MAC
ADDED PMF WALL INFORMATION; ADDED LLO TO PLAN VIEW
R 0 CEC JMR SRK TKM JEV JEV JHC
INITIAL ISSUE

SCALE: 1" = 100' EXCEPT AS NOTED

BLUE RIDGE DAM
EMBANKMENT

GENERAL PLAN
AND SECTIONS

C.E.CALDWELL | J.M.RICHARDSON | S.R.KRAMER | T.K.MCENTIRE | J.E.WARNER | J.E.WARNER | J.H.COULSON

BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

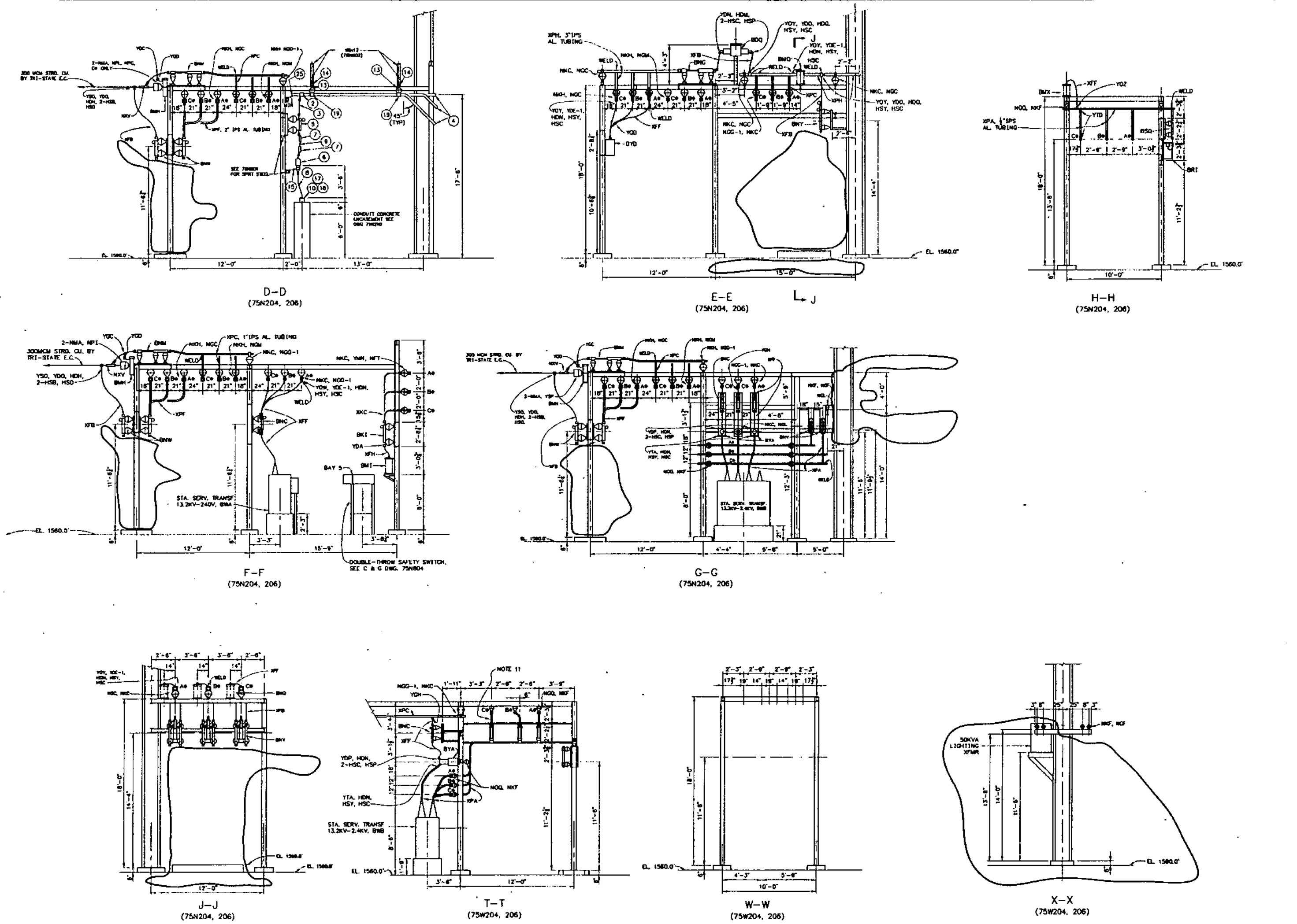
AUTOCAD R12 | #48 | P | 21W200 | R 1

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: REV NO.

#48 P 121W80



NOTES:
FOR NOTES SEE DWG 75N204

75BM204 ---- BILL OF MATERIAL
75W207 ---- BILL OF MATERIAL AND NAMEPLATES
78N801 ---- SWYD STRUCTURAL STEEL
78N802 ---- SWYD STRUCTURAL STEEL
71N210 ---- CONCRETE FOUNDATION DETAILS
LC-24584 ---- SUBSTATION FOUNDATION PLAN

THIS DRAWING SUPERSEDES LC-24582

FIRST ISSUED FOR P.A. 1735, W.O. 92-35048 AND P.A. 1823, W.O. H12-82-41511

DEC 26 2007

R 6 | | GSH | GSH | BAL | ADH | | RDC | MAC | HY00041 | | D
DCN BRH-07-21; SWYD OIL CONTAINMENT PROJECT
R 5 | 11-9-04 | HOW | HOW | RDH | REB | VAN | RWT | MAC | | | J
INITIAL CAD, AS-BUILT DECOMMISSIONED 2.4KV LINE/EQUIPMENT SUPPLYING SPLWY/INTAKE.

SCALE: 1/4"=1'-0" EXCEPT AS NOTED

SWITCHYARD

ELECTRICAL EQUIPMENT 13.2 KV STR AND 2.4 KV STR CROSS SECTIONS

DESIGNED BY	DRAWN BY	CHECKED BY	SUPERVISED BY	REVIEWED BY	APPROVED BY	ISSUED BY
RAM	RAM	RAM	FJW	RRL	ERS	CM

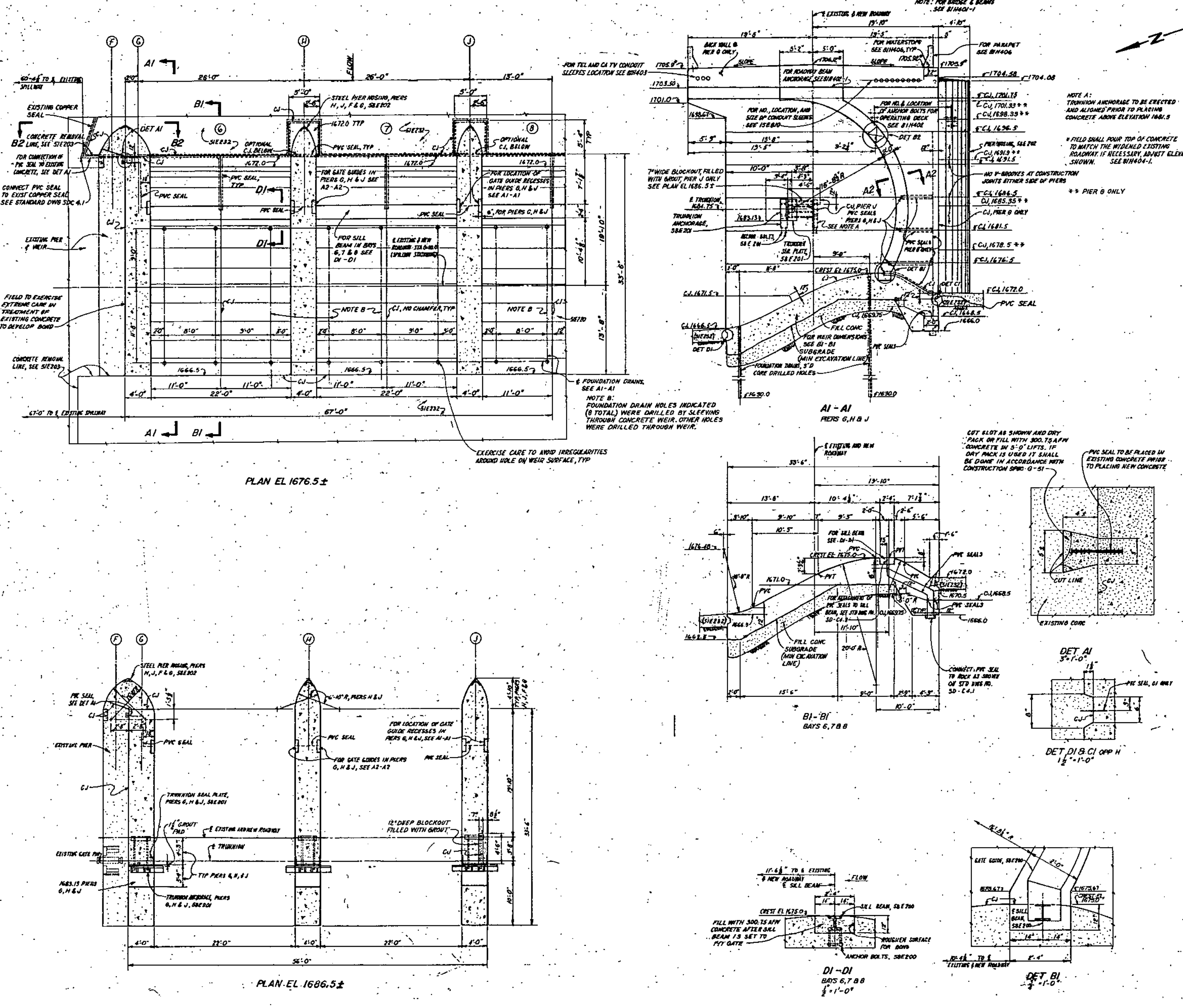
BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

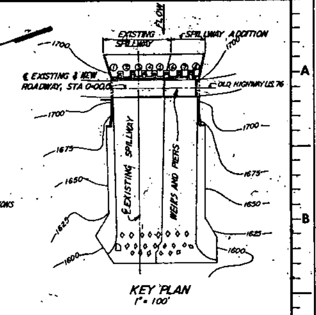
AUTOCAD R14 | DATE 5-1-64 | 48 | E | 75W210 | R 6

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN
AND SUPERSEDES : (75N210 R4)

PLOT FACTOR:48
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY





NOTES:

1. THE NORTH SECTION OF BAY 6 SHALL BE PLACED IMMEDIATELY AFTER COMPLETION OF EXCAVATION AND PIERS F AND G SHALL BE PLACED AS SOON AS POSSIBLE.
2. SPECIAL CARE SHALL BE TAKEN TO AVOID OFFSETS IN THE FINISHED CONCRETE SURFACE AT JOINTS IN THE FORM LINING.
3. POST-TENSIONING OF GATE ANCHORAGE SHALL NOT BE DONE UNTIL CONCRETE HAS ATTAINED 28-DAY STRENGTH.
4. FOUNDATION DRAINS SHALL NOT BE DRILLED UNTIL ALL FOUNDATION GROUTING AT LEFT END OF WEIR CUTOFF WALL (REQUIRED TO STOP SEEPAGE) IS COMPLETE.
5. FIELD TO SOUND ALL FOUNDATION DRAINS PRIOR TO FLOODING TO BE SURE THEY ARE CLEAR OF DEBRIS. ELEVATION OF BOTTOMS OF DRAINS ARE TO BE RECORDED AND REPORTED TO ENGINEERING DESIGN.
6. PVC SEALS ARE TO BE TYPE II (WITHOUT CENTER BULB). ALL SEALS SHALL CONFORM TO TVA SPECIFICATION PF 1026.
7. SCREED THE ROADWAY SURFACE TO A SMOOTH FINISH. AFTER THE ROADWAY SURFACE HAS HARDENED SUFFICIENTLY, THE SURFACE SHALL BE GIVEN A BROOM FINISH IN THE TRANSVERSE DIRECTION USING A STIFF BRISTLED BROOM.
8. FOR ADDITIONAL NOTES SEE 5IE205 AND 5IE206.

REFERENCE DRAWING:
BILL OF MATERIAL 51BM210
CONDUIT AND CABLE SCHEDULE 15E810

3		9-16-86	FINAL FIELD REVISION
2		1-5-84	REV A1-A1, KEY PLAN, REMOVED DETAIL E1 & RELEASED ENTIRE DRAWING
1		10-6-83	REV PLAN EL 1676.5±, A1-A1, B1-B1, PLAN EL 1686.5±, KEY PLAN, & ADDED NOTES
REV NO.	ECN NO.	DATE	

M.E. NOEL
M.E. NORRIS
H.A. MANSON
H.A. MANSON 8-3-82

SCALE: 3/16" = 1'-0" EXCEPT AS NOTED

SPILLWAY ADDITION

CONCRETE WEIRS & PIERS OUTLINE

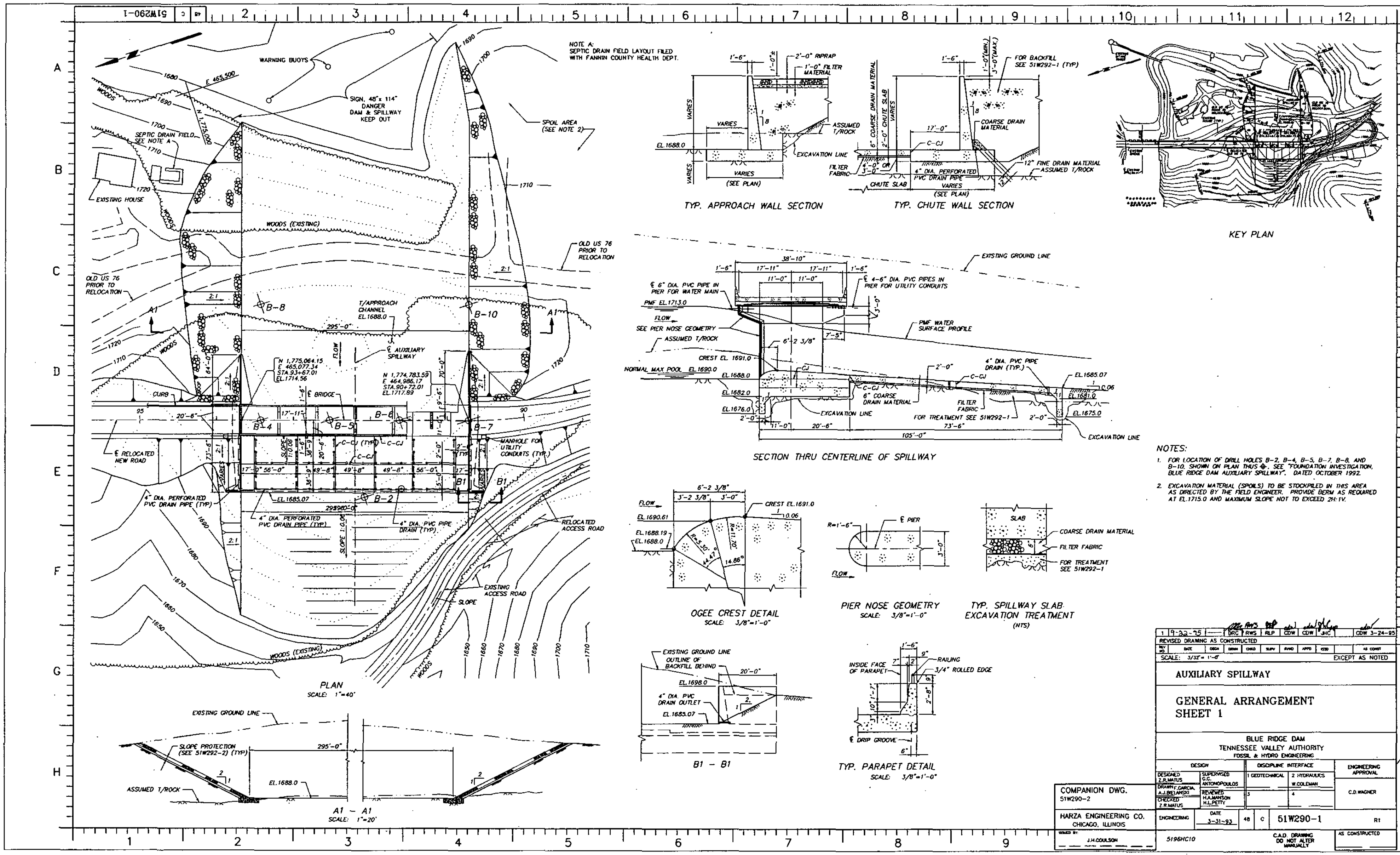
BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED | RECOMMENDED | APPROVED

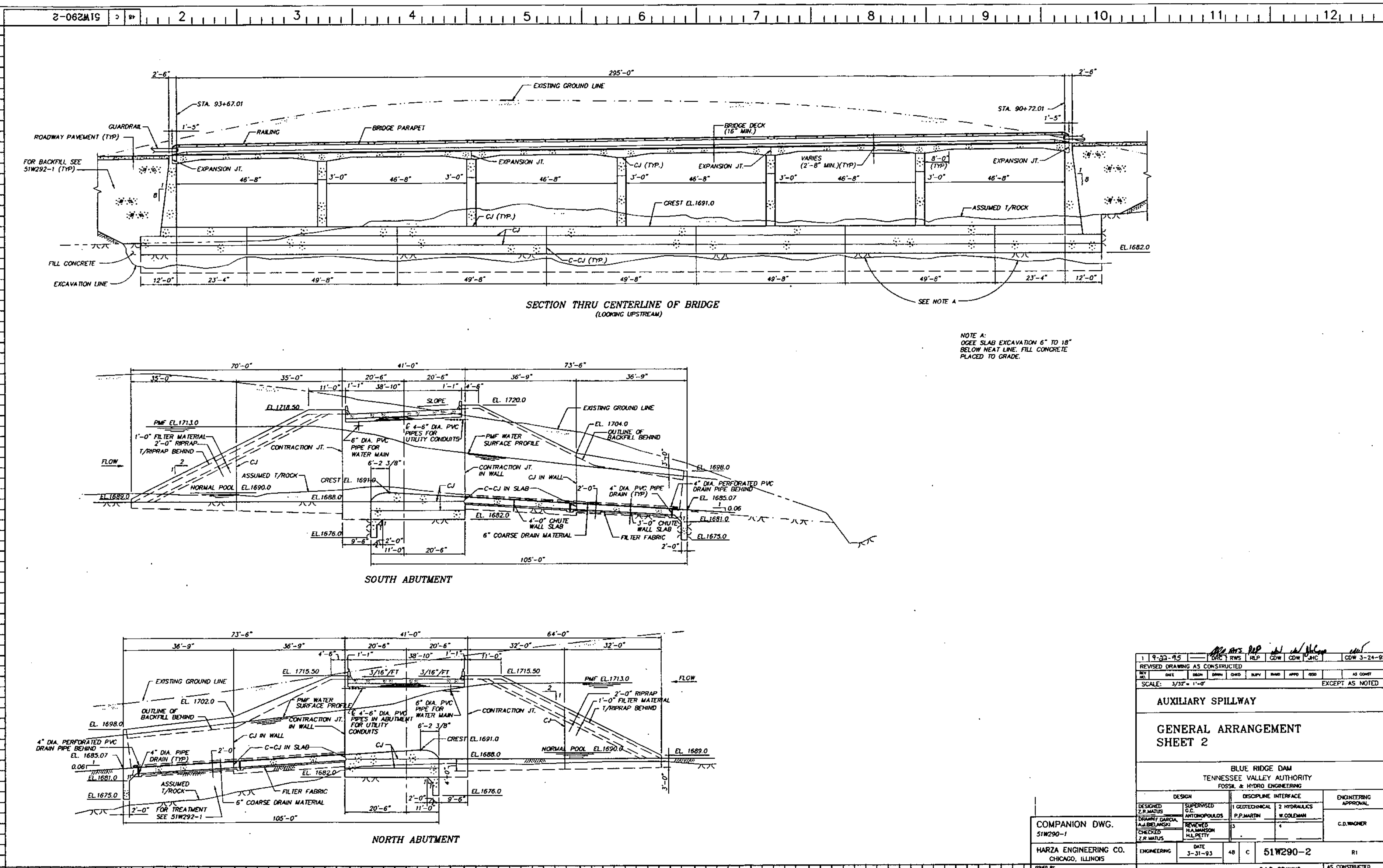
INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE 9-20-82 | 48 | C | 5IE210-1 R3

RECORD DRAWING AS CONSTRUCTED 9-24-85



51W290-1
NOTE A:
SEPTIC DRAIN FIELD LAYOUT FILED WITH FANNIN COUNTY HEALTH DEPT.
WARNING BUOYS
SIGN, 48" x 114" DANGER DAM & SPILLWAY KEEP OUT
SPOIL AREA (SEE NOTE 2)
SEPTIC DRAIN FIELD SEE NOTE A
EXISTING HOUSE
WOODS (EXISTING)
OLD US 76 PRIOR TO RELOCATION
T/APPROACH CHANNEL EL.1688.0
℄ AUXILIARY SPILLWAY
N 1,775,064.15 E 465,077.34 STA.93+67.01 EL.1714.56
N 1,774,783.59 E 464,986.17 STA.90+72.01 EL.1717.89
BRIDGE
CURB
℄ RELOCATED NEW ROAD
MANHOLE FOR UTILITY CONDUITS (TYP.)
4" DIA. PERFORATED PVC DRAIN PIPE (TYP)
4" DIA. PVC PIPE DRAIN (TYP)
EL.1685.07
RELOCATED ACCESS ROAD
EXISTING ACCESS ROAD
SLOPE
PLAN
SCALE: 1"=40'
EXISTING GROUND LINE
SLOPE PROTECTION (SEE 51W292-2) (TYP)
ASSUMED T/ROCK
EL.1688.0
A1 - A1
SCALE: 1"=20'
TYP. APPROACH WALL SECTION
TYP. CHUTE WALL SECTION
2'-0" RIPRAP
1'-0" FILTER MATERIAL
ASSUMED T/ROCK
EXCAVATION LINE
FILTER FABRIC
FOR BACKFILL SEE 51W292-1 (TYP)
COARSE DRAIN MATERIAL
12" FINE DRAIN MATERIAL
4" DIA. PERFORATED PVC DRAIN PIPE
CHUTE SLAB
VARIES (SEE PLAN)
KEY PLAN
SECTION THRU CENTERLINE OF SPILLWAY
EXISTING GROUND LINE
℄ 6" DIA. PVC PIPE IN PIER FOR WATER MAIN
℄ 4-6" DIA. PVC PIPES IN PIER FOR UTILITY CONDUITS
PMF EL.1713.0
SEE PIER NOSE GEOMETRY
PMF WATER SURFACE PROFILE
CREST EL.1691.0
NORMAL MAX POOL EL.1690.0
6" COARSE DRAIN MATERIAL
FOR TREATMENT SEE 51W292-1
EXCAVATION LINE
NOTES:
1. FOR LOCATION OF DRILL HOLES B-2, B-4, B-5, B-7, B-8, AND B-10, SHOWN ON PLAN THUS ⊕, SEE "FOUNDATION INVESTIGATION, BLUE RIDGE DAM AUXILIARY SPILLWAY", DATED OCTOBER 1992.
2. EXCAVATION MATERIAL (SPOILS) TO BE STOCKPILED IN THIS AREA AS DIRECTED BY THE FIELD ENGINEER. PROVIDE BERM AS REQUIRED AT EL.1715.0 AND MAXIMUM SLOPE NOT TO EXCEED 2H:1V.
OGEE CREST DETAIL
SCALE: 3/8"=1'-0"
PIER NOSE GEOMETRY
SCALE: 3/8"=1'-0"
TYP. SPILLWAY SLAB EXCAVATION TREATMENT
(NTS)
COARSE DRAIN MATERIAL
FILTER FABRIC
FOR TREATMENT SEE 51W292-1
OUTLINE OF BACKFILL BEHIND
4" DIA. PVC DRAIN OUTLET
B1 - B1
TYP. PARAPET DETAIL
SCALE: 3/8"=1'-0"
INSIDE FACE OF PARAPET
RAILING
3/4" ROLLED EDGE
DRIP GROOVE
REVISED DRAWING AS CONSTRUCTED
SCALE: 3/32"=1'-0" EXCEPT AS NOTED
AUXILIARY SPILLWAY
GENERAL ARRANGEMENT SHEET 1
BLUE RIDGE DAM
TENNESSEE VALLEY AUTHORITY
FOSSIL & HYDRO ENGINEERING
COMPANION DWG. 51W290-2
HARZA ENGINEERING CO. CHICAGO, ILLINOIS
DATE 3-31-93
51W290-1
5196HC10
C.A.D. DRAWING DO NOT ALTER MANUALLY
AS CONSTRUCTED



COMPANION DWG.	51W290-1
HARZA ENGINEERING CO.	CHICAGO, ILLINOIS

1 | 9-22-95 | REVISED DRAWING AS CONSTRUCTED | CDW 3-24-95

SCALE: 3/32" = 1'-0" EXCEPT AS NOTED

AUXILIARY SPILLWAY

GENERAL ARRANGEMENT
SHEET 2

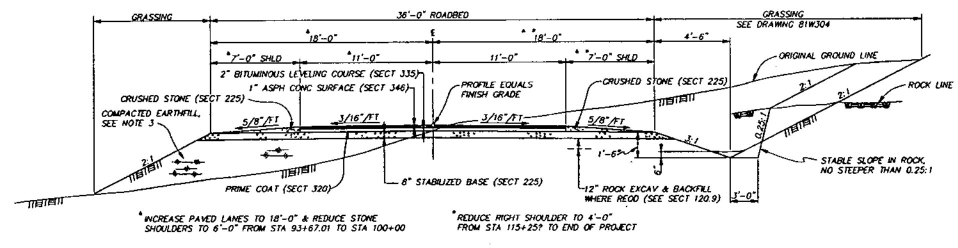
BLUE RIDGE DAM
TENNESSEE VALLEY AUTHORITY
FOSSIL & HYDRO ENGINEERING

DESIGNED Z.R.MATUS — SUPERVISED C.C. ANTONOPOULOS — 1 GEOTECHNICAL P.P.MARTIN — 2 HYDRAULICS W.COLEMAN — ENGINEERING APPROVAL C.D.WAGNER

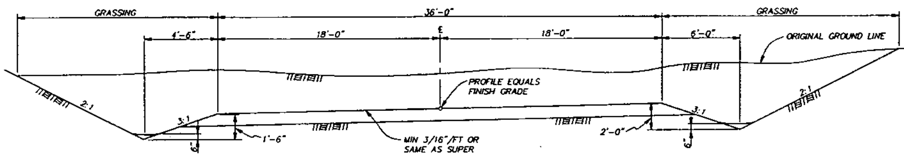
DRAWN F.GARCIA, A.J.BIELANSKI — CHECKED Z.R.MATUS — REVIEWED H.A.MANSON, H.L.PETTY

ENGINEERING DATE 3-31-93 | 48 | C | 51W290-2 | R1

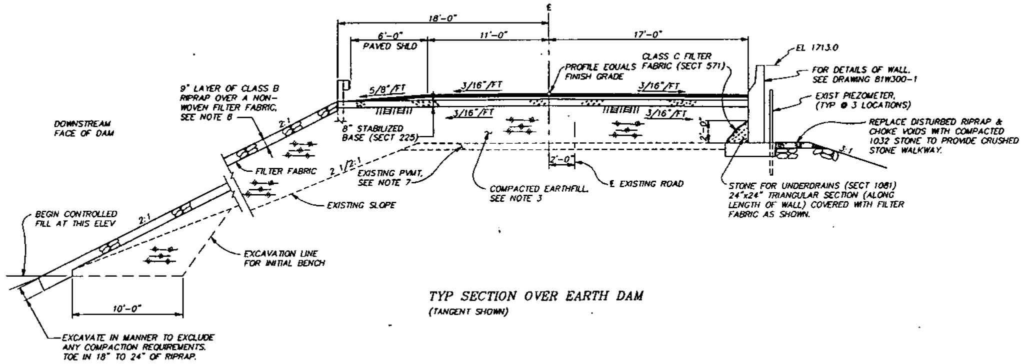
ISSUED BY: J.H.COULSON — 5196HC11 — C.A.D. DRAWING DO NOT ALTER MANUALLY — AS CONSTRUCTED



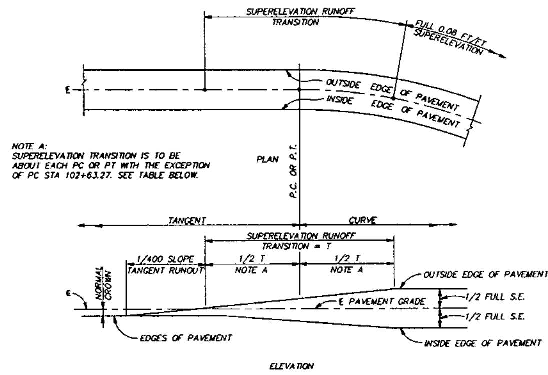
TANGENT SECTION



SUPERELEVATION SECTION



TYP SECTION OVER EARTH DAM
(TANGENT SHOWN)

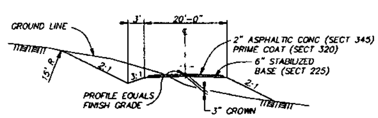


TYP SUPERELEVATION TRANSITION

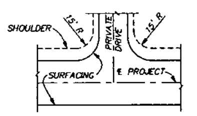
SUPERELEVATION TABLE			
DESCRIPTION	STATION	LENGTH OF RUNOFF (FT)	(e) MAX FT/FT
BEGIN TANGENT RUNOUT	84+03.22		
BEGIN TRANSITION	84+80.00		
		160	
END TRANSITION	86+39.00		
BEGIN MAX (e)			0.08
END MAX (e)	89+92.01		
BEGIN TRANSITION			
		160	
END TRANSITION	91+52.01		
END TANGENT RUNOUT	92+64.33		
BEGIN TANGENT RUNOUT	102+11.76		
BEGIN TRANSITION	102+79.76		
		160	
END TRANSITION	104+39.76		
BEGIN MAX (e)			0.08
END MAX (e)	104+81.46		
BEGIN TRANSITION			
END TRANSITION	106+41.46		
END TANGENT RUNOUT	107+09.46		
BEGIN TANGENT RUNOUT	112+45.89		
BEGIN TRANSITION	113+13.89		
		160	
END TRANSITION	114+73.89		
BEGIN MAX (e)			0.08
END MAX (e)	115+42.79		
BEGIN TRANSITION			
		160	
END TRANSITION	117+02.79		
END TANGENT RUNOUT	117+70.79		

NOTES:

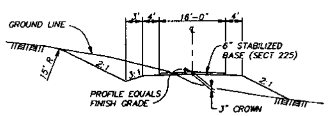
1. ALL WORK SHALL BE DONE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATION NO. T-1 UNLESS OTHERWISE NOTED. ALL SECTION NUMBERS REFER DIRECTLY TO THE T-1 SPECIFICATION.
2. FOUNDATION PREPARATION FOR ALL EMBANKMENTS SHALL CONSIST OF REMOVING ORGANIC TOPSOIL TO A DEPTH THAT WILL REMOVE ALL ROOTS. AND EXCAVATION SHALL CONTINUE TO A DEPTH THAT WILL OBTAIN A FOUNDATION THAT WILL SUPPORT EARTHMOVING EQUIPMENT WITHOUT RUTTING INTO THE GROUND AND HEAVING THE GROUND SO AS TO REDUCE ITS STABILITY.
3. EARTHFILL SHALL BE CONSTRUCTED IN 8-INCH THICK LAYERS IN ACCORDANCE WITH SECTION 120. EACH LAYER SHALL BE COMPACTED TO AT LEAST 95% OF MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698. MOISTURE CONTENT SHALL BE BETWEEN 3% BELOW AND 3% ABOVE OPTIMUM MOISTURE CONTENT. IN-PLACE DENSITY TESTS USING THE SAND CONE (ASTM D1556) OR RUBBER BALLOON (ASTM D2167) TEST METHODS SHALL BE CONDUCTED AT A RATE OF AT LEAST ONE TEST PER EACH 2000 CY OF EARTHFILL PLACED OR A MINIMUM OF ONE PER DAY THAT FILL IS PLACED. IF NUCLEAR DENSITY METHODS ARE USED (ASTM D2922), SUFFICIENT NUMBERS OF THE SAND CONE OR RUBBER BALLOON TESTS WILL BE REQUIRED TO CORRELATE AND VERIFY THE NUCLEAR GAUGE RESULTS.
4. EARTH BORROW IS TO BE OBTAINED FROM THE DESIGNATED BORROW AREA OR FROM AN OFFSITE BORROW PIT APPROVED BY THE ENGINEER.
5. CLEARING AND GRUBBING SHALL BE IN ACCORDANCE WITH SECTION 101.
6. PROFILE GRADE REPRESENTS FINISHED GRADE ELEVATION ON CENTERLINE ALIGNMENT.
7. THE EXISTING ASPHALT IN THIS AREA IS TO BE BROKEN UP, REMOVED AND BURIED IN THE SPOIL AREA.
8. TYPE B RIPRAP SHALL BE 9" THICK. A MINIMUM OF 50%, BY WEIGHT, OF STONES SHALL BE 25 POUNDS EACH AND IN ACCORDANCE WITH SECTION 575. FILTER FABRIC SHALL BE NON-WOVEN, CLASS C PER TVA T-1 SPECIFICATION, SECTION 571.
9. ALL ELEVATIONS ARE BASED ON TENNESSEE ELECTRIC POWER COMPANY DATUM. TENNESSEE ELECTRIC POWER COMPANY DATUM IS USC & GS + 0.18'.
10. COORDINATES ARE GEORGIA (WEST) STATE SYSTEM OF RECTANGULAR COORDINATES.
11. FOR DESIGN CALCULATIONS, SEE RIMS NO. B65 930323 002.



TYP SECTION
PRIVATE DRIVE



TYP PLAN
PRIVATE DRIVE



TYP SECTION
ACCESS RD TO WATER TREATMENT PLANT

1	9-22-95	—	RWS	RLP	CDW	CDW	JHC	CDW 3-24-95

REVISE DRAWING AS CONSTRUCTED

SCALE: NTS — EXCEPT AS NOTED

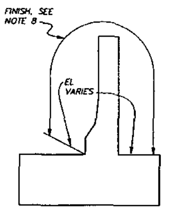
RELOCATED ROADWAY OVER DAM
DAM SAFETY MODIFICATIONS

TYPICAL SECTIONS
OLD US HWY 76

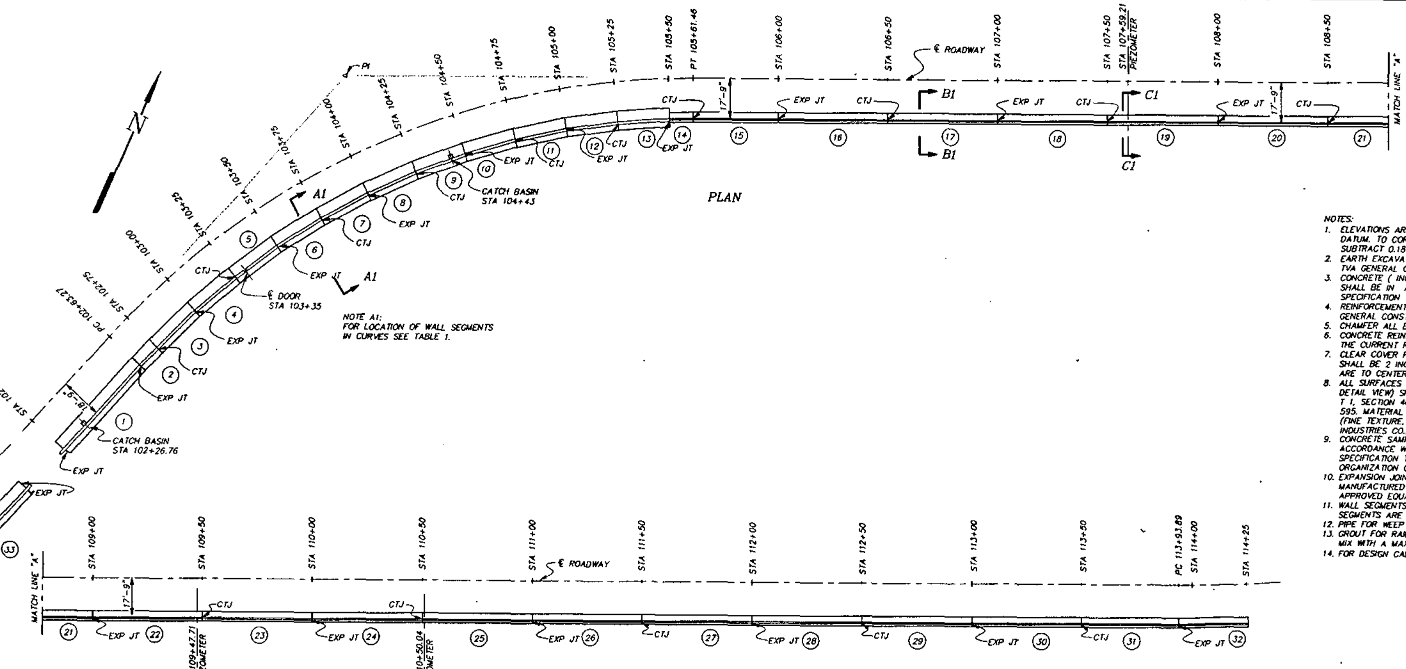
BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY

DESIGNED R.W. SHARP — SUPERVISED H.L. PETTY
DRAWN D.R. COLLINS — REVIEWED
CHECKED C.B. DODD — H.L. PETTY
ENGINEERING APPROVAL C.D. WAGNER
ENGINEERING DATE 3-31-93 | 48 | C | 81W200 | R1

ISSUED BY J.H. COULSON



CONCRETE FINISH DETAIL
RETAINING WALL TYPICAL EACH SECTION
NTS



PLAN

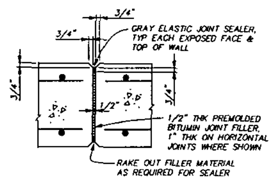
PLAN (CONT)

NOTES:

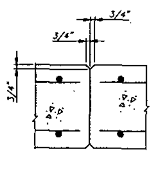
1. ELEVATIONS ARE BASED ON TENNESSEE ELECTRIC POWER COMPANY DATUM. TO CORRECT TO USC & GS 1936 SUPPLEMENTARY ADJUSTMENT, SUBTRACT 0.18 FEET.
2. EARTH EXCAVATION AND BACKFILL SHALL BE IN ACCORDANCE WITH TVA GENERAL CONSTRUCTION SPECIFICATION T 1, SECTION 125.4.
3. CONCRETE (INCLUDING MATERIAL, FORMWORK, PLACEMENT AND CURING) SHALL BE IN ACCORDANCE WITH TVA GENERAL CONSTRUCTION SPECIFICATION T1, SECTION 400. CONCRETE SHALL BE CLASS X.
4. REINFORCEMENT STEEL PLACEMENT SHALL BE IN ACCORDANCE WITH TVA GENERAL CONSTRUCTION SPECIFICATION T1, SECTION 425.
5. CHAMFER ALL EXPOSED EDGES 3/4 INCHES UNLESS OTHERWISE NOTED.
6. CONCRETE REINFORCMENT SHALL BE DEFORMED BILLET STEEL MEETING THE CURRENT REQUIREMENTS OF ASTM A 615, GRADE 60.
7. CLEAR COVER FROM FACE OF CONCRETE TO NEAREST REINFORCING BAR SHALL BE 2 INCHES UNLESS OTHERWISE NOTED. ALL OTHER DIMENSIONS ARE TO CENTERLINE OF REINFORCING.
8. ALL SURFACES EXPOSED TO PUBLIC ACCESS (SEE CONCRETE FINISH DETAIL VIEW) SHALL BE GIVEN A CLASS I ORDINARY SURFACE FINISH PER T 1, SECTION 400.27 AND AN APPLIED TEXTURE FINISH PER T1, SECTION 595. MATERIAL FOR TEXTURE FINISH SHALL BE ONE COAT OF TAMMSCOAT (FINE TEXTURE, COLOR-LIMESTONE) AS MANUFACTURED BY TAMMS INDUSTRIES CO., MENTOR, OH.
9. CONCRETE SAMPLING AND TESTING SHALL BE PERFORMED IN ACCORDANCE WITH THE REQUIREMENTS OF TVA GENERAL CONSTRUCTION SPECIFICATION T1, SECTION 400.10 BY AN INDEPENDANT TESTING ORGANIZATION CERTIFIED ACCORDING TO ASTM E 329.
10. EXPANSION JOINT SEALER SHALL BE DYNATROL I, COLOR LIMESTONE, AS MANUFACTURED BY PECORA CORP., HARLEYVILLE, PA. OR AN APPROVED EQUAL.
11. WALL SEGMENTS DENOTED THUS (2) ON PLAN. STATIONS SHOWN ON END OF SEGMENTS ARE STATIONS AT CENTERLINE OF ROADWAY.
12. PIPE FOR WEEP HOLES SHALL BE PVC SCH 40, WHITE.
13. GROUT FOR RAILING INSERTS SHALL BE A SAND-PORTLAND CEMENT MIX WITH A MAXIMUM MIX RATIO OF 3:1.
14. FOR DESIGN CALCULATIONS, SEE RIMS NO. B65 930323 002.

TABLE 1

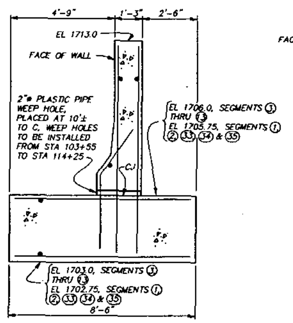
STATION	DISTANCE - € ROAD TO FACE OF TOP OF WALL
102+11.76	18'-9"
102+63.27	18'-9"
102+75	18'-9"
103+00	18'-7 3/8"
103+25	18'-5 5/8"
103+50	18'-4"
103+75	18'-2 1/4"
104+00	18'-0 5/8"
104+25	17'-11"
104+50	17'-9"
104+75	17'-9"
105+00	17'-9"
105+25	17'-9"
105+50	17'-9"
105+61.46	17'-9"
113+93.69	17'-9"
114+25	17'-9"



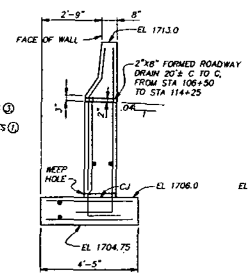
TYP EXPANSION JOINT
1 1/2" = 1'-0"



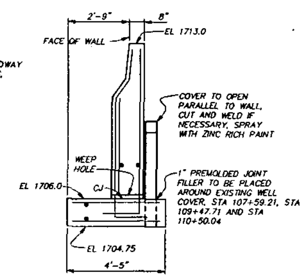
TYP CONTRACTION JOINT
1 1/2" = 1'-0"



A1 - A1
1/2" = 1'-0"



B1 - B1
1/2" = 1'-0"



C1 - C1
1/2" = 1'-0"

REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APVD	ISSD		AS CONST
1	9-22-95	—	DRC	RWS	RLP	CDW	CDW	JHC		CDW 3-24-95

REVISE DRAWING AS CONSTRUCTED

SCALE: 1" = 20' EXCEPT AS NOTED

ROADWAY RETAINING WALL
DAM SAFETY MODIFICATIONS

CONCRETE - RETAINING WALL
OUTLINE AND REINFORCEMENT
PLAN, SECTIONS AND DETAILS

BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY

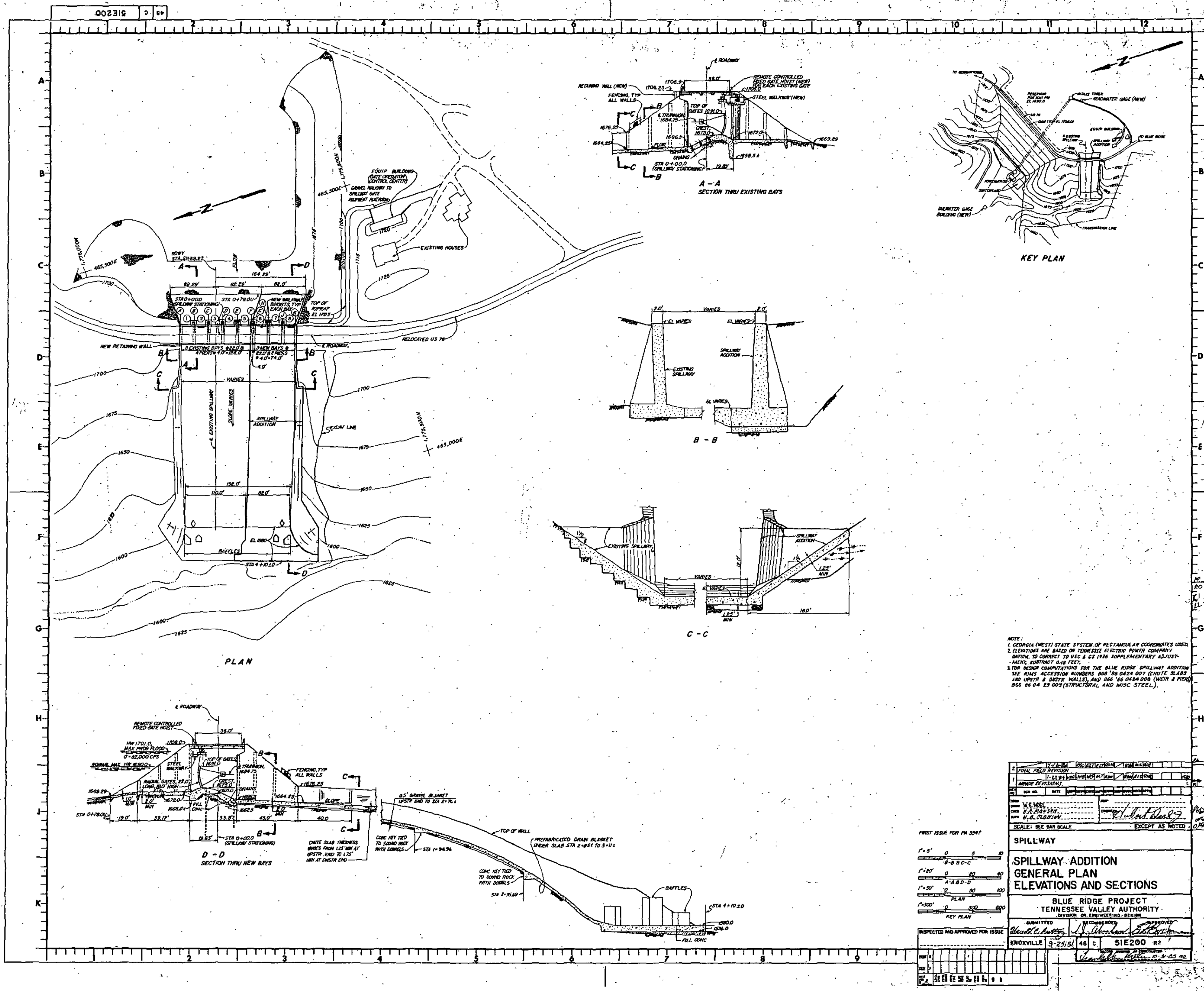
DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DESIGNED HL PETTY	SUPERVISED HA MANSON	1	2	C D WAGNER
DRAWN GL HICKEY				
CHECKED KB KNOWLES	REVIEWED HA MANSON	3	4	

ENGINEERING DATE 3-31-93 | 48 | C | 81W300-1 | R1

ISSUED BY: J H COULSON

AS CONSTRUCTED:

CAD SYSTEM ORIGINAL
DO NOT CHANGE MANUALLY


PLAN
A - A
SECTION THRU EXISTING BAYS
B - B
C - C
D - D
SECTION THRU NEW BAYS
KEY PLAN
NOTE:
1. GEORGIA (WEST) STATE SYSTEM OF RECTANGULAR COORDINATES USED.
2. ELEVATIONS ARE BASED ON TENNESSEE ELECTRIC POWER COMPANY DATUM. TO CORRECT TO USC & GS 1936 SUPPLEMENTARY ADJUSTMENT, SUBTRACT 0.18 FEET.
3. FOR DESIGN COMPUTATIONS FOR THE BLUE RIDGE SPILLWAY ADDITION SEE RIMS ACCESSION NUMBERS B66 '86 0424 007 (CHUTE SLABS AND UPSTR & DNSTR WALLS), AND B66 '86 0424 008 (WEIR & PIERS) B66 86 04 23 003 (STRUCTURAL AND MISC STEEL).
FIRST ISSUE FOR PA 3547
1" = 5' B-B & C-C
1" = 20' A-A & D-D
1" = 50' PLAN
1" = 300' KEY PLAN
2 FINAL FIELD REVISION
1 1-23-84 MINOR REVISIONS
SCALE: SEE BAR SCALE EXCEPT AS NOTED
SPILLWAY
SPILLWAY ADDITION
GENERAL PLAN
ELEVATIONS AND SECTIONS
BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN
SUBMITTED
RECOMMENDED
APPROVED
INSPECTED AND APPROVED FOR ISSUE
KNOXVILLE 9-25-81 48 C 51E200 R2

TENNESSEE VALLEY AUTHORITY
RIVER OPERATIONS

BLUE RIDGE DAM

SPILLWAY AND LOW-LEVEL OUTLET DISCHARGE TABLES

APRIL 2008

CONTENTS

PART 1

SPILLWAY DISCHARGE TABLES

APRIL 2008

INSTRUCTIONS FOR USE OF TABLES

The spillway and low-level outlet may be used in conjunction with either or both generating units. Selection of spillway or low-level outlet should be based on multipurpose operating objectives.

1. Tables Update

These tables supersede the tables dated January 2007. Discharges for headwater elevations above 1691 feet are slightly lower in these tables because the effective length of the auxiliary spillway has been reduced to 280 feet from 295 feet to account for the bridge piers on the crest. The gate openings on which these tables are based were measured in February and November 2006. The computer code SPILLQ generated the tabulated discharges.

The tabulated discharges are based on known gate openings for each indicator position. Consequently, whenever modifications in the spillway gate controls result in changes in the relationship between counter readings and gate opening heights, the opening heights under the spillway gates at every defined gate opening position must be re-measured and the spillway tables must be re-computed. In addition, the known gate openings and, therefore, the tabulated discharges are accurate only when the zero indicator settings are properly set. The indicators should read zero when the gates are closed with the slack removed from the wire ropes. The zero indicator settings should be verified whenever the gates are inspected.

2. Purpose of Tables

These tables provide a means for setting required spillway discharges and for determining the discharge when a specific arrangement of gates is in use.

Because model data are not available for discharges over the gated spillways at Blue Ridge Dam, the spillway gate discharges included in these tables are based on estimated discharge coefficients obtained from ratings of other spillways that are not identical to Blue Ridge Dam spillway.

3. Range of Tables

The tables cover a discharge range from zero to 98,450 cubic feet per second. Headwater elevations range from 1675 feet to 1700 feet.

The tabulated discharges include discharge over the auxiliary spillway for headwater elevations greater than its crest elevation of 1691 feet. These discharges are based on textbook discharge coefficients for ogee crests corrected for upstream friction.

4. Arrangement of Tables

The tables show spillway discharges in cubic feet per second. Headwater elevations for each 0.1 foot of headwater elevation are shown at the top of each column. The headwater range is shown at the bottom of each page.

The discharge is tabulated under the headwater elevations for specific arrangements of gate openings, which are indicated by number in the left and right columns of each page. The numbered arrangements are defined in the table of Spillway Gate Arrangements on page 5. Reference to this table and to the drawing showing the location of the gates on page 4 will determine the gate opening to which each gate is to be set for any particular discharge given in the tables.

5. Discharge Intervals

The tables have been prepared so that the incremental discharge between the tabulated values for consecutive gate arrangements is generally less than 5 percent of the tabulated discharge. The incremental discharge between tabulated values of consecutive headwater elevations is generally less than 1 percent. These increments are exceeded in some cases near the extreme ends of the tables where operation is relatively infrequent. In general, it is possible to set any required discharge within 2-1/2 percent and to know the actual discharge for any given set of conditions within 1 percent. These tolerances are considered acceptable and therefore it will not be necessary to interpolate between values given in these tables.

When the tables do not include the exact headwater elevation, the discharge for the closest headwater elevation is used. For example, the column headed 1687.2 should be used for actual headwater elevations between

1687.15 feet and 1687.24 feet inclusive. When the actual headwater elevation is exactly halfway between tabular values, the larger value is used.

6. Raising and Lowering Gates

The operating mechanism for raising and lowering the spillway gates is located on the deck of the dam. Mechanical counters indicate gate position as varying from zero (closed) to about 1520 (full open). The relationship between these counter readings and the gate positions referred to in the table of Spillway Gate Arrangements on page 5 is given in the following table:

Gate Opening Position	Counter Reading
0	0
1	130
2	260
3	390
4	510
5	630
6	760
7	880
8	1000
9	1130
10	1250
11	1380
12	1505

These positions will eventually be programmed into the control panels for each gate (not yet complete in January 2007).

7. Special Instruction – Preventing Flow over Top of Spillway Gates When Headwater Elevation is above 1691 feet

If the headwater elevation exceeds 1691 feet (actually, 1690.8 feet to provide a 0.2-foot margin of safety) the spillway gates must be set to one of the gate arrangements listed in the tables to prevent flow over the tops of the gates. The minimum gate openings are those corresponding to the lowest numbered gate arrangement for which a discharge value is provided in the tables.

8. Use of Tables

The tables can be used in two ways: (1) to determine the arrangement of gates needed to pass a required discharge at a given headwater elevation, and (2) to determine the discharge for a given arrangement of gates and headwater elevation.

Example 1 -- What gate arrangement is necessary to pass a discharge of 20,000 cubic feet per second with the headwater at elevation 1686.88 feet?

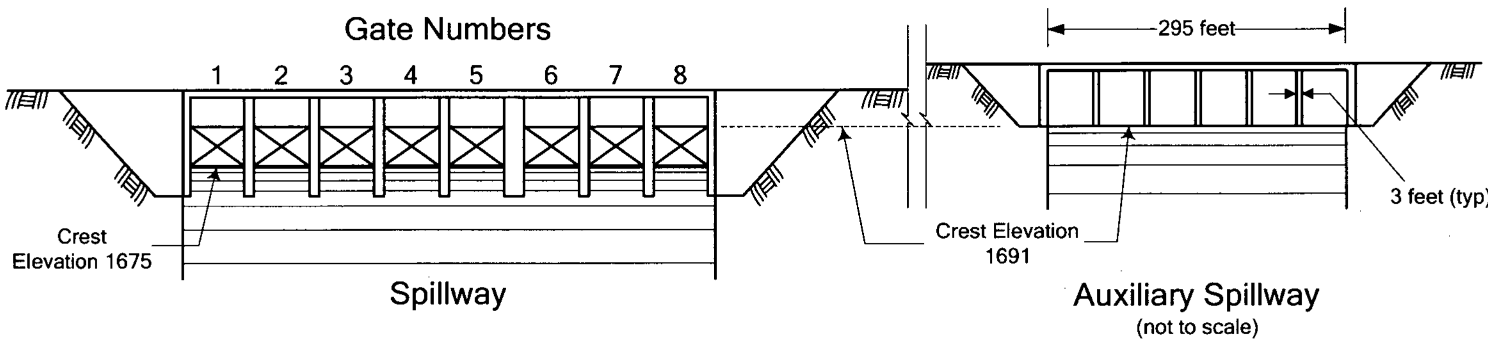
The first step is to find the table in which the headwater elevation appears. Referring to the contents page, we find that headwater elevations between 1685 feet and 1687 feet are found on page 11. The headwater elevation closest to 1686.88 feet is 1686.9 feet. In the column headed 1686.9 the discharge nearest to the required 20,000 cubic feet per second is 20,100 cubic feet per second. By tracing the horizontal line in which 20,100 cubic feet per second appears, to either side of the page, we find that gate arrangement 37 is the one for producing the discharge closest to 20,000 cubic feet per second at headwater elevation 1686.88 feet. Referring to page 5 it is found that the gates should be set with the gate opening indicators reading as follows: gates 3, 5, and 7 at gate position 4 and gates 1, 2, 4, 6, and 8 at gate position 5.

After all the gates are set, changes in the headwater elevation may require changes in the gate arrangement to maintain the desired discharge. For example, if the headwater should fall to 1686.14 feet, the discharge will be found in the column headed 1686.1. In this column the discharge closest to 20,000 cubic feet per second is 20,240 cubic feet per second for gate arrangement 38. To change to gate arrangement 38 from gate arrangement 37, gate 5 would be opened to gate position 5.

Example 2 -- Suppose the operating records show that the headwater is at elevation 1689.65 feet, and gate arrangement 25 is in use. The headwater is found on page 14, which is marked "Headwater 1689 to 1691." The elevation given is exactly halfway between elevation 1689.6 feet and 1689.7 feet. The larger value, 1689.7 feet, should be used. In the column headed 1689.7 opposite gate arrangement 25, the discharge is found to be 15,390 cubic feet per second.

BLUE RIDGE DAM

LOCATION OF SPILLWAY GATES



DOWNSTREAM ELEVATION

BLUE RIDGE DAM

SPILLWAY GATE ARRANGEMENTS

Arrangement Number	Gate Number 1	2	3	4	5	6	7	8
1	-	-	-	1	-	-	-	-
2	-	-	-	1	-	1	-	-
3	-	1	-	1	-	1	-	-
4	-	1	-	1	-	1	-	1
5	1	1	-	1	-	1	-	1
6	1	1	-	1	1	1	-	1
7	1	1	-	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	2	1	1	1	1
10	1	1	1	2	1	2	1	1
11	1	2	1	2	1	2	1	1
12	1	2	1	2	1	2	1	2
13	2	2	1	2	1	2	1	2
14	2	2	1	2	2	2	1	2
15	2	2	1	2	2	2	2	2
16	2	2	2	2	2	2	2	2
17	2	2	2	3	2	2	2	2
18	2	2	2	3	2	3	2	2
19	2	3	2	3	2	3	2	2
20	2	3	2	3	2	3	2	3
21	3	3	2	3	2	3	2	3
22	3	3	2	3	3	3	2	3
23	3	3	2	3	3	3	3	3
24	3	3	3	3	3	3	3	3
25	3	3	3	4	3	3	3	3
26	3	3	3	4	3	4	3	3
27	3	4	3	4	3	4	3	3
28	3	4	3	4	3	4	3	4
29	4	4	3	4	3	4	3	4
30	4	4	3	4	4	4	3	4
31	4	4	3	4	4	4	4	4
32	4	4	4	4	4	4	4	4

Arrangement Number	Gate Number 1	2	3	4	5	6	7	8
33	4	4	4	5	4	4	4	4
34	4	4	4	5	4	5	4	4
35	4	5	4	5	4	5	4	4
36	4	5	4	5	4	5	4	5
37	5	5	4	5	4	5	4	5
38	5	5	4	5	5	5	4	5
39	5	5	4	5	5	5	5	5
40	5	5	5	5	5	5	5	5
41	5	5	5	6	5	5	5	5
42	5	5	5	6	5	6	5	5
43	5	6	5	6	5	6	5	5
44	5	6	5	6	5	6	5	6
45	6	6	5	6	5	6	5	6
46	6	6	5	6	6	6	5	6
47	6	6	5	6	6	6	6	6
48	6	6	6	6	6	6	6	6
49	6	6	6	7	6	6	6	6
50	6	6	6	7	6	7	6	6
51	6	7	6	7	6	7	6	6
52	6	7	6	7	6	7	6	7
53	7	7	6	7	6	7	6	7
54	7	7	6	7	7	7	6	7
55	7	7	6	7	7	7	7	7
56	7	7	7	7	7	7	7	7
57	7	7	7	8	7	7	7	7
58	7	7	7	8	7	8	7	7
59	7	8	7	8	7	8	7	7
60	7	8	7	8	7	8	7	8
61	8	8	7	8	7	8	7	8
62	8	8	7	8	8	8	7	8
63	8	8	7	8	8	8	8	8
64	8	8	8	8	8	8	8	8

Arrangement Number	Gate Number 1	2	3	4	5	6	7	8
65	8	8	8	9	8	8	8	8
66	8	8	8	9	8	9	8	8
67	8	9	8	9	8	9	8	8
68	8	9	8	9	8	9	8	9
69	9	9	8	9	8	9	8	9
70	9	9	8	9	9	9	8	9
71	9	9	8	9	9	9	9	9
72	9	9	9	9	9	9	9	9
73	9	9	9	10	9	9	9	9
74	9	9	9	10	9	10	9	9
75	9	10	9	10	9	10	9	9
76	9	10	9	10	9	10	9	10
77	10	10	9	10	9	10	9	10
78	10	10	9	10	10	10	9	10
79	10	10	9	10	10	10	10	10
80	10	10	10	10	10	10	10	10
81	10	10	10	11	10	10	10	10
82	10	10	10	11	10	11	10	10
83	10	11	10	11	10	11	10	10
84	10	11	10	11	10	11	10	11
85	11	11	10	11	10	11	10	11
86	11	11	10	11	11	11	10	11
87	11	11	10	11	11	11	11	11
88	11	11	11	11	11	11	11	11
89	11	11	11	12	11	11	11	11
90	11	11	11	12	11	12	11	11
91	11	12	11	12	11	12	11	11
92	11	12	11	12	11	12	11	12
93	12	12	11	12	11	12	11	12
94	12	12	11	12	12	12	11	12
95	12	12	11	12	12	12	12	12
96	12	12	12	12	12	12	12	12

GATE OPENINGS

Figures in columns under each gate number refer to gate opening positions (see table on Page 3 for counter readings)
dash (-) indicates closed gate

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1675.0	1675.1	1675.2	1675.3	1675.4	1675.5	1675.6	1675.7	1675.8	1675.9	1676.0	1676.1	1676.2	1676.3	1676.4	1676.5	1676.6	1676.7	1676.8	1676.9	1677.0	
1	0	0	5	10	15	25	30	40	45	55	65	75	85	100	110	120	130	150	160	180	190	1
2	0	5	10	20	35	45	60	75	95	110	130	150	170	200	220	240	270	300	320	350	380	2
3	0	5	15	30	50	70	90	110	140	170	200	230	260	290	330	370	400	440	480	530	570	3
4	0	10	25	40	65	90	120	150	190	220	260	300	350	390	440	490	540	590	640	700	760	4
5	0	10	30	55	80	110	150	190	230	280	330	380	430	490	550	610	670	740	810	880	950	5
6	0	10	35	65	100	140	180	230	280	330	390	450	520	590	660	730	810	890	970	1, 050	1, 140	6
7	0	15	40	75	110	160	210	270	330	390	460	530	610	680	770	850	940	1, 030	1, 130	1, 230	1, 330	7
8	0	15	45	85	130	180	240	300	370	450	520	610	690	780	880	970	1, 080	1, 180	1, 290	1, 400	1, 520	8
9	0	15	45	85	130	180	240	300	370	450	520	610	690	780	880	970	1, 080	1, 180	1, 290	1, 400	1, 520	9
10	0	15	45	85	130	180	240	300	370	450	520	610	690	780	880	970	1, 080	1, 180	1, 290	1, 400	1, 520	10

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1677.0	1677.1	1677.2	1677.3	1677.4	1677.5	1677.6	1677.7	1677.8	1677.9	1678.0	1678.1	1678.2	1678.3	1678.4	1678.5	1678.6	1678.7	1678.8	1678.9	1679.0	
1	190	200	210	210	220	220	220	230	230	240	240	240	250	250	260	260	270	270	280	280	280	1
2	380	410	420	430	440	450	460	460	470	480	480	490	500	510	520	530	540	550	560	570	580	2
3	570	610	630	640	660	670	680	690	700	710	720	740	750	770	780	790	810	820	830	850	860	3
4	760	810	840	860	880	900	910	930	940	960	970	990	1,010	1,030	1,040	1,060	1,080	1,100	1,120	1,130	1,150	4
5	950	1,020	1,050	1,070	1,100	1,120	1,140	1,160	1,180	1,190	1,210	1,230	1,250	1,280	1,300	1,330	1,350	1,370	1,390	1,410	1,440	5
6	1,140	1,220	1,270	1,290	1,320	1,350	1,370	1,390	1,420	1,440	1,450	1,480	1,510	1,540	1,570	1,600	1,620	1,650	1,680	1,700	1,730	6
7	1,330	1,420	1,480	1,510	1,550	1,580	1,600	1,630	1,660	1,680	1,700	1,730	1,760	1,800	1,830	1,860	1,900	1,930	1,960	1,990	2,020	7
8	1,520	1,630	1,690	1,730	1,760	1,800	1,830	1,860	1,890	1,910	1,940	1,970	2,010	2,050	2,090	2,130	2,160	2,200	2,240	2,270	2,300	8
9	1,520	1,630	1,700	1,750	1,800	1,840	1,890	1,930	1,970	2,020	2,060	2,100	2,160	2,210	2,260	2,320	2,370	2,420	2,470	2,530	2,580	9
10	1,520	1,630	1,700	1,770	1,820	1,880	1,940	2,000	2,050	2,110	2,170	2,230	2,300	2,360	2,430	2,500	2,570	2,640	2,710	2,770	2,840	10
11	1,520	1,630	1,720	1,790	1,860	1,930	2,000	2,070	2,140	2,210	2,280	2,360	2,440	2,520	2,610	2,690	2,770	2,860	2,940	3,030	3,120	11
12	1,520	1,630	1,720	1,800	1,890	1,970	2,050	2,140	2,220	2,310	2,390	2,480	2,580	2,680	2,770	2,870	2,970	3,070	3,170	3,280	3,380	12
13	1,520	1,630	1,730	1,830	1,920	2,020	2,110	2,210	2,310	2,410	2,510	2,610	2,720	2,830	2,950	3,060	3,180	3,290	3,410	3,530	3,660	13
14	1,520	1,630	1,740	1,840	1,950	2,050	2,160	2,270	2,390	2,500	2,620	2,740	2,860	2,990	3,110	3,240	3,380	3,510	3,640	3,780	3,920	14
15	1,520	1,630	1,740	1,860	1,980	2,090	2,220	2,340	2,470	2,600	2,730	2,860	3,000	3,140	3,280	3,430	3,570	3,720	3,870	4,030	4,180	15
16	1,520	1,630	1,760	1,880	2,010	2,140	2,280	2,410	2,550	2,700	2,840	2,990	3,140	3,300	3,460	3,620	3,780	3,950	4,110	4,280	4,460	16
17	1,520	1,630	1,760	1,880	2,010	2,140	2,280	2,410	2,550	2,700	2,840	2,990	3,140	3,300	3,460	3,620	3,780	3,950	4,110	4,280	4,460	17
18	1,520	1,630	1,760	1,880	2,010	2,140	2,280	2,410	2,550	2,700	2,840	2,990	3,140	3,300	3,460	3,620	3,780	3,950	4,110	4,280	4,460	18
19	1,520	1,630	1,760	1,880	2,010	2,140	2,280	2,410	2,550	2,700	2,840	2,990	3,140	3,300	3,460	3,620	3,780	3,950	4,110	4,280	4,460	19
20	1,520	1,630	1,760	1,880	2,010	2,140	2,280	2,410	2,550	2,700	2,840	2,990	3,140	3,300	3,460	3,620	3,780	3,950	4,110	4,280	4,460	20

BLUE RIDGE DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1679.0	1679.1	1679.2	1679.3	1679.4	1679.5	1679.6	1679.7	1679.8	1679.9	1680.0	1680.1	1680.2	1680.3	1680.4	1680.5	1680.6	1680.7	1680.8	1680.9	1681.0	
1	280	290	290	300	300	300	310	310	320	320	320	330	330	330	340	340	340	350	350	360	360	1
2	580	580	590	600	610	620	630	630	640	650	660	660	670	680	690	690	700	710	710	720	730	2
3	860	870	890	900	910	920	930	950	960	970	980	990	1,000	1,010	1,020	1,030	1,040	1,050	1,070	1,080	1,090	3
4	1,150	1,170	1,190	1,200	1,220	1,230	1,250	1,270	1,280	1,300	1,310	1,330	1,340	1,360	1,370	1,380	1,400	1,410	1,430	1,440	1,450	4
5	1,440	1,460	1,480	1,500	1,520	1,540	1,560	1,580	1,600	1,620	1,640	1,650	1,670	1,690	1,710	1,730	1,740	1,760	1,780	1,800	1,810	5
6	1,730	1,750	1,780	1,800	1,830	1,850	1,880	1,900	1,920	1,950	1,970	1,990	2,010	2,040	2,060	2,080	2,100	2,120	2,140	2,160	2,180	6
7	2,020	2,050	2,080	2,110	2,140	2,170	2,190	2,220	2,250	2,270	2,300	2,330	2,350	2,380	2,400	2,430	2,450	2,480	2,500	2,530	2,550	7
8	2,300	2,340	2,370	2,410	2,440	2,470	2,500	2,530	2,560	2,590	2,620	2,650	2,680	2,710	2,740	2,770	2,800	2,830	2,850	2,880	2,910	8
9	2,580	2,630	2,680	2,730	2,780	2,840	2,890	2,920	2,950	2,970	3,000	3,020	3,040	3,070	3,090	3,110	3,140	3,170	3,200	3,230	3,260	9
10	2,840	2,910	2,980	3,050	3,120	3,190	3,260	3,300	3,320	3,340	3,360	3,380	3,400	3,420	3,430	3,440	3,470	3,500	3,540	3,580	3,610	10
11	3,120	3,200	3,290	3,380	3,470	3,560	3,650	3,690	3,710	3,720	3,740	3,750	3,760	3,770	3,780	3,780	3,810	3,850	3,890	3,930	3,960	11
12	3,380	3,490	3,590	3,700	3,810	3,920	4,030	4,070	4,080	4,090	4,100	4,110	4,110	4,120	4,120	4,120	4,140	4,180	4,230	4,270	4,310	12
13	3,660	3,780	3,900	4,030	4,160	4,280	4,410	4,460	4,470	4,470	4,480	4,480	4,480	4,470	4,470	4,460	4,480	4,520	4,570	4,620	4,670	13
14	3,920	4,060	4,200	4,350	4,490	4,640	4,790	4,850	4,870	4,870	4,870	4,860	4,860	4,850	4,830	4,820	4,830	4,870	4,920	4,980	5,030	14
15	4,180	4,340	4,500	4,670	4,830	5,000	5,170	5,240	5,250	5,240	5,240	5,220	5,210	5,190	5,180	5,150	5,160	5,210	5,260	5,320	5,370	15
16	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,620	5,630	5,620	5,610	5,590	5,570	5,550	5,520	5,490	5,500	5,550	5,610	5,670	5,730	16
17	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,640	5,670	5,690	5,700	5,710	5,720	5,730	5,730	5,730	5,760	5,830	5,910	5,990	6,070	17
18	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,660	5,710	5,760	5,800	5,830	5,870	5,900	5,940	5,970	6,020	6,110	6,210	6,310	6,410	18
19	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,680	5,760	5,820	5,890	5,960	6,020	6,080	6,140	6,200	6,290	6,390	6,510	6,630	6,750	19
20	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,690	5,800	5,890	5,980	6,080	6,170	6,260	6,350	6,440	6,550	6,670	6,810	6,950	7,090	20
21	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,710	5,840	5,960	6,080	6,200	6,320	6,440	6,560	6,680	6,810	6,960	7,110	7,270	7,430	21
22	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,710	5,850	6,000	6,140	6,290	6,440	6,590	6,740	6,890	7,050	7,220	7,400	7,580	7,760	22
23	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,720	5,890	6,060	6,240	6,410	6,580	6,760	6,940	7,120	7,310	7,500	7,700	7,900	8,100	23
24	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,740	5,940	6,130	6,330	6,530	6,740	6,940	7,150	7,360	7,570	7,790	8,000	8,220	8,440	24
25	4,460	4,630	4,810	4,990	5,180	5,360	5,550	5,740	5,940	6,130	6,330	6,530	6,740	6,940	7,150	7,360	7,570	7,790	8,000	8,220	8,440	25

BLUE RIDGE DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGEMENT	HEADWATER ELEVATION																					GATE ARRANGEMENT
	1681.0	1681.1	1681.2	1681.3	1681.4	1681.5	1681.6	1681.7	1681.8	1681.9	1682.0	1682.1	1682.2	1682.3	1682.4	1682.5	1682.6	1682.7	1682.8	1682.9	1683.0	
1	360	360	370	370	370	370	380	380	380	390	390	390	400	400	400	410	410	410	410	420	420	1
2	730	730	740	750	750	760	770	770	780	790	790	800	800	810	820	820	830	830	840	850	850	2
3	1,090	1,100	1,110	1,120	1,130	1,130	1,140	1,150	1,160	1,170	1,180	1,190	1,200	1,210	1,220	1,230	1,240	1,250	1,250	1,260	1,270	3
4	1,450	1,470	1,480	1,490	1,510	1,520	1,530	1,550	1,560	1,570	1,580	1,600	1,610	1,620	1,630	1,640	1,660	1,670	1,680	1,690	1,700	4
5	1,810	1,830	1,850	1,860	1,880	1,890	1,910	1,930	1,940	1,960	1,970	1,990	2,000	2,020	2,030	2,050	2,060	2,080	2,090	2,110	2,120	5
6	2,180	2,200	2,220	2,240	2,260	2,280	2,300	2,320	2,340	2,360	2,380	2,400	2,410	2,430	2,450	2,470	2,490	2,500	2,520	2,540	2,560	6
7	2,550	2,570	2,600	2,620	2,640	2,670	2,690	2,710	2,730	2,760	2,780	2,800	2,820	2,840	2,860	2,890	2,910	2,930	2,950	2,970	2,990	7
8	2,910	2,940	2,960	2,990	3,020	3,040	3,070	3,090	3,120	3,140	3,170	3,190	3,220	3,240	3,270	3,290	3,310	3,340	3,360	3,380	3,410	8
9	3,260	3,290	3,320	3,360	3,390	3,410	3,440	3,470	3,500	3,530	3,560	3,590	3,620	3,650	3,670	3,700	3,730	3,760	3,780	3,810	3,840	9
10	3,610	3,640	3,680	3,710	3,750	3,780	3,810	3,850	3,880	3,910	3,950	3,980	4,010	4,040	4,070	4,100	4,140	4,170	4,200	4,230	4,260	10
11	3,960	4,000	4,040	4,080	4,120	4,150	4,190	4,230	4,270	4,300	4,340	4,370	4,410	4,450	4,480	4,520	4,550	4,580	4,620	4,650	4,690	11
12	4,310	4,350	4,400	4,440	4,480	4,520	4,560	4,600	4,640	4,680	4,720	4,760	4,800	4,840	4,880	4,920	4,960	4,990	5,030	5,070	5,110	12
13	4,670	4,710	4,760	4,800	4,850	4,890	4,940	4,980	5,030	5,070	5,120	5,160	5,200	5,240	5,290	5,330	5,370	5,410	5,450	5,490	5,540	13
14	5,030	5,080	5,130	5,170	5,220	5,270	5,320	5,370	5,420	5,470	5,510	5,560	5,610	5,650	5,700	5,750	5,790	5,840	5,880	5,930	5,970	14
15	5,370	5,430	5,480	5,530	5,580	5,640	5,690	5,740	5,790	5,850	5,900	5,950	6,000	6,050	6,100	6,150	6,200	6,250	6,290	6,340	6,390	15
16	5,730	5,780	5,840	5,900	5,950	6,010	6,070	6,120	6,180	6,230	6,290	6,350	6,400	6,450	6,510	6,560	6,610	6,660	6,720	6,770	6,820	16
17	6,070	6,150	6,230	6,300	6,380	6,460	6,540	6,620	6,700	6,760	6,800	6,850	6,890	6,940	6,980	7,020	7,060	7,100	7,150	7,200	7,260	17
18	6,410	6,510	6,610	6,710	6,810	6,900	7,010	7,110	7,210	7,290	7,330	7,360	7,400	7,430	7,470	7,500	7,530	7,560	7,590	7,650	7,710	18
19	6,750	6,870	6,990	7,110	7,230	7,350	7,480	7,600	7,730	7,810	7,840	7,870	7,890	7,920	7,940	7,960	7,980	8,000	8,030	8,080	8,140	19
20	7,090	7,230	7,370	7,510	7,660	7,800	7,950	8,090	8,240	8,350	8,370	8,380	8,400	8,410	8,430	8,440	8,450	8,450	8,470	8,530	8,590	20
21	7,430	7,590	7,760	7,920	8,080	8,250	8,420	8,590	8,760	8,870	8,880	8,890	8,890	8,900	8,900	8,900	8,900	8,890	8,900	8,960	9,030	21
22	7,760	7,940	8,120	8,310	8,490	8,680	8,870	9,060	9,250	9,390	9,400	9,400	9,390	9,390	9,380	9,370	9,350	9,340	9,340	9,400	9,470	22
23	8,100	8,300	8,510	8,710	8,920	9,130	9,340	9,550	9,770	9,920	9,920	9,910	9,900	9,890	9,870	9,850	9,820	9,800	9,780	9,840	9,910	23
24	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,440	10,430	10,420	10,390	10,370	10,340	10,310	10,270	10,230	10,210	10,280	10,350	24
25	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,460	10,490	10,500	10,510	10,520	10,530	10,530	10,530	10,530	10,540	10,630	10,730	25
26	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,460	10,520	10,570	10,610	10,650	10,690	10,730	10,770	10,810	10,850	10,970	11,090	26
27	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,480	10,570	10,650	10,730	10,810	10,880	10,960	11,030	11,100	11,180	11,320	11,460	27
28	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,490	10,600	10,720	10,830	10,940	11,050	11,160	11,270	11,380	11,500	11,650	11,820	28
29	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,500	10,650	10,800	10,950	11,090	11,240	11,380	11,530	11,670	11,820	12,000	12,200	29
30	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,500	10,680	10,860	11,040	11,220	11,400	11,580	11,760	11,940	12,130	12,340	12,550	30
31	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,510	10,720	10,930	11,140	11,350	11,570	11,780	12,000	12,220	12,440	12,680	12,910	31
32	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,520	10,770	11,010	11,260	11,500	11,750	12,000	12,260	12,510	12,770	13,030	13,290	32
33	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,520	10,770	11,010	11,260	11,500	11,750	12,000	12,260	12,510	12,770	13,030	13,290	33
34	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,520	10,770	11,010	11,260	11,500	11,750	12,000	12,260	12,510	12,770	13,030	13,290	34
35	8,440	8,660	8,890	9,120	9,350	9,580	9,810	10,050	10,290	10,520	10,770	11,010	11,260	11,500	11,750	12,000	12,260	12,510	12,770	13,030	13,290	35

BLUE RIDGE DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1683.0	1683.1	1683.2	1683.3	1683.4	1683.5	1683.6	1683.7	1683.8	1683.9	1684.0	1684.1	1684.2	1684.3	1684.4	1684.5	1684.6	1684.7	1684.8	1684.9	1685.0	
1	420	420	430	430	430	430	440	440	440	440	450	450	450	460	460	460	460	470	470	470	470	1
2	850	860	860	870	870	880	890	890	900	900	910	910	920	920	930	930	940	940	950	960	960	2
3	1,270	1,280	1,290	1,300	1,310	1,310	1,320	1,330	1,340	1,350	1,350	1,360	1,370	1,380	1,390	1,390	1,400	1,410	1,420	1,430	1,430	3
4	1,700	1,710	1,730	1,740	1,750	1,760	1,770	1,780	1,790	1,800	1,820	1,830	1,840	1,850	1,860	1,870	1,880	1,890	1,900	1,910	1,920	4
5	2,120	2,140	2,150	2,170	2,180	2,190	2,210	2,220	2,240	2,250	2,260	2,280	2,290	2,300	2,320	2,330	2,340	2,360	2,370	2,380	2,390	5
6	2,560	2,570	2,590	2,610	2,620	2,640	2,660	2,670	2,690	2,710	2,720	2,740	2,760	2,770	2,790	2,800	2,820	2,840	2,850	2,870	2,880	6
7	2,990	3,010	3,030	3,050	3,070	3,090	3,110	3,130	3,150	3,170	3,180	3,200	3,220	3,240	3,260	3,280	3,300	3,310	3,330	3,350	3,370	7
8	3,410	3,430	3,450	3,480	3,500	3,520	3,540	3,570	3,590	3,610	3,630	3,650	3,670	3,700	3,720	3,740	3,760	3,780	3,800	3,820	3,840	8
9	3,840	3,860	3,890	3,920	3,940	3,970	3,990	4,020	4,040	4,070	4,090	4,120	4,140	4,170	4,190	4,220	4,240	4,270	4,290	4,310	4,340	9
10	4,260	4,290	4,320	4,350	4,380	4,400	4,430	4,460	4,490	4,520	4,550	4,580	4,600	4,630	4,660	4,690	4,710	4,740	4,770	4,790	4,820	10
11	4,690	4,720	4,750	4,790	4,820	4,850	4,880	4,910	4,950	4,980	5,010	5,040	5,070	5,100	5,130	5,160	5,190	5,220	5,250	5,280	5,310	11
12	5,110	5,140	5,180	5,220	5,250	5,290	5,320	5,360	5,390	5,430	5,460	5,500	5,530	5,570	5,600	5,630	5,670	5,700	5,730	5,760	5,800	12
13	5,540	5,580	5,620	5,660	5,690	5,730	5,770	5,810	5,850	5,890	5,930	5,960	6,000	6,040	6,070	6,110	6,150	6,180	6,220	6,260	6,290	13
14	5,970	6,010	6,060	6,100	6,140	6,190	6,230	6,270	6,310	6,350	6,390	6,440	6,480	6,520	6,560	6,600	6,640	6,680	6,720	6,750	6,790	14
15	6,390	6,440	6,480	6,530	6,580	6,620	6,670	6,710	6,760	6,800	6,850	6,890	6,940	6,980	7,020	7,070	7,110	7,150	7,190	7,230	7,280	15
16	6,820	6,870	6,920	6,970	7,020	7,070	7,120	7,170	7,210	7,260	7,310	7,360	7,400	7,450	7,500	7,540	7,590	7,640	7,680	7,730	7,770	16
17	7,260	7,310	7,370	7,420	7,470	7,520	7,570	7,630	7,680	7,730	7,780	7,830	7,880	7,930	7,980	8,030	8,080	8,130	8,180	8,230	8,270	17
18	7,710	7,760	7,820	7,880	7,930	7,990	8,040	8,100	8,150	8,210	8,260	8,310	8,370	8,420	8,470	8,530	8,580	8,630	8,680	8,740	8,790	18
19	8,140	8,200	8,260	8,320	8,380	8,440	8,500	8,550	8,610	8,670	8,730	8,790	8,840	8,900	8,960	9,010	9,070	9,120	9,180	9,240	9,290	19
20	8,590	8,660	8,720	8,780	8,840	8,900	8,960	9,020	9,090	9,150	9,210	9,270	9,330	9,390	9,450	9,510	9,570	9,630	9,690	9,750	9,810	20
21	9,030	9,100	9,160	9,230	9,290	9,360	9,420	9,480	9,550	9,610	9,680	9,740	9,810	9,870	9,930	9,990	10,060	10,120	10,180	10,250	10,310	21
22	9,470	9,540	9,610	9,670	9,740	9,810	9,870	9,940	10,010	10,080	10,140	10,210	10,280	10,350	10,410	10,480	10,540	10,610	10,680	10,740	10,810	22
23	9,910	9,990	10,060	10,130	10,200	10,270	10,340	10,410	10,480	10,550	10,620	10,700	10,770	10,840	10,900	10,970	11,040	11,110	11,180	11,250	11,320	23
24	10,350	10,430	10,500	10,580	10,650	10,730	10,800	10,870	10,940	11,020	11,090	11,170	11,240	11,320	11,390	11,460	11,530	11,600	11,680	11,750	11,830	24
25	10,730	10,830	10,930	11,020	11,120	11,220	11,320	11,410	11,480	11,550	11,620	11,680	11,750	11,810	11,870	11,930	11,990	12,060	12,140	12,220	12,290	25
26	11,090	11,210	11,330	11,460	11,580	11,700	11,820	11,940	12,040	12,110	12,160	12,220	12,270	12,330	12,380	12,430	12,480	12,540	12,610	12,690	12,770	26
27	11,460	11,610	11,750	11,900	12,050	12,190	12,340	12,490	12,580	12,640	12,690	12,730	12,780	12,820	12,860	12,900	12,940	13,000	13,070	13,150	13,230	27
28	11,820	11,990	12,160	12,330	12,500	12,670	12,840	13,020	13,140	13,190	13,230	13,270	13,310	13,340	13,370	13,400	13,430	13,480	13,550	13,630	13,710	28
29	12,200	12,390	12,580	12,780	12,970	13,170	13,360	13,560	13,680	13,730	13,760	13,780	13,810	13,830	13,850	13,870	13,890	13,930	14,010	14,090	14,180	29
30	12,550	12,770	12,990	13,200	13,420	13,640	13,860	14,090	14,230	14,280	14,300	14,320	14,330	14,350	14,360	14,370	14,380	14,410	14,470	14,560	14,650	30
31	12,910	13,150	13,390	13,640	13,880	14,120	14,370	14,620	14,780	14,830	14,840	14,850	14,860	14,870	14,870	14,870	14,860	14,880	14,950	15,040	15,130	31
32	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,320	15,360	15,370	15,370	15,360	15,360	15,350	15,340	15,330	15,340	15,410	15,500	15,590	32
33	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,350	15,430	15,460	15,500	15,530	15,560	15,590	15,620	15,640	15,690	15,780	15,890	16,010	33
34	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,350	15,450	15,520	15,590	15,660	15,730	15,790	15,850	15,920	16,000	16,120	16,260	16,400	34
35	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,380	15,510	15,620	15,720	15,830	15,930	16,030	16,130	16,230	16,340	16,490	16,660	16,820	35
36	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,380	15,540	15,680	15,820	15,950	16,090	16,230	16,370	16,500	16,660	16,830	17,030	17,220	36
37	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,410	15,600	15,770	15,950	16,120	16,300	16,470	16,650	16,820	17,000	17,200	17,420	17,640	37
38	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,410	15,620	15,830	16,040	16,250	16,460	16,670	16,880	17,090	17,310	17,550	17,790	18,030	38
39	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,410	15,650	15,890	16,130	16,380	16,630	16,870	17,120	17,370	17,630	17,890	18,160	18,420	39
40	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,430	15,710	15,990	16,270	16,550	16,830	17,110	17,400	17,680	17,970	18,260	18,550	18,840	40
41	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,430	15,710	15,990	16,270	16,550	16,830	17,110	17,400	17,680	17,970	18,260	18,550	18,840	41
42	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,430	15,710	15,990	16,270	16,550	16,830	17,110	17,400	17,680	17,970	18,260	18,550	18,840	42
43	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,430	15,710	15,990	16,270	16,550	16,830	17,110	17,400	17,680	17,970	18,260	18,550	18,840	43
44	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,430	15,710	15,990	16,270	16,550	16,830	17,110	17,400	17,680	17,970	18,260	18,550	18,840	44
45	13,290	13,550	13,810	14,080	14,350	14,620	14,890	15,160	15,430	15,710	15,990	16,270	16,550	16,830	17,110	17,400	17,680	17,970	18,260	18,550	18,840	45

BLUE RIDGE DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1685.0	1685.1	1685.2	1685.3	1685.4	1685.5	1685.6	1685.7	1685.8	1685.9	1686.0	1686.1	1686.2	1686.3	1686.4	1686.5	1686.6	1686.7	1686.8	1686.9	1687.0	
1	470	480	480	480	480	490	490	490	490	500	500	500	500	510	510	510	510	510	520	520	520	1
2	960	970	970	980	980	990	990	1,000	1,000	1,010	1,010	1,020	1,020	1,020	1,030	1,030	1,040	1,040	1,050	1,050	1,060	2
3	1,430	1,440	1,450	1,460	1,460	1,470	1,480	1,490	1,490	1,500	1,510	1,520	1,520	1,530	1,540	1,540	1,550	1,560	1,570	1,570	1,580	3
4	1,920	1,930	1,940	1,950	1,960	1,970	1,980	1,990	2,000	2,010	2,020	2,030	2,040	2,050	2,060	2,070	2,080	2,090	2,100	2,110	2,120	4
5	2,390	2,410	2,420	2,430	2,440	2,460	2,470	2,480	2,490	2,510	2,520	2,530	2,540	2,550	2,570	2,580	2,590	2,600	2,610	2,630	2,640	5
6	2,880	2,900	2,910	2,930	2,940	2,960	2,970	2,990	3,000	3,020	3,030	3,050	3,060	3,080	3,090	3,100	3,120	3,130	3,150	3,160	3,180	6
7	3,370	3,390	3,410	3,420	3,440	3,460	3,480	3,490	3,510	3,530	3,540	3,560	3,580	3,600	3,610	3,630	3,650	3,660	3,680	3,700	3,710	7
8	3,840	3,860	3,880	3,900	3,920	3,940	3,960	3,980	4,000	4,020	4,040	4,060	4,080	4,100	4,120	4,140	4,160	4,180	4,200	4,210	4,230	8
9	4,340	4,360	4,380	4,410	4,430	4,450	4,480	4,500	4,520	4,540	4,570	4,590	4,610	4,630	4,650	4,680	4,700	4,720	4,740	4,760	4,780	9
10	4,820	4,850	4,870	4,900	4,920	4,950	4,980	5,000	5,030	5,050	5,080	5,100	5,130	5,150	5,180	5,200	5,230	5,250	5,280	5,300	5,320	10
11	5,310	5,340	5,370	5,400	5,430	5,460	5,490	5,520	5,550	5,570	5,600	5,630	5,660	5,680	5,710	5,740	5,770	5,790	5,820	5,850	5,880	11
12	5,800	5,830	5,860	5,890	5,930	5,960	5,990	6,020	6,050	6,080	6,110	6,140	6,180	6,210	6,240	6,270	6,300	6,330	6,360	6,390	6,410	12
13	6,290	6,330	6,360	6,400	6,430	6,470	6,500	6,540	6,570	6,600	6,640	6,670	6,700	6,740	6,770	6,800	6,840	6,870	6,900	6,930	6,970	13
14	6,790	6,830	6,870	6,910	6,950	6,980	7,020	7,060	7,100	7,130	7,170	7,210	7,240	7,280	7,310	7,350	7,390	7,420	7,460	7,490	7,530	14
15	7,280	7,320	7,360	7,400	7,440	7,480	7,520	7,560	7,600	7,640	7,680	7,720	7,760	7,800	7,840	7,880	7,910	7,950	7,990	8,030	8,070	15
16	7,770	7,810	7,860	7,900	7,950	7,990	8,030	8,080	8,120	8,160	8,200	8,250	8,290	8,330	8,370	8,410	8,450	8,500	8,540	8,580	8,620	16
17	8,270	8,320	8,370	8,420	8,470	8,510	8,560	8,610	8,650	8,700	8,740	8,790	8,830	8,880	8,920	8,970	9,010	9,060	9,100	9,150	9,190	17
18	8,790	8,840	8,890	8,940	8,990	9,040	9,090	9,140	9,190	9,240	9,290	9,340	9,390	9,440	9,490	9,540	9,580	9,630	9,680	9,730	9,770	18
19	9,290	9,350	9,400	9,460	9,510	9,570	9,620	9,670	9,730	9,780	9,830	9,880	9,940	9,990	10,040	10,090	10,140	10,190	10,240	10,290	10,340	19
20	9,810	9,870	9,920	9,980	10,040	10,100	10,160	10,210	10,270	10,330	10,380	10,440	10,490	10,550	10,600	10,660	10,710	10,770	10,820	10,870	10,930	20
21	10,310	10,370	10,440	10,500	10,560	10,620	10,680	10,740	10,800	10,860	10,920	10,980	11,040	11,100	11,160	11,210	11,270	11,330	11,390	11,440	11,500	21
22	10,810	10,880	10,940	11,010	11,070	11,140	11,200	11,270	11,330	11,390	11,460	11,520	11,580	11,640	11,700	11,760	11,830	11,890	11,950	12,010	12,070	22
23	11,320	11,390	11,460	11,530	11,600	11,670	11,740	11,800	11,870	11,940	12,010	12,070	12,140	12,200	12,270	12,330	12,400	12,460	12,520	12,590	12,650	23
24	11,830	11,900	11,970	12,050	12,120	12,190	12,260	12,330	12,400	12,470	12,540	12,610	12,680	12,750	12,820	12,890	12,950	13,020	13,090	13,160	13,220	24
25	12,290	12,370	12,440	12,520	12,590	12,670	12,740	12,810	12,880	12,960	13,030	13,100	13,170	13,240	13,310	13,380	13,450	13,520	13,590	13,660	13,730	25
26	12,770	12,850	12,930	13,000	13,080	13,150	13,230	13,300	13,380	13,450	13,530	13,600	13,670	13,750	13,820	13,890	13,960	14,040	14,110	14,180	14,250	26
27	13,230	13,310	13,390	13,470	13,550	13,630	13,710	13,780	13,860	13,940	14,010	14,090	14,160	14,240	14,310	14,390	14,460	14,540	14,610	14,690	14,760	27
28	13,710	13,790	13,880	13,960	14,040	14,120	14,200	14,270	14,350	14,430	14,510	14,590	14,670	14,740	14,820	14,900	14,970	15,050	15,130	15,210	15,290	28
29	14,180	14,260	14,340	14,430	14,510	14,590	14,670	14,750	14,830	14,920	15,000	15,080	15,160	15,230	15,310	15,390	15,470	15,550	15,630	15,710	15,790	29
30	14,650	14,740	14,820	14,910	14,990	15,070	15,160	15,240	15,320	15,410	15,490	15,570	15,650	15,730	15,810	15,890	15,980	16,060	16,140	16,230	16,310	30
31	15,130	15,220	15,300	15,390	15,480	15,560	15,650	15,730	15,820	15,900	15,990	16,070	16,160	16,240	16,320	16,400	16,490	16,570	16,660	16,750	16,830	31
32	15,590	15,680	15,770	15,860	15,950	16,040	16,120	16,210	16,300	16,390	16,470	16,560	16,650	16,730	16,810	16,900	16,980	17,070	17,160	17,250	17,340	32
33	16,010	16,130	16,240	16,360	16,470	16,590	16,700	16,800	16,880	16,960	17,040	17,120	17,200	17,280	17,360	17,430	17,510	17,600	17,690	17,780	17,870	33
34	16,400	16,550	16,690	16,830	16,970	17,110	17,250	17,380	17,470	17,540	17,620	17,690	17,760	17,830	17,900	17,970	18,040	18,120	18,220	18,310	18,400	34
35	16,820	16,990	17,160	17,330	17,490	17,660	17,830	17,970	18,050	18,120	18,190	18,250	18,320	18,380	18,440	18,500	18,560	18,650	18,750	18,840	18,930	35
36	17,220	17,410	17,600	17,800	17,990	18,180	18,370	18,540	18,640	18,700	18,760	18,820	18,870	18,930	18,980	19,040	19,090	19,170	19,270	19,370	19,460	36
37	17,640	17,860	18,070	18,290	18,510	18,730	18,950	19,140	19,220	19,280	19,330	19,380	19,430	19,480	19,520	19,570	19,620	19,700	19,800	19,900	19,990	37
38	18,030	18,270	18,520	18,760	19,010	19,250	19,500	19,710	19,810	19,860	19,900	19,950	19,990	20,030	20,070	20,110	20,150	20,230	20,330	20,420	20,520	38
39	18,420	18,690	18,960	19,230	19,500	19,780	20,050	20,290	20,390	20,440	20,480	20,510	20,550	20,580	20,610	20,640	20,680	20,750	20,850	20,950	21,050	39
40	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,880	20,980	21,010	21,050	21,080	21,110	21,130	21,160	21,180	21,200	21,280	21,380	21,480	21,580	40
41	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,890	21,020	21,090	21,160	21,230	21,290	21,350	21,410	21,470	21,530	21,630	21,760	21,890	22,020	41
42	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,890	21,040	21,140	21,250	21,350	21,440	21,540	21,640	21,730	21,830	21,960	22,120	22,270	22,430	42
43	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,900	21,090	21,220	21,360	21,490	21,630	21,760	21,890	22,020	22,150	22,310	22,500	22,680	22,860	43
44	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,900	21,110	21,280	21,450	21,610	21,780	21,950	22,120	22,280	22,450	22,640	22,850	23,060	23,280	44
45	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,920	21,150	21,360	21,560	21,760	21,970	22,170	22,370	22,580	22,780	23,000	23,230	23,470	23,710	45
46	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,920	21,170	21,400	21,640	21,880	22,120	22,360	22,590	22,830	23,070	23,330	23,590	23,850	24,120	46
47	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,920	21,190	21,460	21,730	22,000	22,270	22,540	22,820	23,090	23,370	23,660	23,940	24,240	24,530	47
48	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,930	21,230	21,540	21,840	22,150	22,460	22,760	23,070	23,390	23,700	24,010	24,320	24,640	24,970	48
49	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,930	21,230	21,540	21,840	22,150	22,460	22,760	23,070	23,390	23,700	24,010	24,320	24,640	24,970	49
50	18,840	19,140	19,430	19,730	20,030	20,330	20,630	20,930	21,230	21,540	21,840	22,150	22,460	22,760	23,070	23,390	23,700	24,010	24,320	24,640	24,970	50

BLUE RIDGE DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1687.0	1687.1	1687.2	1687.3	1687.4	1687.5	1687.6	1687.7	1687.8	1687.9	1688.0	1688.1	1688.2	1688.3	1688.4	1688.5	1688.6	1688.7	1688.8	1688.9	1689.0	
1	520	520	530	530	530	530	530	540	540	540	540	550	550	550	550	550	560	560	560	560	570	1
2	1,060	1,060	1,070	1,070	1,080	1,080	1,090	1,090	1,090	1,100	1,100	1,110	1,110	1,120	1,120	1,130	1,130	1,130	1,140	1,140	1,150	2
3	1,580	1,590	1,590	1,600	1,610	1,610	1,620	1,630	1,630	1,640	1,650	1,650	1,660	1,670	1,670	1,680	1,690	1,690	1,700	1,710	1,710	3
4	2,120	2,120	2,130	2,140	2,150	2,160	2,170	2,180	2,190	2,200	2,210	2,220	2,220	2,230	2,240	2,250	2,260	2,270	2,280	2,290	2,290	4
5	2,640	2,650	2,660	2,670	2,680	2,690	2,710	2,720	2,730	2,740	2,750	2,760	2,770	2,780	2,790	2,810	2,820	2,830	2,840	2,850	2,860	5
6	3,180	3,190	3,200	3,220	3,230	3,240	3,260	3,270	3,280	3,300	3,310	3,330	3,340	3,350	3,360	3,380	3,390	3,400	3,420	3,430	3,440	6
7	3,710	3,730	3,740	3,760	3,780	3,790	3,810	3,820	3,840	3,860	3,870	3,890	3,900	3,920	3,930	3,950	3,960	3,980	3,990	4,010	4,020	7
8	4,230	4,250	4,270	4,290	4,310	4,320	4,340	4,360	4,380	4,400	4,420	4,430	4,450	4,470	4,490	4,500	4,520	4,540	4,560	4,570	4,590	8
9	4,780	4,810	4,830	4,850	4,870	4,890	4,910	4,930	4,950	4,970	4,990	5,010	5,030	5,050	5,070	5,090	5,110	5,130	5,150	5,170	5,190	9
10	5,320	5,350	5,370	5,400	5,420	5,440	5,470	5,490	5,510	5,540	5,560	5,580	5,600	5,630	5,650	5,670	5,690	5,720	5,740	5,760	5,780	10
11	5,880	5,900	5,930	5,950	5,980	6,010	6,030	6,060	6,080	6,110	6,140	6,160	6,190	6,210	6,240	6,260	6,290	6,310	6,340	6,360	6,390	11
12	6,410	6,440	6,470	6,500	6,530	6,560	6,590	6,620	6,650	6,670	6,700	6,730	6,760	6,790	6,810	6,840	6,870	6,900	6,920	6,950	6,980	12
13	6,970	7,000	7,030	7,060	7,090	7,120	7,160	7,190	7,220	7,250	7,280	7,310	7,340	7,370	7,400	7,430	7,460	7,490	7,520	7,550	7,580	13
14	7,530	7,560	7,600	7,630	7,660	7,700	7,730	7,770	7,800	7,830	7,870	7,900	7,930	7,970	8,000	8,030	8,060	8,100	8,130	8,160	8,190	14
15	8,070	8,100	8,140	8,180	8,210	8,250	8,290	8,320	8,360	8,400	8,430	8,470	8,500	8,540	8,580	8,610	8,650	8,680	8,720	8,750	8,780	15
16	8,620	8,660	8,700	8,740	8,780	8,820	8,860	8,890	8,930	8,970	9,010	9,050	9,090	9,130	9,160	9,200	9,240	9,280	9,310	9,350	9,390	16
17	9,190	9,230	9,280	9,320	9,360	9,400	9,450	9,490	9,530	9,570	9,610	9,650	9,700	9,740	9,780	9,820	9,860	9,900	9,940	9,980	10,020	17
18	9,770	9,820	9,870	9,910	9,960	10,000	10,050	10,090	10,140	10,180	10,230	10,270	10,320	10,360	10,410	10,450	10,490	10,540	10,580	10,620	10,670	18
19	10,340	10,390	10,440	10,490	10,540	10,590	10,640	10,690	10,740	10,780	10,830	10,880	10,930	10,970	11,020	11,070	11,110	11,160	11,210	11,250	11,300	19
20	10,930	10,980	11,030	11,090	11,140	11,190	11,240	11,290	11,340	11,400	11,450	11,500	11,550	11,600	11,650	11,700	11,750	11,800	11,850	11,890	11,940	20
21	11,500	11,560	11,610	11,670	11,720	11,780	11,830	11,890	11,940	12,000	12,050	12,100	12,160	12,210	12,260	12,320	12,370	12,420	12,470	12,520	12,580	21
22	12,070	12,130	12,190	12,240	12,300	12,360	12,420	12,480	12,530	12,590	12,650	12,700	12,760	12,820	12,870	12,930	12,980	13,040	13,090	13,150	13,200	22
23	12,650	12,710	12,780	12,840	12,900	12,960	13,020	13,080	13,140	13,200	13,260	13,320	13,380	13,440	13,500	13,560	13,620	13,680	13,730	13,790	13,850	23
24	13,220	13,290	13,350	13,420	13,480	13,550	13,610	13,680	13,740	13,800	13,870	13,930	13,990	14,050	14,120	14,180	14,240	14,300	14,360	14,420	14,480	24
25	13,730	13,800	13,870	13,940	14,000	14,070	14,140	14,210	14,270	14,340	14,400	14,470	14,540	14,600	14,670	14,730	14,800	14,860	14,920	14,990	15,050	25
26	14,250	14,320	14,400	14,470	14,540	14,610	14,680	14,750	14,820	14,890	14,960	15,030	15,100	15,160	15,230	15,300	15,370	15,430	15,500	15,570	15,630	26
27	14,760	14,840	14,910	14,980	15,060	15,130	15,200	15,280	15,350	15,420	15,500	15,570	15,640	15,710	15,780	15,850	15,920	15,990	16,060	16,130	16,200	27
28	15,290	15,360	15,440	15,510	15,590	15,670	15,740	15,820	15,900	15,970	16,050	16,120	16,200	16,270	16,350	16,420	16,490	16,570	16,640	16,710	16,790	28
29	15,790	15,870	15,950	16,030	16,110	16,190	16,270	16,350	16,430	16,510	16,590	16,670	16,740	16,820	16,900	16,970	17,050	17,130	17,200	17,280	17,350	29
30	16,310	16,390	16,480	16,560	16,640	16,720	16,800	16,890	16,970	17,050	17,130	17,210	17,300	17,380	17,460	17,540	17,620	17,700	17,770	17,850	17,930	30
31	16,830	16,920	17,000	17,090	17,170	17,260	17,340	17,430	17,510	17,600	17,690	17,770	17,850	17,940	18,020	18,100	18,190	18,270	18,350	18,430	18,510	31
32	17,340	17,430	17,520	17,610	17,690	17,780	17,870	17,960	18,050	18,140	18,220	18,310	18,400	18,490	18,570	18,660	18,740	18,830	18,910	19,000	19,080	32
33	17,870	17,960	18,050	18,140	18,230	18,320	18,410	18,500	18,590	18,680	18,770	18,860	18,950	19,030	19,120	19,210	19,300	19,390	19,470	19,560	19,640	33
34	18,400	18,490	18,580	18,670	18,760	18,850	18,940	19,030	19,130	19,220	19,310	19,400	19,490	19,580	19,670	19,760	19,840	19,930	20,020	20,110	20,200	34
35	18,930	19,030	19,120	19,210	19,300	19,390	19,480	19,580	19,670	19,760	19,850	19,950	20,040	20,130	20,220	20,310	20,400	20,490	20,580	20,670	20,760	35
36	19,460	19,550	19,650	19,740	19,830	19,920	20,020	20,110	20,210	20,300	20,390	20,490	20,580	20,670	20,760	20,850	20,950	21,040	21,130	21,230	21,320	36
37	19,990	20,090	20,180	20,280	20,370	20,460	20,560	20,650	20,750	20,840	20,940	21,030	21,130	21,220	21,310	21,400	21,500	21,600	21,690	21,790	21,880	37
38	20,520	20,620	20,710	20,810	20,900	21,000	21,090	21,190	21,290	21,390	21,480	21,580	21,670	21,760	21,860	21,950	22,050	22,150	22,250	22,340	22,440	38
39	21,050	21,150	21,240	21,340	21,440	21,530	21,630	21,730	21,820	21,920	22,020	22,120	22,210	22,310	22,400	22,500	22,600	22,700	22,800	22,890	22,990	39
40	21,580	21,680	21,780	21,880	21,970	22,070	22,170	22,270	22,370	22,470	22,570	22,660	22,760	22,860	22,950	23,050	23,150	23,250	23,350	23,460	23,560	40
41	22,020	22,140	22,270	22,400	22,520	22,650	22,780	22,910	23,040	23,130	23,230	23,320	23,420	23,510	23,600	23,690	23,790	23,890	23,990	24,090	24,190	41
42	22,430	22,590	22,740	22,900	23,050	23,210	23,360	23,520	23,680	23,800	23,890	23,980	24,070	24,160	24,250	24,340	24,430	24,520	24,620	24,720	24,820	42
43	22,860	23,050	23,230	23,420	23,600	23,790	23,980	24,160	24,350	24,470	24,560	24,640	24,730	24,820	24,900	24,980	25,070	25,160	25,250	25,350	25,460	43
44	23,280	23,490	23,700	23,920	24,130	24,350	24,560	24,780	25,000	25,130	25,220	25,300	25,390	25,470	25,550	25,630	25,710	25,790	25,880	25,980	26,090	44
45	23,710	23,950	24,200	24,440	24,680	24,930	25,170	25,420	25,670	25,800	25,880	25,960	26,040	26,120	26,200	26,270	26,350	26,420	26,510	26,620	26,720	45
46	24,120	24,390	24,660	24,940	25,210	25,480	25,760	26,040	26,310	26,480	26,560	26,640	26,720	26,790	26,860	26,930	27,010	27,080	27,160	27,260	27,370	46
47	24,530	24,830	25,130	25,430	25,740	26,040	26,350	26,650	26,960	27,140	27,230	27,300	27,370	27,440	27,510	27,580	27,650	27,710	27,790	27,890	28,000	47
48	24,970	25,300	25,630	25,960	26,290	26,620	26,960	27,290	27,630	27,810	27,890	27,960	28,030	28,100	28,160	28,220	28,290	28,340	28,420	28,530	28,640	48
49	24,970	25,300	25,630	25,960	26,290	26,620	26,960	27,290	27,630	27,840	27,960	28,060	28,160	28,270	28,370	28,470	28,560	28,660	28,770	28,910	29,050	49
50	24,970	25,300	25,630	25,960	26,290	26,620	26,960	27,290	27,630	27,850	28,000	28,140	28,280	28,410	28,550	28,680	28,820	28,950	29,100	29,270	29,440	50

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1687.0	1687.1	1687.2	1687.3	1687.4	1687.5	1687.6	1687.7	1687.8	1687.9	1688.0	1688.1	1688.2	1688.3	1688.4	1688.5	1688.6	1688.7	1688.8	1688.9	1689.0	
51	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 880	28, 070	28, 240	28, 410	28, 580	28, 760	28, 930	29, 100	29, 270	29, 450	29, 640	29, 850	51
52	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 900	28, 110	28, 320	28, 530	28, 730	28, 940	29, 150	29, 350	29, 560	29, 770	30, 000	30, 240	52
53	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 930	28, 180	28, 420	28, 660	28, 900	29, 140	29, 390	29, 630	29, 870	30, 120	30, 380	30, 650	53
54	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 930	28, 200	28, 480	28, 750	29, 030	29, 310	29, 580	29, 860	30, 140	30, 430	30, 720	31, 020	54
55	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 940	28, 250	28, 560	28, 870	29, 180	29, 490	29, 800	30, 120	30, 430	30, 760	31, 080	31, 410	55
56	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 970	28, 310	28, 660	29, 000	29, 350	29, 700	30, 050	30, 400	30, 750	31, 100	31, 460	31, 820	56
57	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 970	28, 310	28, 660	29, 000	29, 350	29, 700	30, 050	30, 400	30, 750	31, 100	31, 460	31, 820	57
58	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 970	28, 310	28, 660	29, 000	29, 350	29, 700	30, 050	30, 400	30, 750	31, 100	31, 460	31, 820	58
59	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 970	28, 310	28, 660	29, 000	29, 350	29, 700	30, 050	30, 400	30, 750	31, 100	31, 460	31, 820	59
60	24, 970	25, 300	25, 630	25, 960	26, 290	26, 620	26, 960	27, 290	27, 630	27, 970	28, 310	28, 660	29, 000	29, 350	29, 700	30, 050	30, 400	30, 750	31, 100	31, 460	31, 820	60

BLUE RIDGE DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGEMENT	HEADWATER ELEVATION																					GATE ARRANGEMENT
	1689.0	1689.1	1689.2	1689.3	1689.4	1689.5	1689.6	1689.7	1689.8	1689.9	1690.0	1690.1	1690.2	1690.3	1690.4	1690.5	1690.6	1690.7	1690.8	1690.9	1691.0	
1	570	570	570	570	570	580	580	580	580	580	590	590	590	590	590	600	600	600	600			1
2	1,150	1,150	1,160	1,160	1,160	1,170	1,170	1,180	1,180	1,180	1,190	1,190	1,200	1,200	1,210	1,210	1,210	1,220	1,220			2
3	1,710	1,720	1,730	1,730	1,740	1,740	1,750	1,760	1,760	1,770	1,780	1,780	1,790	1,790	1,800	1,810	1,810	1,820	1,820			3
4	2,290	2,300	2,310	2,320	2,330	2,340	2,340	2,350	2,360	2,370	2,380	2,390	2,390	2,400	2,410	2,420	2,430	2,440	2,440			4
5	2,860	2,870	2,880	2,890	2,900	2,910	2,920	2,930	2,940	2,950	2,960	2,970	2,980	2,990	3,010	3,020	3,030	3,040	3,050			5
6	3,440	3,460	3,470	3,480	3,490	3,510	3,520	3,530	3,540	3,560	3,570	3,580	3,590	3,610	3,620	3,630	3,640	3,660	3,670			6
7	4,020	4,040	4,050	4,070	4,080	4,100	4,110	4,130	4,140	4,160	4,170	4,190	4,200	4,220	4,230	4,240	4,260	4,270	4,290			7
8	4,590	4,610	4,620	4,640	4,660	4,680	4,690	4,710	4,730	4,740	4,760	4,780	4,790	4,810	4,820	4,840	4,860	4,870	4,890	4,910	4,920	8
9	5,190	5,210	5,230	5,250	5,270	5,290	5,310	5,330	5,350	5,370	5,390	5,400	5,420	5,440	5,460	5,480	5,500	5,520	5,540	5,550	5,570	9
10	5,780	5,810	5,830	5,850	5,870	5,890	5,910	5,940	5,960	5,980	6,000	6,020	6,040	6,060	6,090	6,110	6,130	6,150	6,170	6,190	6,210	10
11	6,390	6,410	6,440	6,460	6,480	6,510	6,530	6,560	6,580	6,600	6,630	6,650	6,680	6,700	6,720	6,750	6,770	6,790	6,810	6,840	6,860	11
12	6,980	7,000	7,030	7,060	7,080	7,110	7,140	7,160	7,190	7,220	7,240	7,270	7,290	7,320	7,350	7,370	7,400	7,420	7,450	7,470	7,500	12
13	7,580	7,610	7,640	7,670	7,700	7,730	7,760	7,780	7,810	7,840	7,870	7,900	7,930	7,950	7,980	8,010	8,040	8,070	8,090	8,120	8,150	13
14	8,190	8,230	8,260	8,290	8,320	8,350	8,380	8,410	8,450	8,480	8,510	8,540	8,570	8,600	8,630	8,660	8,690	8,720	8,750	8,780	8,810	14
15	8,780	8,820	8,850	8,890	8,920	8,960	8,990	9,020	9,060	9,090	9,120	9,160	9,190	9,220	9,250	9,290	9,320	9,350	9,380	9,420	9,450	15
16	9,390	9,420	9,460	9,500	9,530	9,570	9,610	9,640	9,680	9,710	9,750	9,790	9,820	9,860	9,890	9,930	9,960	10,000	10,030	10,070	10,100	16
17	10,020	10,060	10,100	10,140	10,180	10,220	10,260	10,300	10,330	10,370	10,410	10,450	10,490	10,530	10,560	10,600	10,640	10,680	10,710	10,750	10,790	17
18	10,670	10,710	10,750	10,790	10,840	10,880	10,920	10,960	11,000	11,040	11,090	11,130	11,170	11,210	11,250	11,290	11,330	11,370	11,410	11,450	11,490	18
19	11,300	11,340	11,390	11,430	11,480	11,520	11,570	11,610	11,660	11,700	11,750	11,790	11,830	11,880	11,920	11,960	12,010	12,050	12,090	12,140	12,180	19
20	11,940	11,990	12,040	12,090	12,140	12,180	12,230	12,280	12,330	12,370	12,420	12,470	12,510	12,560	12,610	12,650	12,700	12,740	12,790	12,830	12,880	20
21	12,580	12,630	12,680	12,730	12,780	12,830	12,880	12,930	12,980	13,030	13,080	13,130	13,180	13,230	13,280	13,330	13,380	13,420	13,470	13,520	13,570	21
22	13,200	13,260	13,310	13,370	13,420	13,470	13,530	13,580	13,630	13,690	13,740	13,790	13,840	13,890	13,950	14,000	14,050	14,100	14,150	14,200	14,250	22
23	13,850	13,910	13,960	14,020	14,080	14,130	14,190	14,250	14,300	14,360	14,410	14,470	14,520	14,580	14,630	14,690	14,740	14,790	14,850	14,900	14,950	23
24	14,480	14,540	14,600	14,660	14,720	14,780	14,840	14,900	14,960	15,020	15,070	15,130	15,190	15,250	15,300	15,360	15,420	15,470	15,530	15,590	15,640	24
25	15,050	15,110	15,180	15,240	15,300	15,360	15,430	15,490	15,550	15,610	15,670	15,730	15,790	15,850	15,910	15,970	16,030	16,090	16,150	16,210	16,270	25
26	15,630	15,700	15,770	15,830	15,900	15,960	16,030	16,090	16,150	16,220	16,280	16,350	16,410	16,470	16,530	16,600	16,660	16,720	16,780	16,840	16,910	26
27	16,200	16,270	16,340	16,410	16,480	16,540	16,610	16,680	16,750	16,810	16,880	16,950	17,010	17,080	17,140	17,210	17,270	17,340	17,400	17,470	17,530	27
28	16,790	16,860	16,930	17,000	17,070	17,140	17,210	17,280	17,350	17,420	17,490	17,560	17,630	17,700	17,770	17,830	17,900	17,970	18,040	18,100	18,170	28
29	17,350	17,430	17,500	17,580	17,650	17,730	17,800	17,870	17,940	18,020	18,090	18,160	18,230	18,300	18,370	18,450	18,520	18,590	18,660	18,730	18,800	29
30	17,930	18,010	18,090	18,160	18,240	18,320	18,390	18,470	18,540	18,620	18,690	18,770	18,840	18,920	18,990	19,060	19,140	19,210	19,280	19,360	19,430	30
31	18,510	18,590	18,680	18,760	18,840	18,910	18,990	19,070	19,150	19,230	19,310	19,380	19,460	19,540	19,620	19,690	19,770	19,840	19,920	19,990	20,070	31
32	19,080	19,170	19,250	19,330	19,420	19,500	19,580	19,660	19,740	19,820	19,900	19,980	20,060	20,140	20,220	20,300	20,380	20,460	20,540	20,620	20,690	32
33	19,640	19,730	19,820	19,900	19,990	20,070	20,160	20,240	20,330	20,410	20,490	20,580	20,660	20,740	20,830	20,910	20,990	21,070	21,150	21,230	21,310	33
34	20,200	20,290	20,370	20,460	20,550	20,640	20,720	20,810	20,900	20,990	21,070	21,160	21,250	21,330	21,420	21,500	21,590	21,670	21,760	21,840	21,920	34
35	20,760	20,850	20,940	21,030	21,120	21,210	21,300	21,390	21,480	21,570	21,660	21,750	21,840	21,930	22,020	22,110	22,200	22,280	22,370	22,460	22,540	35
36	21,320	21,410	21,500	21,590	21,680	21,780	21,870	21,960	22,060	22,150	22,240	22,340	22,430	22,520	22,610	22,700	22,790	22,880	22,980	23,060	23,150	36
37	21,880	21,970	22,070	22,160	22,250	22,350	22,450	22,540	22,640	22,740	22,830	22,930	23,030	23,120	23,210	23,310	23,400	23,500	23,590	23,680	23,770	37
38	22,440	22,530	22,630	22,720	22,820	22,920	23,020	23,120	23,220	23,320	23,420	23,520	23,620	23,710	23,810	23,910	24,000	24,100	24,200	24,290	24,390	38
39	22,990	23,090	23,190	23,280	23,380	23,480	23,590	23,690	23,790	23,900	24,000	24,100	24,200	24,300	24,400	24,500	24,600	24,700	24,800	24,900	25,000	39
40	23,560	23,650	23,750	23,850	23,950	24,060	24,160	24,270	24,380	24,480	24,590	24,690	24,800	24,900	25,010	25,110	25,210	25,310	25,420	25,520	25,620	40
41	24,190	24,290	24,390	24,490	24,590	24,690	24,800	24,910	25,010	25,120	25,230	25,330	25,440	25,540	25,650	25,750	25,850	25,960	26,060	26,160	26,270	41
42	24,820	24,920	25,020	25,120	25,220	25,330	25,430	25,540	25,650	25,750	25,860	25,970	26,070	26,180	26,280	26,390	26,490	26,590	26,700	26,800	26,910	42
43	25,460	25,560	25,660	25,760	25,860	25,970	26,070	26,180	26,290	26,390	26,500	26,610	26,710	26,820	26,920	27,030	27,130	27,240	27,340	27,450	27,560	43
44	26,090	26,190	26,290	26,400	26,500	26,600	26,700	26,810	26,920	27,030	27,130	27,240	27,350	27,450	27,560	27,660	27,770	27,880	27,980	28,090	28,200	44
45	26,720	26,830	26,930	27,030	27,140	27,240	27,340	27,450	27,560	27,670	27,770	27,880	27,990	28,090	28,200	28,300	28,410	28,520	28,630	28,740	28,850	45
46	27,370	27,480	27,580	27,680	27,790	27,890	27,990	28,100	28,200	28,310	28,420	28,530	28,640	28,750	28,850	28,960	29,060	29,170	29,280	29,390	29,500	46
47	28,000	28,110	28,210	28,320	28,420	28,520	28,630	28,730	28,840	28,950	29,060	29,170	29,270	29,380	29,490	29,590	29,700	29,810	29,920	30,030	30,140	47
48	28,640	28,740	28,850	28,950	29,060	29,160	29,260	29,370	29,480	29,590	29,700	29,810	29,910	30,020	30,130	30,230	30,340	30,450	30,570	30,680	30,790	48
49	29,050	29,190	29,320	29,460	29,600	29,730	29,870	30,000	30,110	30,210	30,320	30,430	30,530	30,630	30,740	30,840	30,940	31,050	31,170	31,280	31,390	49
50	29,440	29,610	29,780	29,950	30,110	30,280	30,450	30,620	30,760	30,860	30,960	31,070	31,170	31,270	31,370	31,460	31,560	31,670	31,780	31,890	32,000	50

See special instruction for preventing gate overflow on page 3.

BLUE RIDGE DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1689.0	1689.1	1689.2	1689.3	1689.4	1689.5	1689.6	1689.7	1689.8	1689.9	1690.0	1690.1	1690.2	1690.3	1690.4	1690.5	1690.6	1690.7	1690.8	1690.9	1691.0	
51	29,850	30,050	30,250	30,450	30,650	30,850	31,060	31,250	31,390	31,490	31,590	31,690	31,780	31,880	31,980	32,070	32,160	32,270	32,380	32,490	32,600	51
52	30,240	30,470	30,700	30,940	31,170	31,400	31,640	31,870	32,040	32,130	32,230	32,330	32,420	32,510	32,600	32,690	32,780	32,880	32,990	33,110	33,220	52
53	30,650	30,910	31,180	31,440	31,710	31,980	32,240	32,500	32,670	32,760	32,850	32,950	33,040	33,130	33,210	33,300	33,380	33,480	33,590	33,700	33,810	53
54	31,020	31,310	31,610	31,910	32,210	32,510	32,810	33,100	33,300	33,390	33,480	33,570	33,660	33,740	33,830	33,910	33,990	34,080	34,190	34,300	34,410	54
55	31,410	31,740	32,060	32,390	32,730	33,060	33,390	33,720	33,950	34,040	34,120	34,210	34,290	34,370	34,450	34,530	34,610	34,700	34,810	34,920	35,030	55
56	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,350	34,580	34,660	34,750	34,830	34,910	34,990	35,060	35,140	35,210	35,300	35,410	35,520	35,620	56
57	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,360	34,620	34,740	34,860	34,980	35,090	35,210	35,320	35,440	35,550	35,670	35,810	35,960	36,100	57
58	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,360	34,620	34,780	34,930	35,090	35,240	35,390	35,550	35,700	35,850	36,010	36,190	36,370	36,540	58
59	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,360	34,660	34,850	35,040	35,230	35,430	35,620	35,810	36,000	36,190	36,380	36,590	36,810	37,020	59
60	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,360	34,660	34,890	35,120	35,340	35,570	35,800	36,030	36,260	36,480	36,720	36,970	37,220	37,460	60
61	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,360	34,700	34,960	35,230	35,490	35,760	36,020	36,290	36,560	36,820	37,090	37,370	37,660	37,940	61
62	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,360	34,700	35,000	35,300	35,600	35,900	36,210	36,510	36,810	37,120	37,430	37,750	38,060	38,380	62
63	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,360	34,700	35,030	35,370	35,710	36,050	36,390	36,730	37,070	37,420	37,770	38,120	38,470	38,830	63
64	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,370	34,740	35,110	35,480	35,860	36,230	36,610	36,990	37,370	37,760	38,140	38,530	38,910	39,300	64
65	31,820	32,180	32,540	32,900	33,260	33,630	34,000	34,370	34,740	35,110	35,480	35,860	36,230	36,610	36,990	37,370	37,760	38,140	38,530	38,910	39,300	65

BLUE RIDGE DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1691.0	1691.1	1691.2	1691.3	1691.4	1691.5	1691.6	1691.7	1691.8	1691.9	1692.0	1692.1	1692.2	1692.3	1692.4	1692.5	1692.6	1692.7	1692.8	1692.9	1693.0	
6																						6
7																						7
8	4,920	4,960	5,020	5,100	5,180	5,270	5,380	5,490	5,600	5,730	5,860	5,990										8
9	5,570	5,610	5,680	5,750	5,840	5,940	6,040	6,150	6,270	6,400	6,530	6,670										9
10	6,210	6,250	6,320	6,400	6,490	6,580	6,690	6,810	6,930	7,050	7,190	7,330										10
11	6,860	6,910	6,980	7,060	7,150	7,250	7,360	7,470	7,600	7,730	7,860	8,000										11
12	7,500	7,550	7,620	7,700	7,790	7,900	8,010	8,130	8,250	8,380	8,520	8,670										12
13	8,150	8,200	8,270	8,360	8,450	8,560	8,670	8,790	8,920	9,050	9,200	9,340										13
14	8,810	8,860	8,940	9,030	9,120	9,230	9,350	9,470	9,600	9,740	9,880	10,030										14
15	9,450	9,500	9,580	9,670	9,770	9,880	10,000	10,120	10,260	10,390	10,540	10,690										15
16	10,100	10,160	10,240	10,330	10,430	10,540	10,660	10,790	10,920	11,070	11,210	11,370	11,530	11,690	11,860	12,040	12,220	12,400	12,590	12,790	12,990	16
17	10,790	10,850	10,930	11,020	11,130	11,240	11,370	11,500	11,630	11,780	11,930	12,080	12,250	12,410	12,590	12,760	12,950	13,130	13,330	13,520	13,720	17
18	11,490	11,550	11,640	11,730	11,840	11,960	12,080	12,220	12,360	12,500	12,660	12,820	12,980	13,150	13,320	13,510	13,690	13,880	14,080	14,280	14,480	18
19	12,180	12,240	12,330	12,430	12,540	12,660	12,790	12,920	13,070	13,220	13,370	13,530	13,700	13,870	14,050	14,230	14,420	14,610	14,810	15,010	15,220	19
20	12,880	12,950	13,040	13,140	13,250	13,380	13,510	13,650	13,790	13,940	14,100	14,260	14,430	14,610	14,790	14,970	15,160	15,360	15,560	15,760	15,970	20
21	13,570	13,640	13,730	13,840	13,950	14,080	14,210	14,350	14,500	14,650	14,810	14,980	15,150	15,330	15,510	15,700	15,890	16,090	16,290	16,500	16,710	21
22	14,250	14,330	14,420	14,530	14,650	14,770	14,910	15,050	15,200	15,360	15,520	15,690	15,870	16,050	16,230	16,420	16,620	16,820	17,020	17,230	17,450	22
23	14,950	15,030	15,130	15,240	15,360	15,490	15,630	15,770	15,930	16,090	16,250	16,420	16,600	16,780	16,970	17,160	17,360	17,570	17,770	17,990	18,200	23
24	15,640	15,720	15,820	15,930	16,060	16,190	16,330	16,480	16,640	16,800	16,970	17,140	17,320	17,510	17,700	17,890	18,090	18,300	18,510	18,720	18,940	24
25	16,270	16,350	16,450	16,570	16,690	16,830	16,970	17,120	17,280	17,450	17,620	17,790	17,980	18,160	18,360	18,550	18,760	18,970	19,180	19,390	19,620	25
26	16,910	16,990	17,100	17,220	17,340	17,480	17,630	17,780	17,940	18,110	18,280	18,460	18,650	18,840	19,030	19,240	19,440	19,650	19,870	20,090	20,310	26
27	17,530	17,620	17,730	17,850	17,980	18,120	18,270	18,430	18,590	18,760	18,930	19,120	19,300	19,500	19,690	19,900	20,110	20,320	20,540	20,760	20,990	27
28	18,170	18,260	18,370	18,500	18,630	18,770	18,930	19,080	19,250	19,420	19,600	19,790	19,980	20,170	20,370	20,580	20,790	21,000	21,220	21,450	21,680	28
29	18,800	18,890	19,000	19,130	19,270	19,410	19,570	19,730	19,900	20,070	20,250	20,440	20,630	20,830	21,030	21,240	21,450	21,670	21,900	22,120	22,350	29
30	19,430	19,520	19,640	19,770	19,910	20,060	20,210	20,380	20,550	20,730	20,910	21,100	21,300	21,500	21,700	21,910	22,130	22,350	22,580	22,810	23,040	30
31	20,070	20,170	20,290	20,420	20,560	20,710	20,870	21,040	21,210	21,390	21,580	21,770	21,970	22,170	22,380	22,590	22,810	23,040	23,260	23,500	23,730	31
32	20,690	20,790	20,920	21,050	21,200	21,350	21,510	21,680	21,860	22,040	22,230	22,420	22,620	22,830	23,040	23,260	23,480	23,700	23,930	24,170	24,410	32
33	21,310	21,420	21,540	21,680	21,830	21,980	22,150	22,320	22,500	22,690	22,880	23,080	23,280	23,490	23,700	23,920	24,140	24,370	24,610	24,840	25,080	33
34	21,920	22,030	22,160	22,300	22,450	22,610	22,780	22,950	23,130	23,320	23,520	23,720	23,920	24,140	24,350	24,570	24,800	25,030	25,270	25,510	25,750	34
35	22,540	22,650	22,780	22,930	23,080	23,240	23,410	23,590	23,780	23,970	24,170	24,370	24,580	24,790	25,010	25,240	25,470	25,700	25,940	26,180	26,430	35
36	23,150	23,270	23,400	23,550	23,700	23,870	24,040	24,220	24,410	24,610	24,810	25,010	25,220	25,440	25,660	25,890	26,120	26,360	26,600	26,840	27,090	36
37	23,770	23,890	24,030	24,180	24,330	24,500	24,680	24,860	25,050	25,250	25,450	25,660	25,880	26,100	26,320	26,550	26,790	27,030	27,270	27,520	27,770	37
38	24,390	24,510	24,650	24,800	24,960	25,130	25,310	25,500	25,690	25,890	26,100	26,310	26,530	26,750	26,980	27,210	27,450	27,690	27,940	28,190	28,440	38
39	25,000	25,120	25,260	25,420	25,580	25,760	25,940	26,130	26,320	26,530	26,740	26,950	27,170	27,400	27,630	27,860	28,100	28,350	28,600	28,850	29,110	39
40	25,620	25,740	25,890	26,050	26,210	26,390	26,580	26,770	26,970	27,170	27,390	27,600	27,830	28,050	28,290	28,530	28,770	29,020	29,270	29,520	29,780	40
41	26,270	26,390	26,540	26,700	26,870	27,050	27,230	27,430	27,630	27,840	28,060	28,280	28,500	28,740	28,970	29,210	29,460	29,710	29,970	30,230	30,490	41
42	26,910	27,040	27,180	27,340	27,510	27,690	27,880	28,080	28,290	28,500	28,720	28,940	29,170	29,410	29,650	29,890	30,140	30,400	30,660	30,920	31,190	42
43	27,560	27,690	27,830	28,000	28,170	28,350	28,540	28,750	28,950	29,170	29,390	29,620	29,850	30,090	30,330	30,580	30,830	31,090	31,350	31,620	31,890	43
44	28,200	28,330	28,480	28,640	28,810	29,000	29,190	29,400	29,610	29,830	30,060	30,290	30,520	30,760	31,010	31,260	31,520	31,780	32,040	32,310	32,590	44
45	28,850	28,980	29,130	29,290	29,470	29,650	29,850	30,060	30,280	30,500	30,730	30,960	31,200	31,450	31,700	31,950	32,210	32,470	32,740	33,010	33,290	45
46	29,500	29,640	29,790	29,950	30,130	30,320	30,520	30,730	30,950	31,170	31,410	31,640	31,890	32,130	32,390	32,650	32,910	33,180	33,450	33,720	34,000	46
47	30,140	30,280	30,430	30,600	30,780	30,960	31,170	31,380	31,600	31,830	32,070	32,310	32,560	32,810	33,060	33,330	33,590	33,860	34,140	34,420	34,700	47
48	30,790	30,930	31,080	31,250	31,430	31,620	31,820	32,040	32,270	32,500	32,740	32,990	33,230	33,490	33,750	34,010	34,280	34,560	34,830	35,120	35,400	48
49	31,390	31,530	31,680	31,850	32,030	32,210	32,420	32,640	32,860	33,090	33,330	33,570	33,820	34,080	34,330	34,600	34,870	35,140	35,420	35,700	35,990	49
50	32,000	32,140	32,290	32,460	32,640	32,820	33,030	33,240	33,470	33,700	33,930	34,180	34,420	34,680	34,930	35,200	35,460	35,740	36,020	36,300	36,590	50
51	32,600	32,740	32,890	33,060	33,230	33,420	33,620	33,830	34,060	34,290	34,520	34,760	35,010	35,260	35,520	35,780	36,050	36,320	36,600	36,880	37,170	51
52	33,220	33,350	33,500	33,670	33,850	34,030	34,230	34,440	34,660	34,890	35,130	35,370	35,610	35,860	36,120	36,380	36,650	36,920	37,200	37,480	37,770	52
53	33,810	33,950	34,100	34,270	34,440	34,620	34,820	35,030	35,260	35,480	35,720	35,960	36,200	36,450	36,700	36,960	37,230	37,500	37,780	38,070	38,350	53
54	34,410	34,540	34,700	34,860	35,040	35,220	35,410	35,630	35,850	36,070	36,310	36,540	36,790	37,030	37,290	37,540	37,810	38,090	38,360	38,650	38,930	54
55	35,030	35,160	35,310	35,470	35,650	35,830	36,020	36,230	36,450	36,680	36,910	37,150	37,390	37,630	37,890	38,140	38,410	38,680	38,960	39,240	39,530	55

. *See special instruction for preventing gate overflow on page 3.*

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1691.0	1691.1	1691.2	1691.3	1691.4	1691.5	1691.6	1691.7	1691.8	1691.9	1692.0	1692.1	1692.2	1692.3	1692.4	1692.5	1692.6	1692.7	1692.8	1692.9	1693.0	
56	35, 620	35, 760	35, 910	36, 070	36, 240	36, 420	36, 620	36, 820	37, 040	37, 270	37, 500	37, 730	37, 980	38, 220	38, 470	38, 730	38, 990	39, 270	39, 550	39, 830	40, 120	56
57	36, 100	36, 270	36, 460	36, 660	36, 860	37, 070	37, 260	37, 470	37, 680	37, 900	38, 130	38, 360	38, 590	38, 830	39, 070	39, 330	39, 590	39, 870	40, 140	40, 420	40, 710	57
58	36, 540	36, 750	36, 970	37, 200	37, 450	37, 700	37, 920	38, 130	38, 340	38, 550	38, 770	39, 000	39, 230	39, 460	39, 700	39, 950	40, 210	40, 480	40, 760	41, 040	41, 320	58
59	37, 020	37, 260	37, 520	37, 790	38, 070	38, 350	38, 570	38, 770	38, 980	39, 180	39, 400	39, 620	39, 840	40, 070	40, 300	40, 550	40, 810	41, 080	41, 350	41, 630	41, 910	59
60	37, 460	37, 740	38, 030	38, 340	38, 660	38, 970	39, 230	39, 440	39, 630	39, 840	40, 050	40, 260	40, 480	40, 700	40, 930	41, 170	41, 430	41, 690	41, 970	42, 240	42, 520	60
61	37, 940	38, 250	38, 580	38, 920	39, 280	39, 620	39, 880	40, 080	40, 270	40, 470	40, 670	40, 880	41, 090	41, 310	41, 530	41, 770	42, 030	42, 290	42, 560	42, 840	43, 120	61
62	38, 380	38, 730	39, 090	39, 470	39, 860	40, 240	40, 530	40, 730	40, 910	41, 110	41, 300	41, 510	41, 710	41, 920	42, 140	42, 380	42, 630	42, 890	43, 160	43, 430	43, 710	62
63	38, 830	39, 210	39, 610	40, 020	40, 450	40, 860	41, 190	41, 390	41, 570	41, 760	41, 950	42, 150	42, 350	42, 560	42, 760	42, 990	43, 250	43, 510	43, 770	44, 050	44, 320	63
64	39, 300	39, 720	40, 160	40, 610	41, 070	41, 510	41, 830	42, 030	42, 210	42, 390	42, 580	42, 770	42, 970	43, 170	43, 370	43, 600	43, 850	44, 110	44, 370	44, 640	44, 910	64
65	39, 300	39, 720	40, 160	40, 610	41, 070	41, 520	41, 880	42, 120	42, 340	42, 560	42, 790	43, 020	43, 260	43, 500	43, 750	44, 020	44, 300	44, 600	44, 910	45, 210	45, 530	65
66	39, 300	39, 720	40, 160	40, 610	41, 070	41, 520	41, 880	42, 150	42, 410	42, 670	42, 940	43, 220	43, 500	43, 780	44, 070	44, 380	44, 710	45, 050	45, 390	45, 740	46, 090	66
67	39, 300	39, 720	40, 160	40, 610	41, 070	41, 530	41, 930	42, 240	42, 540	42, 840	43, 160	43, 470	43, 800	44, 120	44, 460	44, 800	45, 170	45, 550	45, 930	46, 310	46, 700	67
68	39, 300	39, 720	40, 160	40, 610	41, 070	41, 530	41, 930	42, 270	42, 610	42, 960	43, 310	43, 670	44, 030	44, 400	44, 780	45, 170	45, 580	45, 990	46, 410	46, 840	47, 270	68
69	39, 300	39, 720	40, 160	40, 610	41, 070	41, 540	41, 980	42, 360	42, 740	43, 130	43, 520	43, 920	44, 330	44, 740	45, 160	45, 590	46, 040	46, 490	46, 950	47, 410	47, 880	69
70	39, 300	39, 720	40, 160	40, 610	41, 070	41, 540	41, 980	42, 400	42, 830	43, 260	43, 690	44, 130	44, 580	45, 040	45, 500	45, 970	46, 460	46, 950	47, 440	47, 950	48, 460	70
71	39, 300	39, 720	40, 160	40, 610	41, 070	41, 540	41, 980	42, 440	42, 900	43, 370	43, 850	44, 330	44, 820	45, 320	45, 820	46, 340	46, 860	47, 390	47, 930	48, 470	49, 020	71
72	39, 300	39, 720	40, 160	40, 610	41, 070	41, 550	42, 030	42, 520	43, 030	43, 540	44, 060	44, 580	45, 120	45, 660	46, 210	46, 760	47, 320	47, 890	48, 460	49, 050	49, 630	72
73	39, 300	39, 720	40, 160	40, 610	41, 070	41, 550	42, 030	42, 520	43, 030	43, 540	44, 060	44, 580	45, 120	45, 660	46, 210	46, 760	47, 320	47, 890	48, 460	49, 050	49, 630	73
74	39, 300	39, 720	40, 160	40, 610	41, 070	41, 550	42, 030	42, 520	43, 030	43, 540	44, 060	44, 580	45, 120	45, 660	46, 210	46, 760	47, 320	47, 890	48, 460	49, 050	49, 630	74
75	39, 300	39, 720	40, 160	40, 610	41, 070	41, 550	42, 030	42, 520	43, 030	43, 540	44, 060	44, 580	45, 120	45, 660	46, 210	46, 760	47, 320	47, 890	48, 460	49, 050	49, 630	75

BLUE RIDGE DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1693.0	1693.1	1693.2	1693.3	1693.4	1693.5	1693.6	1693.7	1693.8	1693.9	1694.0	1694.1	1694.2	1694.3	1694.4	1694.5	1694.6	1694.7	1694.8	1694.9	1695.0	
16	12,990	13,190	13,400	13,610	13,820	14,050																16
17	13,720	13,930	14,140	14,360	14,570	14,800																17
18	14,480	14,690	14,900	15,120	15,340	15,560																18
19	15,220	15,430	15,640	15,860	16,090	16,320																19
20	15,970	16,190	16,400	16,630	16,850	17,080																20
21	16,710	16,930	17,150	17,370	17,600	17,830																21
22	17,450	17,670	17,890	18,120	18,350	18,580																22
23	18,200	18,420	18,650	18,880	19,110	19,350																23
24	18,940	19,160	19,390	19,620	19,860	20,100	20,340	20,590	20,840	21,100	21,360	21,620	21,890	22,160	22,440	22,710	22,990	23,280	23,570	23,860		24
25	19,620	19,840	20,070	20,310	20,550	20,790	21,030	21,290	21,540	21,800	22,060	22,330	22,590	22,870	23,140	23,420	23,710	24,000	24,290	24,580		25
26	20,310	20,540	20,770	21,010	21,250	21,490	21,740	22,000	22,250	22,510	22,780	23,050	23,320	23,590	23,870	24,160	24,440	24,730	25,020	25,320		26
27	20,990	21,220	21,450	21,690	21,930	22,180	22,430	22,690	22,950	23,210	23,480	23,750	24,020	24,300	24,580	24,870	25,160	25,450	25,740	26,040		27
28	21,680	21,910	22,150	22,390	22,640	22,890	23,140	23,400	23,660	23,930	24,200	24,470	24,750	25,030	25,310	25,600	25,890	26,180	26,480	26,780		28
29	22,350	22,590	22,830	23,070	23,320	23,580	23,830	24,090	24,360	24,620	24,900	25,170	25,450	25,730	26,020	26,310	26,600	26,900	27,200	27,500		29
30	23,040	23,280	23,520	23,770	24,020	24,270	24,530	24,790	25,060	25,330	25,610	25,880	26,160	26,450	26,740	27,030	27,330	27,630	27,930	28,230		30
31	23,730	23,970	24,220	24,470	24,720	24,980	25,240	25,510	25,770	26,050	26,320	26,600	26,890	27,180	27,470	27,760	28,060	28,360	28,670	28,970		31
32	24,410	24,650	24,900	25,150	25,410	25,670	25,930	26,200	26,470	26,740	27,020	27,310	27,590	27,880	28,180	28,470	28,770	29,080	29,380	29,690	30,010	32
33	25,080	25,330	25,580	25,840	26,090	26,360	26,620	26,890	27,170	27,450	27,730	28,010	28,300	28,590	28,890	29,190	29,490	29,800	30,110	30,420	30,740	33
34	25,750	26,000	26,250	26,510	26,770	27,040	27,310	27,580	27,860	28,140	28,420	28,710	29,000	29,290	29,590	29,890	30,200	30,510	30,820	31,140	31,460	34
35	26,430	26,680	26,940	27,190	27,460	27,730	28,000	28,270	28,550	28,840	29,120	29,410	29,710	30,010	30,310	30,610	30,920	31,230	31,550	31,860	32,190	35
36	27,090	27,350	27,610	27,870	28,140	28,410	28,680	28,960	29,240	29,530	29,820	30,110	30,410	30,710	31,010	31,320	31,630	31,940	32,260	32,580	32,900	36
37	27,770	28,030	28,290	28,550	28,820	29,100	29,370	29,650	29,940	30,230	30,520	30,820	31,110	31,420	31,720	32,030	32,350	32,660	32,980	33,310	33,630	37
38	28,440	28,700	28,970	29,230	29,500	29,780	30,060	30,340	30,630	30,920	31,220	31,510	31,820	32,120	32,430	32,740	33,060	33,380	33,700	34,030	34,360	38
39	29,110	29,370	29,640	29,910	30,180	30,460	30,740	31,030	31,320	31,610	31,910	32,210	32,510	32,820	33,130	33,450	33,770	34,090	34,410	34,740	35,070	39
40	29,780	30,050	30,320	30,590	30,870	31,150	31,440	31,720	32,020	32,310	32,610	32,920	33,220	33,530	33,850	34,170	34,490	34,810	35,140	35,470	35,800	40
41	30,490	30,760	31,030	31,310	31,590	31,870	32,160	32,450	32,750	33,050	33,350	33,660	33,970	34,280	34,600	34,920	35,240	35,570	35,900	36,230	36,570	41
42	31,190	31,460	31,730	32,010	32,300	32,580	32,870	33,170	33,470	33,770	34,080	34,390	34,700	35,020	35,340	35,660	35,990	36,320	36,650	36,990	37,330	42
43	31,890	32,160	32,440	32,730	33,010	33,300	33,600	33,900	34,200	34,500	34,810	35,130	35,440	35,760	36,080	36,410	36,740	37,070	37,410	37,750	38,090	43
44	32,590	32,860	33,150	33,430	33,720	34,020	34,310	34,610	34,920	35,230	35,540	35,860	36,180	36,500	36,820	37,150	37,490	37,820	38,160	38,510	38,850	44
45	33,290	33,570	33,860	34,150	34,440	34,740	35,040	35,340	35,650	35,960	36,280	36,600	36,920	37,240	37,570	37,900	38,240	38,580	38,920	39,270	39,620	45
46	34,000	34,290	34,580	34,870	35,160	35,460	35,770	36,080	36,390	36,700	37,020	37,340	37,670	38,000	38,330	38,660	39,000	39,350	39,690	40,040	40,390	46
47	34,700	34,990	35,280	35,570	35,870	36,180	36,480	36,790	37,110	37,430	37,750	38,070	38,400	38,730	39,070	39,410	39,750	40,100	40,440	40,800	41,150	47
48	35,400	35,690	35,990	36,290	36,590	36,900	37,210	37,520	37,840	38,160	38,480	38,810	39,140	39,480	39,820	40,160	40,500	40,850	41,200	41,560	41,920	48
49	35,990	36,280	36,570	36,870	37,170	37,480	37,800	38,110	38,430	38,760	39,090	39,420	39,750	40,090	40,430	40,780	41,120	41,470	41,830	42,190	42,550	49
50	36,590	36,880	37,170	37,470	37,770	38,080	38,400	38,720	39,040	39,370	39,700	40,030	40,370	40,710	41,060	41,400	41,750	42,110	42,470	42,830	43,190	50
51	37,170	37,460	37,760	38,050	38,360	38,670	38,990	39,310	39,640	39,970	40,300	40,640	40,980	41,320	41,670	42,020	42,370	42,730	43,090	43,450	43,820	51
52	37,770	38,060	38,350	38,650	38,950	39,270	39,590	39,920	40,250	40,580	40,910	41,250	41,600	41,940	42,300	42,650	43,010	43,370	43,730	44,090	44,460	52
53	38,350	38,640	38,940	39,240	39,540	39,850	40,180	40,510	40,840	41,180	41,520	41,860	42,210	42,560	42,910	43,260	43,620	43,990	44,350	44,720	45,090	53
54	38,930	39,220	39,520	39,820	40,120	40,430	40,760	41,090	41,430	41,770	42,110	42,460	42,810	43,160	43,520	43,870	44,240	44,600	44,970	45,340	45,720	54
55	39,530	39,820	40,120	40,410	40,720	41,030	41,360	41,700	42,040	42,380	42,720	43,070	43,430	43,780	44,140	44,500	44,870	45,240	45,610	45,980	46,360	55
56	40,120	40,410	40,700	41,000	41,300	41,620	41,950	42,290	42,630	42,980	43,330	43,680	44,030	44,390	44,750	45,120	45,490	45,860	46,230	46,610	46,990	56
57	40,710	41,000	41,290	41,590	41,890	42,200	42,540	42,870	43,210	43,550	43,900	44,250	44,600	44,960	45,320	45,680	46,050	46,420	46,790	47,170	47,550	57
58	41,320	41,610	41,900	42,190	42,490	42,800	43,130	43,470	43,800	44,140	44,490	44,830	45,180	45,540	45,900	46,260	46,620	46,990	47,370	47,740	48,120	58
59	41,910	42,200	42,490	42,780	43,080	43,390	43,720	44,050	44,380	44,720	45,060	45,400	45,750	46,100	46,460	46,820	47,190	47,550	47,920	48,300	48,680	59
60	42,520	42,800	43,090	43,380	43,680	43,990	44,310	44,640	44,970	45,310	45,650	45,990	46,330	46,680	47,040	47,400	47,760	48,130	48,500	48,870	49,250	60
61	43,120	43,400	43,680	43,970	44,270	44,570	44,900	45,220	45,550	45,880	46,220	46,560	46,900	47,250	47,600	47,960	48,320	48,690	49,060	49,430	49,800	61
62	43,710	43,990	44,270	44,560	44,850	45,160	45,480	45,800	46,130	46,460	46,790	47,130	47,470	47,810	48,160	48,520	48,880	49,250	49,620	49,980	50,360	62
63	44,320	44,600	44,880	45,160	45,450	45,760	46,080	46,400	46,720	47,050	47,380	47,710	48,050	48,390	48,740	49,100	49,460	49,820	50,190	50,560	50,930	63
64	44,910	45,190	45,470	45,750	46,040	46,350	46,660	46,980	47,300	47,630	47,950	48,280	48,620	48,960	49,310	49,660	50,020	50,380	50,750	51,110	51,480	64
65	45,530	45,840	46,160	46,480	46,800	47,100	47,400	47,710	48,020	48,340	48,660	48,980	49,300	49,630	49,980	50,330	50,690	51,040	51,410	51,770	52,140	65

See special instruction for preventing gate overflow on page 3.

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION										
	1693.0	1693.1	1693.2	1693.3	1693.4	1693.5	1693.6	1693.7	1693.8	1693.9	1694.0
66	46, 090	46, 440	46, 800	47, 160	47, 520	47, 860	48, 170	48, 470	48, 780	49, 080	49, 390
67	46, 700	47, 100	47, 500	47, 900	48, 280	48, 610	48, 910	49, 210	49, 500	49, 790	50, 090
68	47, 270	47, 700	48, 140	48, 580	49, 010	49, 370	49, 680	49, 970	50, 250	50, 540	50, 820
69	47, 880	48, 350	48, 830	49, 320	49, 770	50, 130	50, 430	50, 700	50, 970	51, 250	51, 530
70	48, 460	48, 970	49, 490	50, 010	50, 500	50, 890	51, 180	51, 440	51, 710	51, 970	52, 240
71	49, 020	49, 570	50, 130	50, 690	51, 230	51, 650	51, 950	52, 200	52, 460	52, 710	52, 970
72	49, 630	50, 220	50, 820	51, 430	51, 990	52, 400	52, 690	52, 930	53, 180	53, 430	53, 680
73	49, 630	50, 220	50, 820	51, 430	52, 000	52, 460	52, 800	53, 090	53, 380	53, 680	53, 980
74	49, 630	50, 220	50, 820	51, 430	52, 000	52, 460	52, 830	53, 170	53, 510	53, 860	54, 210
75	49, 630	50, 220	50, 820	51, 430	52, 010	52, 520	52, 940	53, 320	53, 720	54, 110	54, 510
76	49, 630	50, 220	50, 820	51, 430	52, 010	52, 520	52, 970	53, 400	53, 840	54, 290	54, 730
77	49, 630	50, 220	50, 820	51, 430	52, 030	52, 580	53, 080	53, 560	54, 050	54, 540	55, 040
78	49, 630	50, 220	50, 820	51, 430	52, 030	52, 600	53, 140	53, 670	54, 210	54, 750	55, 290
79	49, 630	50, 220	50, 820	51, 430	52, 030	52, 600	53, 170	53, 750	54, 330	54, 920	55, 520
80	49, 630	50, 220	50, 820	51, 430	52, 040	52, 660	53, 280	53, 900	54, 540	55, 180	55, 820
81	49, 630	50, 220	50, 820	51, 430	52, 040	52, 660	53, 280	53, 900	54, 540	55, 180	55, 820
82	49, 630	50, 220	50, 820	51, 430	52, 040	52, 660	53, 280	53, 900	54, 540	55, 180	55, 820
83	49, 630	50, 220	50, 820	51, 430	52, 040	52, 660	53, 280	53, 900	54, 540	55, 180	55, 820
84	49, 630	50, 220	50, 820	51, 430	52, 040	52, 660	53, 280	53, 900	54, 540	55, 180	55, 820
85	49, 630	50, 220	50, 820	51, 430	52, 040	52, 660	53, 280	53, 900	54, 540	55, 180	55, 820

1694.1	1694.2	1694.3	1694.4	1694.5	1694.6	1694.7	1694.8	1694.9	1695.0	GATE ARRANGE-MENT
49, 700	50, 010	50, 330	50, 670	51, 010	51, 360	51, 720	52, 080	52, 440	52, 800	66
50, 390	50, 700	51, 010	51, 340	51, 680	52, 030	52, 380	52, 740	53, 100	53, 460	67
51, 120	51, 410	51, 710	52, 030	52, 360	52, 710	53, 060	53, 410	53, 770	54, 130	68
51, 810	52, 090	52, 380	52, 700	53, 030	53, 370	53, 720	54, 070	54, 420	54, 780	69
52, 510	52, 790	53, 060	53, 370	53, 700	54, 040	54, 390	54, 730	55, 080	55, 430	70
53, 230	53, 500	53, 760	54, 060	54, 380	54, 720	55, 060	55, 410	55, 750	56, 100	71
53, 930	54, 180	54, 440	54, 730	55, 050	55, 390	55, 720	56, 070	56, 410	56, 750	72
54, 280	54, 580	54, 890	55, 230	55, 590	55, 960	56, 350	56, 730	57, 120	57, 510	73
54, 560	54, 910	55, 270	55, 650	56, 060	56, 480	56, 910	57, 330	57, 760	58, 200	74
54, 910	55, 310	55, 720	56, 150	56, 600	57, 060	57, 530	58, 000	58, 470	58, 950	75
55, 180	55, 640	56, 100	56, 580	57, 070	57, 580	58, 090	58, 600	59, 120	59, 640	76
55, 540	56, 040	56, 550	57, 070	57, 610	58, 160	58, 710	59, 270	59, 830	60, 390	77
55, 840	56, 400	56, 960	57, 530	58, 110	58, 700	59, 300	59, 900	60, 500	61, 110	78
56, 120	56, 720	57, 330	57, 960	58, 580	59, 220	59, 860	60, 500	61, 150	61, 800	79
56, 470	57, 120	57, 780	58, 450	59, 120	59, 800	60, 480	61, 160	61, 850	62, 550	80
56, 470	57, 120	57, 780	58, 450	59, 120	59, 800	60, 480	61, 160	61, 850	62, 550	81
56, 470	57, 120	57, 780	58, 450	59, 120	59, 800	60, 480	61, 160	61, 850	62, 550	82
56, 470	57, 120	57, 780	58, 450	59, 120	59, 800	60, 480	61, 160	61, 850	62, 550	83
56, 470	57, 120	57, 780	58, 450	59, 120	59, 800	60, 480	61, 160	61, 850	62, 550	84
56, 470	57, 120	57, 780	58, 450	59, 120	59, 800	60, 480	61, 160	61, 850	62, 550	85

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1695.0	1695.1	1695.2	1695.3	1695.4	1695.5	1695.6	1695.7	1695.8	1695.9	1696.0	1696.1	1696.2	1696.3	1696.4	1696.5	1696.6	1696.7	1696.8	1696.9	1697.0	
31																						31
32	30,010	30,330	30,650	30,970	31,300	31,630	31,960	32,300	32,640	32,980	33,330	33,680										32
33	30,740	31,060	31,380	31,710	32,040	32,370	32,710	33,040	33,390	33,730	34,080	34,430										33
34	31,460	31,780	32,100	32,430	32,760	33,100	33,440	33,780	34,130	34,470	34,820	35,180										34
35	32,190	32,510	32,840	33,170	33,500	33,840	34,180	34,530	34,870	35,220	35,580	35,930										35
36	32,900	33,230	33,560	33,900	34,230	34,570	34,920	35,260	35,610	35,970	36,320	36,680										36
37	33,630	33,960	34,300	34,630	34,970	35,310	35,660	36,010	36,360	36,720	37,080	37,440										37
38	34,360	34,690	35,020	35,360	35,700	36,050	36,400	36,750	37,100	37,460	37,820	38,190										38
39	35,070	35,410	35,750	36,090	36,430	36,780	37,130	37,490	37,840	38,200	38,570	38,930										39
40	35,800	36,140	36,480	36,820	37,170	37,520	37,880	38,230	38,590	38,950	39,320	39,690	40,060	40,440	40,810	41,190	41,580	41,960	42,350	42,750	43,140	40
41	36,570	36,910	37,250	37,600	37,950	38,300	38,660	39,020	39,380	39,750	40,120	40,490	40,860	41,240	41,620	42,000	42,390	42,780	43,170	43,570	43,960	41
42	37,330	37,670	38,020	38,370	38,720	39,080	39,430	39,800	40,160	40,530	40,900	41,280	41,650	42,030	42,420	42,800	43,190	43,590	43,980	44,380	44,780	42
43	38,090	38,440	38,790	39,140	39,500	39,860	40,220	40,580	40,950	41,320	41,700	42,070	42,460	42,840	43,220	43,610	44,010	44,400	44,800	45,200	45,600	43
44	38,850	39,200	39,550	39,910	40,270	40,630	40,990	41,360	41,730	42,110	42,480	42,860	43,250	43,630	44,020	44,420	44,810	45,210	45,610	46,010	46,420	44
45	39,620	39,970	40,330	40,680	41,050	41,410	41,780	42,150	42,520	42,900	43,280	43,660	44,050	44,440	44,830	45,220	45,620	46,020	46,430	46,830	47,240	45
46	40,390	40,750	41,110	41,470	41,830	42,200	42,570	42,950	43,320	43,700	44,080	44,470	44,860	45,250	45,650	46,040	46,440	46,850	47,250	47,660	48,080	46
47	41,150	41,510	41,870	42,230	42,600	42,970	43,350	43,720	44,100	44,490	44,870	45,260	45,650	46,050	46,440	46,850	47,250	47,650	48,060	48,480	48,890	47
48	41,920	42,280	42,640	43,010	43,380	43,750	44,130	44,510	44,890	45,280	45,670	46,060	46,450	46,850	47,250	47,650	48,060	48,470	48,880	49,300	49,710	48
49	42,550	42,910	43,280	43,650	44,020	44,400	44,780	45,160	45,550	45,930	46,330	46,720	47,120	47,520	47,920	48,330	48,740	49,150	49,560	49,980	50,400	49
50	43,190	43,560	43,930	44,300	44,680	45,060	45,440	45,820	46,210	46,600	47,000	47,390	47,790	48,200	48,600	49,010	49,420	49,840	50,260	50,680	51,100	50
51	43,820	44,190	44,560	44,940	45,320	45,700	46,090	46,470	46,860	47,260	47,660	48,060	48,460	48,860	49,270	49,680	50,100	50,510	50,930	51,360	51,780	51
52	44,460	44,840	45,210	45,590	45,970	46,360	46,750	47,140	47,530	47,930	48,330	48,730	49,130	49,540	49,950	50,370	50,790	51,210	51,630	52,050	52,480	52
53	45,090	45,470	45,850	46,230	46,610	47,000	47,390	47,790	48,180	48,580	48,980	49,390	49,800	50,210	50,620	51,040	51,460	51,880	52,310	52,740	53,170	53
54	45,720	46,100	46,480	46,860	47,250	47,640	48,030	48,430	48,830	49,230	49,640	50,040	50,460	50,870	51,290	51,710	52,130	52,550	52,980	53,410	53,840	54
55	46,360	46,740	47,130	47,510	47,900	48,300	48,690	49,090	49,490	49,900	50,310	50,720	51,130	51,550	51,970	52,390	52,820	53,240	53,670	54,110	54,540	55
56	46,990	47,380	47,760	48,150	48,550	48,940	49,340	49,740	50,150	50,560	50,970	51,380	51,800	52,220	52,640	53,060	53,490	53,920	54,350	54,790	55,230	56
57	47,550	47,930	48,320	48,710	49,110	49,510	49,910	50,310	50,720	51,130	51,540	51,960	52,380	52,800	53,230	53,650	54,080	54,520	54,950	55,390	55,830	57
58	48,120	48,500	48,880	49,280	49,670	50,080	50,480	50,890	51,300	51,710	52,130	52,550	52,970	53,390	53,820	54,250	54,690	55,120	55,560	56,000	56,450	58
59	48,680	49,060	49,440	49,830	50,230	50,640	51,050	51,460	51,870	52,290	52,710	53,130	53,550	53,980	54,410	54,840	55,280	55,720	56,160	56,600	57,050	59
60	49,250	49,620	50,010	50,400	50,800	51,210	51,620	52,030	52,450	52,870	53,290	53,720	54,140	54,570	55,010	55,440	55,880	56,320	56,770	57,210	57,660	60
61	49,800	50,180	50,560	50,960	51,360	51,770	52,190	52,600	53,020	53,440	53,870	54,300	54,730	55,160	55,590	56,030	56,470	56,920	57,370	57,820	58,270	61
62	50,360	50,730	51,110	51,510	51,920	52,330	52,750	53,170	53,590	54,010	54,440	54,870	55,300	55,740	56,180	56,620	57,060	57,510	57,960	58,410	58,870	62
63	50,930	51,300	51,680	52,070	52,490	52,900	53,320	53,740	54,170	54,590	55,020	55,460	55,890	56,330	56,770	57,220	57,660	58,110	58,570	59,020	59,480	63
64	51,480	51,860	52,240	52,630	53,050	53,460	53,890	54,310	54,740	55,170	55,600	56,040	56,480	56,920	57,360	57,810	58,260	58,710	59,170	59,620	60,080	64
65	52,140	52,510	52,880	53,270	53,680	54,100	54,520	54,940	55,360	55,790	56,220	56,650	57,080	57,520	57,970	58,410	58,860	59,310	59,760	60,210	60,670	65
66	52,800	53,170	53,540	53,930	54,330	54,750	55,160	55,580	56,000	56,420	56,850	57,270	57,700	58,140	58,580	59,020	59,470	59,910	60,360	60,820	61,270	66
67	53,460	53,820	54,190	54,570	54,970	55,380	55,790	56,200	56,620	57,040	57,460	57,880	58,310	58,750	59,180	59,620	60,060	60,510	60,960	61,410	61,860	67
68	54,130	54,490	54,850	55,230	55,620	56,030	56,440	56,850	57,260	57,670	58,090	58,510	58,930	59,360	59,800	60,230	60,670	61,120	61,560	62,010	62,460	68
69	54,780	55,140	55,500	55,870	56,260	56,660	57,070	57,470	57,880	58,290	58,700	59,120	59,540	59,970	60,400	60,830	61,270	61,710	62,150	62,600	63,050	69
70	55,430	55,790	56,140	56,520	56,900	57,300	57,700	58,100	58,500	58,910	59,320	59,730	60,150	60,570	61,000	61,440	61,870	62,310	62,750	63,190	63,630	70
71	56,100	56,450	56,800	57,170	57,550	57,950	58,340	58,740	59,140	59,540	59,950	60,360	60,770	61,190	61,620	62,050	62,480	62,910	63,350	63,790	64,230	71
72	56,750	57,100	57,450	57,820	58,190	58,580	58,970	59,370	59,760	60,160	60,560	60,970	61,380	61,790	62,220	62,650	63,080	63,510	63,940	64,380	64,820	72
73	57,510	57,900	58,240	58,590	58,950	59,320	59,700	60,080	60,460	60,840	61,230	61,620	62,030	62,440	62,860	63,290	63,710	64,140	64,570	65,000	65,440	73
74	58,200	58,630	59,020	59,360	59,710	60,070	60,430	60,790	61,150	61,520	61,890	62,270	62,670	63,080	63,490	63,910	64,330	64,760	65,180	65,610	66,040	74
75	58,950	59,430	59,800	60,130	60,460	60,810	61,150	61,500	61,850	62,200	62,550	62,920	63,320	63,730	64,140	64,550	64,970	65,390	65,810	66,230	66,660	75
76	59,640	60,160	60,580	60,900	61,220	61,550	61,880	62,210	62,540	62,880	63,210	63,570	63,960	64,360	64,770	65,180	65,590	66,000	66,420	66,840	67,260	76
77	60,390	60,960	61,370	61,670	61,980	62,290	62,610	62,920	63,240	63,550	63,870	64,220	64,610	65,010	65,410	65,820	66,230	66,630	67,050	67,460	67,880	77
78	61,110	61,720	62,170	62,470	62,760	63,060	63,350	63,650	63,950	64,250	64,560	64,890	65,270	65,670	66,070	66,470	66,870	67,270	67,680	68,090	68,500	78
79	61,800	62,460	62,950	63,240	63,520	63,800	64,080	64,360	64,650	64,930	65,220	65,540	65,910	66,300	66,700	67,090	67,490	67,890	68,290	68,700	69,110	79
80	62,550	63,250	63,740	64,010	64,270	64,540	64,810	65,070	65,340	65,610	65,880	66,190	66,560	66,950	67,340	67,730	68,130	68,520	68,920	69,320	69,730	80

See special instruction for preventing gate overflow on page 3.

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1695.0	1695.1	1695.2	1695.3	1695.4	1695.5	1695.6	1695.7	1695.8	1695.9	1696.0	1696.1	1696.2	1696.3	1696.4	1696.5	1696.6	1696.7	1696.8	1696.9	1697.0	
81	62, 550	63, 250	63, 790	64, 120	64, 440	64, 760	65, 090	65, 410	65, 740	66, 070	66, 400	66, 760	67, 170	67, 610	68, 050	68, 480	68, 930	69, 370	69, 810	70, 260	70, 720	81
82	62, 550	63, 250	63, 790	64, 170	64, 550	64, 930	65, 310	65, 700	66, 080	66, 470	66, 860	67, 280	67, 740	68, 220	68, 710	69, 190	69, 680	70, 170	70, 670	71, 160	71, 670	82
83	62, 550	63, 250	63, 850	64, 290	64, 720	65, 160	65, 590	66, 040	66, 480	66, 920	67, 370	67, 840	68, 360	68, 880	69, 410	69, 950	70, 480	71, 020	71, 560	72, 110	72, 660	83
84	62, 550	63, 250	63, 850	64, 340	64, 830	65, 320	65, 820	66, 320	66, 820	67, 320	67, 830	68, 360	68, 930	69, 500	70, 080	70, 660	71, 240	71, 830	72, 420	73, 010	73, 610	84
85	62, 550	63, 250	63, 900	64, 450	65, 000	65, 550	66, 100	66, 660	67, 220	67, 780	68, 350	68, 930	69, 540	70, 160	70, 780	71, 410	72, 040	72, 680	73, 310	73, 950	74, 600	85
86	62, 550	63, 250	63, 900	64, 510	65, 110	65, 720	66, 330	66, 940	67, 560	68, 180	68, 810	69, 450	70, 110	70, 780	71, 450	72, 120	72, 800	73, 480	74, 170	74, 860	75, 560	86
87	62, 550	63, 250	63, 900	64, 560	65, 220	65, 880	66, 550	67, 220	67, 900	68, 580	69, 270	69, 970	70, 680	71, 390	72, 110	72, 830	73, 560	74, 290	75, 020	75, 760	76, 510	87
88	62, 550	63, 250	63, 960	64, 670	65, 390	66, 110	66, 830	67, 560	68, 300	69, 040	69, 790	70, 540	71, 290	72, 050	72, 810	73, 580	74, 360	75, 140	75, 920	76, 710	77, 500	88
89	62, 550	63, 250	63, 960	64, 670	65, 390	66, 110	66, 830	67, 560	68, 300	69, 040	69, 790	70, 540	71, 290	72, 050	72, 810	73, 580	74, 360	75, 140	75, 920	76, 710	77, 500	89
90	62, 550	63, 250	63, 960	64, 670	65, 390	66, 110	66, 830	67, 560	68, 300	69, 040	69, 790	70, 540	71, 290	72, 050	72, 810	73, 580	74, 360	75, 140	75, 920	76, 710	77, 500	90

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1697.0	1697.1	1697.2	1697.3	1697.4	1697.5	1697.6	1697.7	1697.8	1697.9	1698.0	1698.1	1698.2	1698.3	1698.4	1698.5	1698.6	1698.7	1698.8	1698.9	1699.0	
36																						36
37																						37
38																						38
39																						39
40	43, 140	43, 540	43, 940																			40
41	43, 960	44, 370	44, 770																			41
42	44, 780	45, 180	45, 590																			42
43	45, 600	46, 010	46, 420																			43
44	46, 420	46, 830	47, 240																			44
45	47, 240	47, 650	48, 070																			45
46	48, 080	48, 490	48, 910																			46
47	48, 890	49, 310	49, 730																			47
48	49, 710	50, 130	50, 560	50, 980	51, 410	51, 840	52, 280	52, 720	53, 160	53, 600	54, 040	54, 490	54, 940	55, 400	55, 850							48
49	50, 400	50, 820	51, 250	51, 680	52, 110	52, 540	52, 980	53, 420	53, 860	54, 310	54, 750	55, 200	55, 660	56, 110	56, 570							49
50	51, 100	51, 520	51, 950	52, 380	52, 820	53, 250	53, 690	54, 140	54, 580	55, 030	55, 480	55, 930	56, 390	56, 850	57, 310							50
51	51, 780	52, 210	52, 640	53, 080	53, 510	53, 950	54, 390	54, 840	55, 290	55, 740	56, 190	56, 650	57, 100	57, 560	58, 030							51
52	52, 480	52, 910	53, 350	53, 780	54, 220	54, 660	55, 110	55, 560	56, 010	56, 460	56, 920	57, 370	57, 830	58, 300	58, 760							52
53	53, 170	53, 600	54, 040	54, 480	54, 920	55, 360	55, 810	56, 260	56, 710	57, 170	57, 630	58, 090	58, 550	59, 020	59, 480							53
54	53, 840	54, 280	54, 720	55, 160	55, 610	56, 050	56, 500	56, 960	57, 410	57, 870	58, 330	58, 790	59, 260	59, 730	60, 200							54
55	54, 540	54, 980	55, 420	55, 870	56, 320	56, 770	57, 220	57, 670	58, 130	58, 590	59, 050	59, 520	59, 990	60, 460	60, 930							55
56	55, 230	55, 670	56, 110	56, 560	57, 010	57, 460	57, 920	58, 380	58, 840	59, 300	59, 760	60, 230	60, 700	61, 180	61, 650	62, 130	62, 610	63, 100	63, 580	64, 070	64, 570	56
57	55, 830	56, 280	56, 720	57, 170	57, 630	58, 080	58, 540	59, 000	59, 460	59, 930	60, 400	60, 870	61, 340	61, 820	62, 290	62, 780	63, 260	63, 750	64, 240	64, 730	65, 220	57
58	56, 450	56, 890	57, 340	57, 790	58, 250	58, 710	59, 170	59, 630	60, 100	60, 560	61, 030	61, 510	61, 980	62, 460	62, 940	63, 430	63, 920	64, 400	64, 900	65, 390	65, 890	58
59	57, 050	57, 500	57, 950	58, 410	58, 860	59, 320	59, 790	60, 250	60, 720	61, 190	61, 670	62, 140	62, 620	63, 100	63, 590	64, 070	64, 560	65, 050	65, 550	66, 040	66, 540	59
60	57, 660	58, 110	58, 570	59, 030	59, 490	59, 950	60, 420	60, 880	61, 360	61, 830	62, 310	62, 780	63, 270	63, 750	64, 240	64, 720	65, 220	65, 710	66, 210	66, 710	67, 210	60
61	58, 270	58, 720	59, 180	59, 640	60, 100	60, 570	61, 040	61, 510	61, 980	62, 460	62, 940	63, 420	63, 900	64, 390	64, 880	65, 370	65, 860	66, 360	66, 860	67, 360	67, 860	61
62	58, 870	59, 320	59, 780	60, 250	60, 710	61, 180	61, 650	62, 130	62, 600	63, 080	63, 560	64, 040	64, 530	65, 020	65, 510	66, 010	66, 500	67, 000	67, 500	68, 010	68, 510	62
63	59, 480	59, 940	60, 400	60, 870	61, 340	61, 810	62, 280	62, 760	63, 240	63, 720	64, 200	64, 690	65, 180	65, 670	66, 160	66, 660	67, 160	67, 660	68, 160	68, 670	69, 180	63
64	60, 080	60, 550	61, 010	61, 480	61, 950	62, 420	62, 900	63, 380	63, 860	64, 340	64, 830	65, 320	65, 810	66, 310	66, 800	67, 300	67, 800	68, 310	68, 810	69, 320	69, 840	64
65	60, 670	61, 130	61, 600	62, 070	62, 550	63, 020	63, 500	63, 990	64, 470	64, 960	65, 450	65, 940	66, 430	66, 930	67, 430	67, 930	68, 430	68, 940	69, 450	69, 960	70, 480	65
66	61, 270	61, 730	62, 200	62, 670	63, 150	63, 620	64, 110	64, 590	65, 080	65, 570	66, 060	66, 560	67, 050	67, 550	68, 060	68, 560	69, 070	69, 580	70, 090	70, 610	71, 120	66
67	61, 860	62, 320	62, 790	63, 260	63, 740	64, 220	64, 710	65, 200	65, 690	66, 180	66, 680	67, 170	67, 670	68, 180	68, 680	69, 190	69, 700	70, 210	70, 730	71, 250	71, 770	67
68	62, 460	62, 910	63, 380	63, 860	64, 340	64, 820	65, 310	65, 800	66, 300	66, 790	67, 290	67, 790	68, 290	68, 800	69, 310	69, 820	70, 330	70, 850	71, 370	71, 890	72, 410	68
69	63, 050	63, 500	63, 970	64, 450	64, 940	65, 420	65, 920	66, 410	66, 910	67, 400	67, 900	68, 410	68, 910	69, 420	69, 930	70, 450	70, 960	71, 480	72, 000	72, 530	73, 050	69
70	63, 630	64, 090	64, 550	65, 040	65, 530	66, 020	66, 510	67, 010	67, 510	68, 010	68, 510	69, 020	69, 530	70, 040	70, 550	71, 070	71, 590	72, 110	72, 640	73, 160	73, 690	70
71	64, 230	64, 680	65, 150	65, 630	66, 120	66, 620	67, 120	67, 610	68, 120	68, 620	69, 130	69, 640	70, 150	70, 660	71, 180	71, 700	72, 220	72, 750	73, 270	73, 800	74, 340	71
72	64, 820	65, 270	65, 740	66, 220	66, 720	67, 220	67, 720	68, 220	68, 730	69, 230	69, 740	70, 260	70, 770	71, 290	71, 810	72, 330	72, 850	73, 380	73, 910	74, 440	74, 980	72
73	65, 440	65, 890	66, 350	66, 830	67, 320	67, 810	68, 310	68, 800	69, 300	69, 800	70, 310	70, 820	71, 330	71, 840	72, 360	72, 880	73, 400	73, 920	74, 450	74, 980	75, 520	73
74	66, 040	66, 490	66, 950	67, 430	67, 910	68, 400	68, 890	69, 380	69, 870	70, 370	70, 870	71, 370	71, 880	72, 390	72, 900	73, 410	73, 930	74, 450	74, 970	75, 500	76, 040	74
75	66, 660	67, 100	67, 560	68, 030	68, 510	68, 990	69, 480	69, 960	70, 450	70, 940	71, 430	71, 940	72, 440	72, 940	73, 450	73, 960	74, 470	74, 990	75, 500	76, 040	76, 580	75
76	67, 260	67, 700	68, 160	68, 630	69, 100	69, 580	70, 050	70, 530	71, 020	71, 500	71, 990	72, 490	72, 990	73, 490	73, 990	74, 500	75, 000	75, 510	76, 020	76, 550	77, 100	76
77	67, 880	68, 320	68, 770	69, 240	69, 700	70, 170	70, 640	71, 120	71, 590	72, 070	72, 560	73, 050	73, 550	74, 040	74, 540	75, 040	75, 550	76, 050	76, 560	77, 090	77, 640	77
78	68, 500	68, 940	69, 390	69, 850	70, 310	70, 780	71, 240	71, 710	72, 180	72, 650	73, 130	73, 620	74, 110	74, 600	75, 100	75, 600	76, 100	76, 600	77, 100	77, 630	78, 180	78
79	69, 110	69, 540	69, 990	70, 450	70, 900	71, 360	71, 820	72, 280	72, 750	73, 210	73, 690	74, 170	74, 660	75, 150	75, 640	76, 130	76, 630	77, 120	77, 620	78, 140	78, 700	79
80	69, 730	70, 160	70, 610	71, 050	71, 500	71, 960	72, 410	72, 870	73, 320	73, 790	74, 260	74, 740	75, 220	75, 700	76, 190	76, 680	77, 170	77, 660	78, 160	78, 680	79, 240	80
81	70, 720	71, 150	71, 570	72, 000	72, 430	72, 860	73, 290	73, 720	74, 160	74, 600	75, 050	75, 530	76, 000	76, 480	76, 960	77, 440	77, 930	78, 410	78, 900	79, 410	79, 960	81
82	71, 670	72, 150	72, 600	73, 000	73, 410	73, 810	74, 220	74, 630	75, 040	75, 460	75, 890	76, 340	76, 810	77, 280	77, 760	78, 230	78, 710	79, 190	79, 670	80, 180	80, 720	82
83	72, 660	73, 140	73, 560	73, 950	74, 330	74, 720	75, 100	75, 490	75, 880	76, 270	76, 680	77, 130	77, 590	78, 060	78, 530	79, 000	79, 470	79, 940	80, 420	80, 910	81, 440	83
84	73, 610	74, 130	74, 590	74, 950	75, 310	75, 670	76, 030	76, 400	76, 760	77, 130	77, 520	77, 940	78, 400	78, 860	79, 320	79, 790	80, 250	80, 720	81, 190	81, 680	82, 190	84
85	74, 600	75, 130	75, 550	75, 890	76, 230	76, 570	76, 910	77, 250	77, 600	77, 940	78, 310	78, 730	79, 180	79, 640	80, 090	80, 550	81, 010	81, 470	81, 940	82, 410	82, 920	85

See special instruction for preventing gate overflow on page 3.

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1697.0	1697.1	1697.2	1697.3	1697.4	1697.5	1697.6	1697.7	1697.8	1697.9	1698.0	1698.1	1698.2	1698.3	1698.4	1698.5	1698.6	1698.7	1698.8	1698.9	1699.0	
86	75, 560	76, 120	76, 560	76, 870	77, 190	77, 510	77, 830	78, 150	78, 470	78, 790	79, 140	79, 530	79, 980	80, 430	80, 880	81, 330	81, 790	82, 240	82, 700	83, 170	83, 660	86
87	76, 510	77, 120	77, 580	77, 870	78, 170	78, 460	78, 760	79, 060	79, 350	79, 650	79, 970	80, 350	80, 790	81, 230	81, 680	82, 120	82, 570	83, 020	83, 470	83, 930	84, 410	87
88	77, 500	78, 110	78, 550	78, 820	79, 090	79, 370	79, 640	79, 910	80, 190	80, 460	80, 770	81, 130	81, 570	82, 010	82, 450	82, 890	83, 330	83, 770	84, 210	84, 670	85, 140	88
89	77, 500	78, 160	78, 660	79, 000	79, 340	79, 680	80, 020	80, 360	80, 710	81, 050	81, 420	81, 840	82, 320	82, 810	83, 300	83, 800	84, 290	84, 790	85, 290	85, 790	86, 310	89
90	77, 500	78, 160	78, 680	79, 090	79, 490	79, 900	80, 310	80, 720	81, 130	81, 550	81, 990	82, 470	83, 010	83, 550	84, 100	84, 640	85, 190	85, 740	86, 290	86, 850	87, 420	90
91	77, 500	78, 200	78, 790	79, 260	79, 740	80, 220	80, 690	81, 170	81, 650	82, 140	82, 640	83, 180	83, 770	84, 360	84, 960	85, 550	86, 150	86, 760	87, 360	87, 970	88, 590	91
92	77, 500	78, 200	78, 810	79, 350	79, 890	80, 440	80, 980	81, 530	82, 080	82, 640	83, 210	83, 820	84, 460	85, 100	85, 750	86, 400	87, 050	87, 710	88, 370	89, 030	89, 710	92
93	77, 500	78, 250	78, 920	79, 530	80, 140	80, 750	81, 370	81, 980	82, 600	83, 230	83, 860	84, 520	85, 210	85, 910	86, 610	87, 310	88, 020	88, 720	89, 440	90, 150	90, 880	93
94	77, 500	78, 250	78, 960	79, 640	80, 310	80, 990	81, 680	82, 360	83, 050	83, 740	84, 450	85, 170	85, 920	86, 660	87, 410	88, 170	88, 930	89, 690	90, 460	91, 230	92, 010	94
95	77, 500	78, 250	78, 980	79, 720	80, 470	81, 210	81, 970	82, 720	83, 480	84, 240	85, 020	85, 810	86, 610	87, 400	88, 210	89, 010	89, 830	90, 640	91, 460	92, 290	93, 120	95
96	77, 500	78, 290	79, 100	79, 900	80, 710	81, 530	82, 350	83, 170	84, 000	84, 830	85, 670	86, 510	87, 360	88, 210	89, 070	89, 930	90, 790	91, 660	92, 530	93, 410	94, 290	96

BLUE RIDGE DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	1699.0	1699.1	1699.2	1699.3	1699.4	1699.5	1699.6	1699.7	1699.8	1699.9	1700.0	1700.1	1700.2	1700.3	1700.4	1700.5	1700.6	1700.7	1700.8	1700.9	1701.0	
56	64, 570	65, 060	65, 560	66, 060																		56
57	65, 220	65, 720	66, 220	66, 720																		57
58	65, 890	66, 390	66, 890	67, 390																		58
59	66, 540	67, 040	67, 550	68, 060																		59
60	67, 210	67, 710	68, 220	68, 730																		60
61	67, 860	68, 370	68, 880	69, 390																		61
62	68, 510	69, 020	69, 540	70, 050																		62
63	69, 180	69, 690	70, 210	70, 720																		63
64	69, 840	70, 350	70, 870	71, 390	71, 910	72, 430	72, 960	73, 490	74, 020	74, 550	75, 090											64
65	70, 480	71, 000	71, 510	72, 040	72, 560	73, 090	73, 620	74, 150	74, 680	75, 220	75, 760											65
66	71, 120	71, 640	72, 170	72, 690	73, 220	73, 750	74, 280	74, 810	75, 350	75, 890	76, 430											66
67	71, 770	72, 290	72, 810	73, 340	73, 870	74, 400	74, 940	75, 480	76, 020	76, 560	77, 100											67
68	72, 410	72, 940	73, 460	73, 990	74, 530	75, 060	75, 600	76, 140	76, 680	77, 230	77, 780											68
69	73, 050	73, 580	74, 110	74, 650	75, 180	75, 720	76, 260	76, 800	77, 350	77, 900	78, 450											69
70	73, 690	74, 220	74, 760	75, 290	75, 830	76, 370	76, 910	77, 460	78, 010	78, 560	79, 110											70
71	74, 340	74, 870	75, 410	75, 940	76, 490	77, 030	77, 580	78, 120	78, 670	79, 230	79, 780											71
72	74, 980	75, 510	76, 050	76, 600	77, 140	77, 690	78, 240	78, 790	79, 340	79, 900	80, 450											72
73	75, 520	76, 060	76, 600	77, 140	77, 690	78, 240	78, 790	79, 350	79, 900	80, 460	81, 020											73
74	76, 040	76, 580	77, 120	77, 670	78, 220	78, 770	79, 330	79, 880	80, 440	81, 000	81, 570											74
75	76, 580	77, 120	77, 670	78, 220	78, 770	79, 330	79, 880	80, 440	81, 000	81, 570	82, 130											75
76	77, 100	77, 650	78, 200	78, 750	79, 300	79, 860	80, 420	80, 980	81, 550	82, 110	82, 680											76
77	77, 640	78, 190	78, 740	79, 300	79, 850	80, 410	80, 980	81, 540	82, 110	82, 680	83, 250											77
78	78, 180	78, 730	79, 290	79, 840	80, 400	80, 970	81, 530	82, 100	82, 670	83, 240	83, 810											78
79	78, 700	79, 250	79, 810	80, 370	80, 930	81, 500	82, 070	82, 640	83, 210	83, 780	84, 360											79
80	79, 240	79, 790	80, 360	80, 920	81, 490	82, 050	82, 620	83, 200	83, 770	84, 350	84, 930											80
81	79, 960	80, 510	81, 070	81, 620	82, 180	82, 740	83, 310	83, 870	84, 440	85, 010	85, 580											81
82	80, 720	81, 260	81, 810	82, 350	82, 910	83, 460	84, 010	84, 570	85, 130	85, 700	86, 260											82
83	81, 440	81, 980	82, 520	83, 060	83, 600	84, 150	84, 700	85, 250	85, 800	86, 360	86, 920											83
84	82, 190	82, 720	83, 250	83, 790	84, 330	84, 860	85, 410	85, 950	86, 490	87, 040	87, 600											84
85	82, 920	83, 440	83, 970	84, 490	85, 020	85, 560	86, 090	86, 620	87, 160	87, 710	88, 260											85
86	83, 660	84, 180	84, 690	85, 210	85, 740	86, 260	86, 790	87, 310	87, 840	88, 380	88, 920											86
87	84, 410	84, 920	85, 430	85, 940	86, 460	86, 980	87, 490	88, 010	88, 540	89, 060	89, 600											87
88	85, 140	85, 640	86, 140	86, 650	87, 160	87, 670	88, 180	88, 690	89, 200	89, 730	90, 260											88
89	86, 310	86, 860	87, 400	87, 880	88, 360	88, 850	89, 330	89, 810	90, 300	90, 800	91, 300											89
90	87, 420	88, 020	88, 610	89, 060	89, 510	89, 970	90, 430	90, 890	91, 350	91, 810	92, 290											90
91	88, 590	89, 240	89, 860	90, 290	90, 720	91, 150	91, 580	92, 010	92, 440	92, 880	93, 320											91
92	89, 710	90, 400	91, 070	91, 470	91, 870	92, 270	92, 680	93, 080	93, 490	93, 900	94, 310											92
93	90, 880	91, 620	92, 330	92, 700	93, 080	93, 450	93, 830	94, 210	94, 590	94, 970	95, 350											93
94	92, 010	92, 790	93, 550	93, 970	94, 320	94, 670	95, 020	95, 370	95, 720	96, 070	96, 430											94
95	93, 120	93, 960	94, 750	95, 150	95, 470	95, 800	96, 120	96, 440	96, 770	97, 090	97, 420											95
96	94, 290	95, 180	96, 010	96, 380	96, 680	96, 980	97, 270	97, 570	97, 860	98, 160	98, 450											96

See special instruction for preventing gate overflow on page 3.

PART 2

LOW-LEVEL OUTLET DISCHARGE TABLES

APRIL 2008

INSTRUCTIONS FOR USE OF TABLES

The spillway and low-level outlet may be used in conjunction with either or both generating units. Selection of spillway or low-level outlet should be based on multipurpose operating objectives.

1. New Tables

These three tables, which are identical to those issued in August 2005 and January 2007, are the first that have been prepared for the low-level outlet at Blue Ridge Dam. Two tables provide discharges for separate operation of the 24-inch and 72-inch cone valves. A third table provides discharge for an additional case in which both valves are open to their maximum discharge position.

The computer code SPILLQ generated the tabulated discharges, which are based on piezometer and current-meter traverse data collected during field tests conducted in December 2004.

2. Purpose of Tables

These tables provide a means of setting up or determining the discharge through the 24-inch and 72-inch cone valves in the low-level outlet at Blue Ridge Dam. They give the total discharge in cubic feet per second through each valve for various headwater elevations and gate opening positions.

3. Low-Level Outlet Operation

Discharge is passed through the low-level outlet using the 24-inch cone valve alone, the 72-inch cone valve alone, or both valves opened to their maximum discharge positions. For both valves, the maximum discharge occurs at the 95-percent opening. Total discharge is unavailable for any other operation alternatives (for example, both valves open to 50 percent).

The 24-inch cone valve should be used for all discharges up to its maximum capacity, which ranges from 105 cubic feet per second at headwater elevation 1610 feet to 185 cubic feet per second at headwater elevation 1700 feet. Openings for the 24-inch cone valve range from 5 percent to 95 percent in 5-percent intervals. When the desired discharge exceeds the capacity of the 24-inch cone valve, this valve should be closed. The 72-inch cone valve should then be used for all discharges up to its maximum capacity, which ranges from 1,160 cubic feet per second at headwater elevation 1620 feet to 1,830 cubic feet per second at headwater elevation 1700 feet. Openings for the 72-inch cone valve range from 8 percent to 30 percent in 2-percent intervals and from 30 percent to 95 percent in 5 percent intervals. The 72-inch cone valve should not be operated at openings less than 8 percent nor at headwater elevations less than 1620 feet.

In rare occasions, the discharges listed for the 95-percent opening position of the 72-inch cone valve may be less than desired. In these cases, both the 24-inch and 72-inch cone valves may be opened to the 95-percent opening position to achieve a higher total discharge. This configuration provides discharges ranging from 1,250 cubic feet per second at headwater elevation 1620 feet to 1,970 cubic feet per second at headwater elevation 1700 feet. Because flow to both valves passes through a common tunnel from the reservoir, the total discharge with both valves opened to 95 percent is not equal to the sum of the discharges passed by the valves operating alone and opened to 95 percent.

4. Arrangement of Tables

The discharge tables show discharges in cubic feet per second for each 5-foot interval of headwater elevation and for various valve opening percentages. Valve opening percentages are listed in the left column (except for the combined discharge table where valve opening is part of the title). Headwater elevations are shown at the top of each column.

Discharges are recorded to the nearest 5 cubic feet per second for discharges less than 200 cubic feet per second and to the nearest 10 cubic feet per second for discharges greater than 200 cubic feet per second. Because the accuracy of the field measurements does not warrant greater refinement, there should be no interpolation between values given in these tables.

The headwater elevations used in these tables are those given by the indicator in the control room. The valve opening positions used in these tables are those indicated by the indicator on the valve control mechanism.

5. Use of Tables

When the tables do not include the exact headwater elevation, the discharge for the closest headwater elevation is used. For example, the column headed 1655 should be used for actual headwater elevations between 1652.5 feet and 1657.4 feet inclusive. When the actual headwater elevation is exactly halfway between tabular values, the larger value is used.

For example, if the headwater elevation is 1654.2 feet and the 72-inch cone valve is set to 90 percent open, the discharge is 1,430 cubic feet per second as found in the column headed 1655 in the table for the 72-inch cone valve.

BLUE RIDGE DAM

LOW LEVEL OUTLET DISCHARGE FROM 24-INCH CONE VALVE

IN CUBIC FEET PER SECOND

VALVE OPENING PERCENT	HEADWATER ELEVATION																					VALVE OPENING PERCENT
	1600	1605	1610	1615	1620	1625	1630	1635	1640	1645	1650	1655	1660	1665	1670	1675	1680	1685	1690	1695	1700	
5			5	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	5
10			15	15	15	15	15	15	20	20	20	20	20	20	20	20	20	25	25	25	25	10
15			20	20	25	25	25	25	25	30	30	30	30	30	30	35	35	35	35	35	35	15
20			30	30	30	30	35	35	35	35	40	40	40	40	45	45	45	45	45	50	50	20
25			35	35	40	40	40	45	45	45	50	50	50	50	55	55	55	55	60	60	60	25
30			40	45	45	50	50	50	55	55	55	60	60	60	65	65	65	70	70	70	70	30
35			50	50	55	55	60	60	60	65	65	70	70	70	75	75	75	80	80	80	85	35
40			55	55	60	65	65	70	70	75	75	75	80	80	85	85	85	90	90	95	95	40
45			60	65	65	70	75	75	80	80	85	85	90	90	95	95	100	100	100	105	105	45
50			65	70	75	80	80	85	85	90	95	95	100	100	105	105	110	110	115	115	120	50
55			70	75	80	85	90	90	95	95	100	105	105	110	110	115	115	120	120	125	125	55
60			80	80	85	90	95	100	100	105	110	110	115	115	120	125	125	130	130	135	135	60
65			85	90	90	95	100	105	110	110	115	120	120	125	130	130	135	135	140	145	145	65
70			85	90	95	100	105	110	115	115	120	125	130	130	135	140	140	145	145	150	155	70
75			90	95	100	105	110	115	120	125	125	130	135	140	140	145	150	150	155	155	160	75
80			95	100	105	110	115	120	125	130	135	135	140	145	150	150	155	160	160	165	170	80
85			100	105	110	115	120	125	130	135	140	140	145	150	155	160	160	165	170	170	175	85
90			105	110	115	120	125	130	135	140	145	150	150	155	160	165	165	170	175	180	180	90
95			105	115	120	125	130	135	140	145	150	150	155	160	165	170	170	175	180	185	185	95

These discharges assume that the 72-inch cone valve is closed.

BLUE RIDGE DAM

LOW LEVEL OUTLET DISCHARGE FROM 72-INCH CONE VALVE

IN CUBIC FEET PER SECOND

VALVE OPENING PERCENT	HEADWATER ELEVATION																					VALVE OPENING PERCENT
	1600	1605	1610	1615	1620	1625	1630	1635	1640	1645	1650	1655	1660	1665	1670	1675	1680	1685	1690	1695	1700	
8					145	150	160	165	170	175	180	185	190	195	200	210	210	220	220	220	230	8
10					180	190	195	200	210	220	230	230	240	250	250	260	260	270	280	280	290	10
12					210	220	230	240	250	260	270	270	280	290	300	300	310	320	320	330	340	12
14					240	260	270	280	290	300	310	310	320	330	340	350	360	360	370	380	390	14
16					280	290	300	310	320	330	340	360	370	370	380	390	400	410	420	430	440	16
18					310	320	340	350	360	370	380	400	410	420	430	440	450	460	470	480	490	18
20					340	360	370	380	400	410	420	440	450	460	470	480	490	510	520	530	540	20
22					370	390	400	420	430	450	460	470	490	500	510	520	540	550	560	570	580	22
24					400	420	430	450	470	480	500	510	530	540	550	570	580	590	600	620	630	24
26					430	450	460	480	500	520	530	550	560	580	590	610	620	640	650	660	670	26
28					460	480	500	520	530	550	570	590	600	620	630	650	660	680	690	710	720	28
30					480	510	530	550	570	590	610	620	640	660	670	690	710	720	740	750	770	30
35					550	580	600	620	650	670	690	710	730	750	770	780	800	820	840	850	870	35
40					620	640	670	700	720	750	770	790	810	840	860	880	900	920	940	960	970	40
45					680	710	740	760	790	820	840	870	890	920	940	960	980	1,010	1,030	1,050	1,070	45
50					730	770	800	830	860	890	920	940	970	1,000	1,020	1,050	1,070	1,090	1,120	1,140	1,160	50
55					790	830	860	890	930	960	990	1,020	1,040	1,070	1,100	1,120	1,150	1,180	1,200	1,220	1,250	55
60					840	880	920	960	990	1,020	1,050	1,090	1,120	1,150	1,170	1,200	1,230	1,260	1,280	1,310	1,330	60
65					890	930	970	1,010	1,040	1,080	1,110	1,150	1,180	1,210	1,240	1,270	1,300	1,330	1,350	1,380	1,410	65
70					940	980	1,020	1,060	1,100	1,140	1,170	1,210	1,240	1,270	1,310	1,340	1,370	1,400	1,430	1,450	1,480	70
75					980	1,030	1,070	1,110	1,150	1,190	1,230	1,270	1,300	1,330	1,370	1,400	1,430	1,460	1,490	1,520	1,550	75
80					1,030	1,080	1,120	1,160	1,210	1,250	1,290	1,320	1,360	1,400	1,430	1,470	1,500	1,530	1,560	1,590	1,630	80
85					1,070	1,120	1,170	1,210	1,260	1,300	1,340	1,380	1,420	1,450	1,490	1,530	1,560	1,590	1,630	1,660	1,690	85
90					1,110	1,170	1,210	1,260	1,310	1,350	1,390	1,430	1,470	1,510	1,550	1,590	1,620	1,660	1,690	1,730	1,760	90
95					1,160	1,210	1,260	1,310	1,360	1,400	1,450	1,490	1,530	1,570	1,610	1,650	1,690	1,720	1,760	1,790	1,830	95

These discharges assume that the 24-inch cone valve is closed.

BLUE RIDGE DAM LOW LEVEL OUTLET

COMBINED DISCHARGE, BOTH VALVES 95 PERCENT OPEN

IN CUBIC FEET PER SECOND

HEADWATER ELEVATION																
1620	1625	1630	1635	1640	1645	1650	1655	1660	1665	1670	1675	1680	1685	1690	1695	1700
1,250	1,300	1,360	1,410	1,460	1,510	1,560	1,600	1,650	1,690	1,730	1,770	1,810	1,850	1,890	1,930	1,970

C. HYDRAULICS OF CONTROL STRUCTURES

9.10. ***Shape for Uncontrolled Ogee Crest.***—As discussed in section 9.8(c), crest shapes that approximate the profile of the undernappe of a jet flowing over a sharp-crested weir provide the ideal form for obtaining optimum discharges. The shape of such a profile depends upon the head, the inclination of the upstream face of the overflow section, and the height of the overflow section above the floor of the entrance channel (which influences the velocity of approach to the crest). Crest shapes have been studied extensively in the Bureau of Reclamation hydraulics laboratories, and data from which profiles for overflow crests can be obtained have been published [18]. For most conditions the data can be summarized according to the form shown on figure 9-21(A), where the profile is defined as it relates to axes at the apex of the crest. That portion upstream from the origin is defined as either a single curve and a tangent or as a compound circular curve. The portion downstream is defined by the equation:

$$\frac{y}{H_o} = -K\left(\frac{x}{H_o}\right)^n \qquad (2)$$

in which K and n are constants whose values depend on the upstream inclination and on the velocity of approach. Figure 9-21 gives values of these constants for different conditions.

The approximate profile shape for a crest with a vertical upstream face and negligible velocity of approach is shown on figure 9-22. The profile is constructed in the form of a compound circular curve with radii expressed in terms of the design head, H_o. This definition is simpler than that shown on figure 9-21, because it avoids the need for solving an exponential equation; furthermore, it is represented in a form easily used by a layman for constructing forms or templates. For ordinary design conditions for small spillways where the approach height, P, is equal to or greater than one-half the maximum head on the crest, this profile is sufficiently accurate to avoid seriously reduced crest pressures and does not materially alter the hydraulic efficiency of the crest. When the approach height is less than one-half the maximum head on the crest, the profile should be determined from figure 9-21.

9.11. ***Discharge Over an Uncontrolled Overflow Ogee Crest.***—(a) *General.*—The discharge over an ogee crest is given by the equation:

$$Q = CLH_e^{3/2} \qquad (3)$$

where:

Q = discharge,
C = variable discharge coefficient,
L = effective length of crest, and
H_e = actual head being considered on the crest, including velocity of approach head, h_a.

The discharge coefficient, C, is influenced by a number of factors, such as (1) the depth of approach, (2) relation of the actual crest shape to the ideal nappe shape, (3) upstream face slope, (4) downstream apron interference, and (5) downstream submergence. The effect of these various factors is discussed in section 9.12.

The total head on the crest, H_e, does not include allowances for approach channel friction losses or other losses caused by the curvature of the upstream channel, entrance loss into the inlet section, and inlet or transition losses. Where the design of the approach channel results in appreciable losses, they must be added to H_e to determine reservoir elevations corresponding to the discharges given by equation (3).

(b) *Pier and Abutment Effects.*—Where crest piers and abutments are shaped to cause side contractions of the overflow, the effective length, L, is less than the net length of the crest. The effect of the end contraction may be taken into account by reducing the net crest length as follows:

$$L = L' - 2(NK_p + K_a)H_e \qquad (4)$$

where:

L = effective length of crest,
L' = net length of crest,
N = number of piers,
K_p = pier contraction coefficient
K_a = abutment contraction coefficient, and
H_e = actual head on crest.

The pier contraction coefficient, K_p, is affected by the shape and location of the pier nose, the thickness of the pier, the design head, and the approach velocity. For conditions of design head, H_o, average pier contraction coefficients may be assumed as follows:

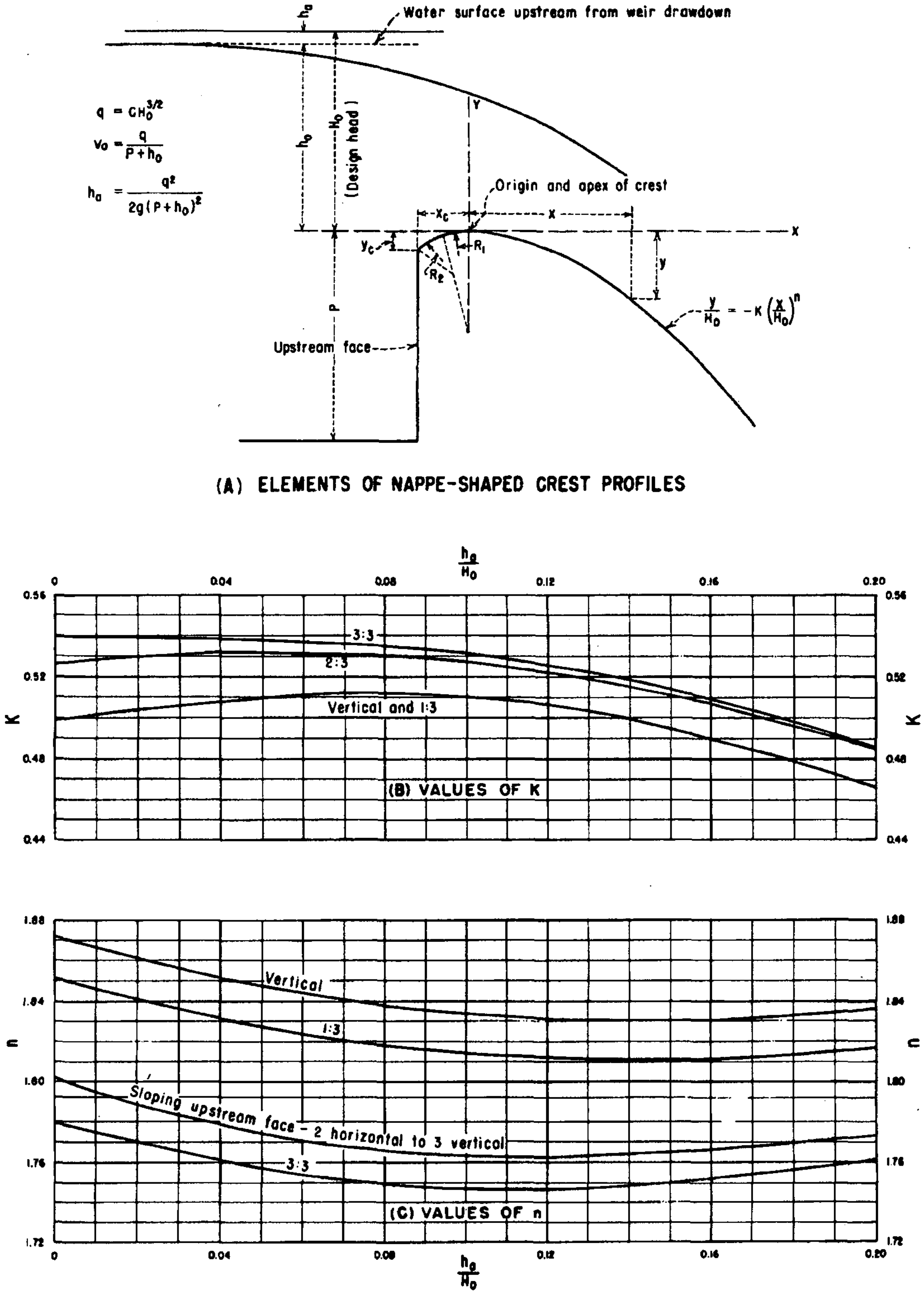


Figure 9-21.—Factors for definition of nappe-shaped crest profiles. 288-D-2406. (Sheet 1 of 2).

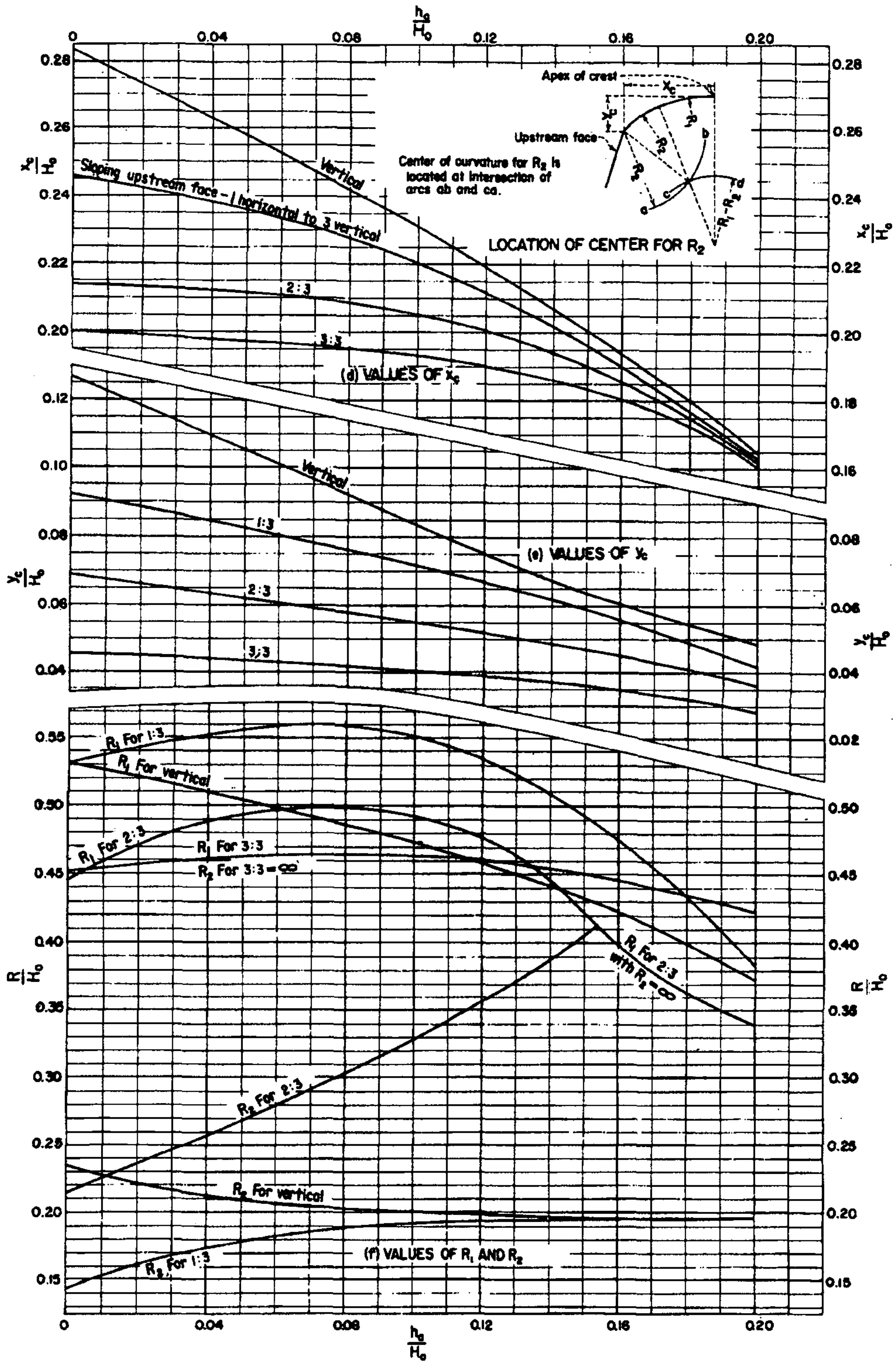


Figure 9-21.—Factors for definition of nappe-shaped crest profiles. 288-D-2407. (Sheet 2 of 2).

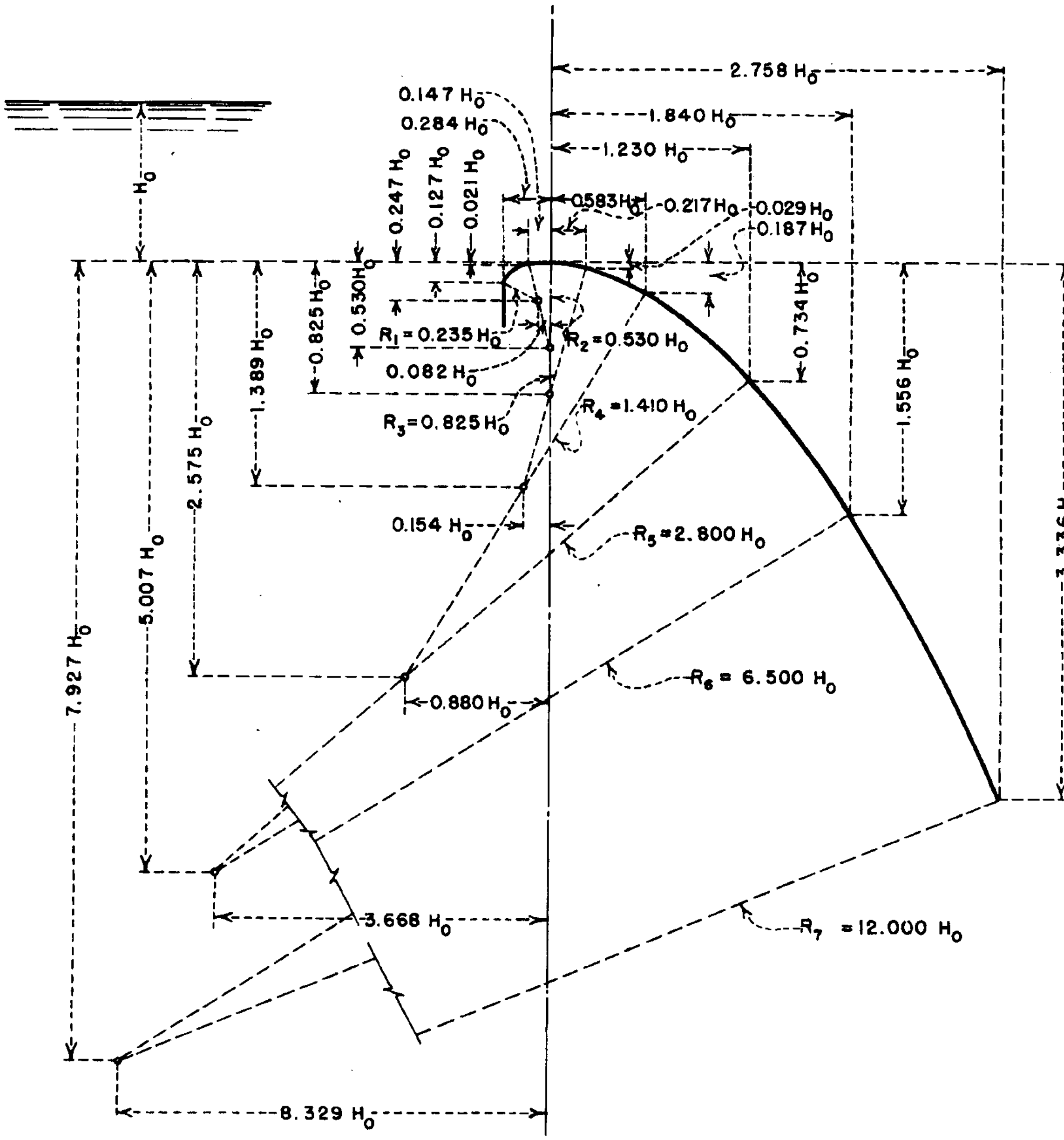


Figure 9-22.—Ogee crest shape defined by compound curves. 288-D-2408.

- For square-nosed piers with corners rounded on a radius equal to about 0.1 of the pier thickness: K_p = 0.02
- For round-nosed piers: K_p = 0.01
- For pointed-nose piers: K_p = 0.0

The abutment contraction coefficient is affected by the shape of the abutment, the angle between the upstream approach wall and the axis of the flow, the head in relation to the design head, and the approach velocity. For conditions of design head, H_o, average coefficients may be assumed as follows:

- For square abutments with headwall at 90° to direction of flow: K_a = 0.20
- For rounded abutments with headwall at 90°

to direction of flow, when $0.5H_o \leq r \leq 0.15H_o$: $K_a = 0.10$

- For rounded abutments where $r > 0.5H_o$ and headwall is placed not more than 45° to direction of flow: $K_a = 0.0$

where r = radius abutment rounding.

9.12. Discharge Coefficient for Uncontrolled Ogee Crests.—(a) *Effect of Depth of Approach.*—For a high sharp-crested weir placed in a channel, the velocity of approach is small and the underside of the nappe flowing over the weir attains maximum vertical contraction. As the approach depth is decreased, the velocity of approach increases and the vertical contraction diminishes. For sharp-crested wiers whose heights are not less than about one-fifth the heads producing flow over them, the discharge coefficient remains fairly constant with a value of about 3.3, although the contraction diminishes. For weir heights less than about one-fifth the head, the contraction of the flow becomes increasingly suppressed and the crest coefficient decreases. When the weir height becomes zero, the contraction is entirely suppressed and the overflow weir becomes, in effect, a channel or a broad-crested weir, for which the theoretical discharge coefficient is 3.087. If the sharp-crested weir coefficients are related to the head measured from the point of maximum contraction instead of to the head above the sharp crest, coefficients applicable to ogee crests shaped to profiles of undernappes for various approach velocities can be established. The relationship of the ogee crest coefficient, C_o, to various values of P/H_o is shown on figure 9-23. These coefficients are valid only when the ogee is formed to the ideal nappe shape; that is, when $H_e/H_o = 1$.

(b) *Effect of Heads Different from Design Head.*—When the ogee crest shape is different from the ideal shape or when the crest has been shaped for a head larger or smaller than the one under consideration, the discharge coefficient will differ from that shown on figure 9-23. A wider shape will result in positive pressures along the crest contact surface, thereby reducing the discharge. With a narrower crest shape, negative pressures along the contact surface will occur, resulting in an increased discharge. Figure 9-24 shows the variation of the coefficient as related to values of H_e/H_o, where H_e is the actual head being considered.

An approximate discharge coefficient for an irregularly shaped crest whose profile has not been formed according to the undernappe of the overflow jet can be estimated by finding the ideal shape that most nearly matches it. The design head, H_o, corresponding to the matching shape can then be used as a basis for determining the coefficients [19].

The coefficients for partial heads on the crest, for preparing a discharge-head relationship, can be determined from figure 9-24.

(c) *Effect of Upstream Face Slope.*—For small ratios of the approach depth to the head on the crest, sloping the upstream face of the overflow results in an increase in the discharge coefficient. For large ratios the effect is a decrease in the coefficient. Within the range considered in this text, the discharge coefficient is reduced for large ratios of P/H_o only for relatively flat upstream slopes. Figure 9-25 shows the ratio for the coefficient for an overflow ogee crest with a sloping (inclined) face, C_i, to the coefficient for a crest with a vertical upstream face, C_v, as obtained from figure 9-23 (and as adjusted by figure 9-24 if appropriate), as related to values of P/H_o.

(d) *Effect of Downstream Apron Interference and Downstream Submergence.*—When the water level below an overflow weir is high enough to affect the discharge, the weir is said to be submerged. The vertical distance from the crest of the overflow to the downstream apron and the depth of flow in the downstream channel, as it relates to the head pool level, are factors that alter the discharge coefficient.

Five distinct characteristic flows can occur below an overflow crest, depending on the relative positions of the apron and the downstream water surface: (1) flow can continue at supercritical stage; (2) a partial or incomplete hydraulic jump can occur immediately downstream from the crest; (3) a true hydraulic jump can occur; (4) a drowned jump can occur in which the high-velocity jet will follow the face of the overflow and then continue in an erratic and fluctuating path for a considerable distance under and through the slower water; and (5) no jump may occur—the jet will break away from the face of the overflow and ride along the surface for a short distance and then erratically intermingle with the slow moving water underneath. Figure 9-26 shows the relationship of the floor positions and downstream submergences that produce these distinctive flows.

Where the downstream flow is at supercritical stage or where the hydraulic jump occurs, the decrease in the discharge coefficient is principally caused by the back-pressure effect of the downstream apron and is independent of any submergence effect from the tailwater. Figure 9-27 shows the effect of downstream apron conditions on the discharge coefficient. It should be noted that this curve plots, in a slightly different form, the same data represented by the vertical dashed lines on figure 9-26. As the downstream apron level nears the crest of the overflow, $(h_d + d)/H_e$ approaches 1.0, and the discharge coefficient is about 77 percent of the coefficient for unretarded flow. On the basis of a coefficient of 4.0 for unretarded flow over a high weir, the coefficient when the weir is submerged will be about 3.08, which is virtually the coefficient for a broad-crested weir.

From figure 9-26, it can be seen that when $(h_d + d)/H_e$ exceeds about 1.7, the downstream floor position has little effect on the coefficient, but there is a decrease in the coefficient caused by tailwater submergence. Figure 9-28 shows the ratio of the discharge coefficient where affected by tailwater conditions to the coefficient for free flow conditions. This curve plots, in a slightly different form, the data represented by the horizontal dashed lines on figure 9-26. Where the dashed lines on figure 9-26 are curved, the decrease in the coefficient is the result of a combination of tailwater effects and downstream apron position.

9.13. Examples of Designs of Uncontrolled Ogee Crests.—The two examples cited below illustrate the methods of designing uncontrolled ogee crests, including the computation of approach channel losses and velocity head, the determination of the total length of the crest, and the correction of the discharge coefficient for various effects.

(a) *Example 1.*—Design an uncontrolled overflow ogee crest for a chute spillway that will discharge 2,000 ft³/s at a 5-foot head, and prepare a discharge-head curve. The upstream face of the

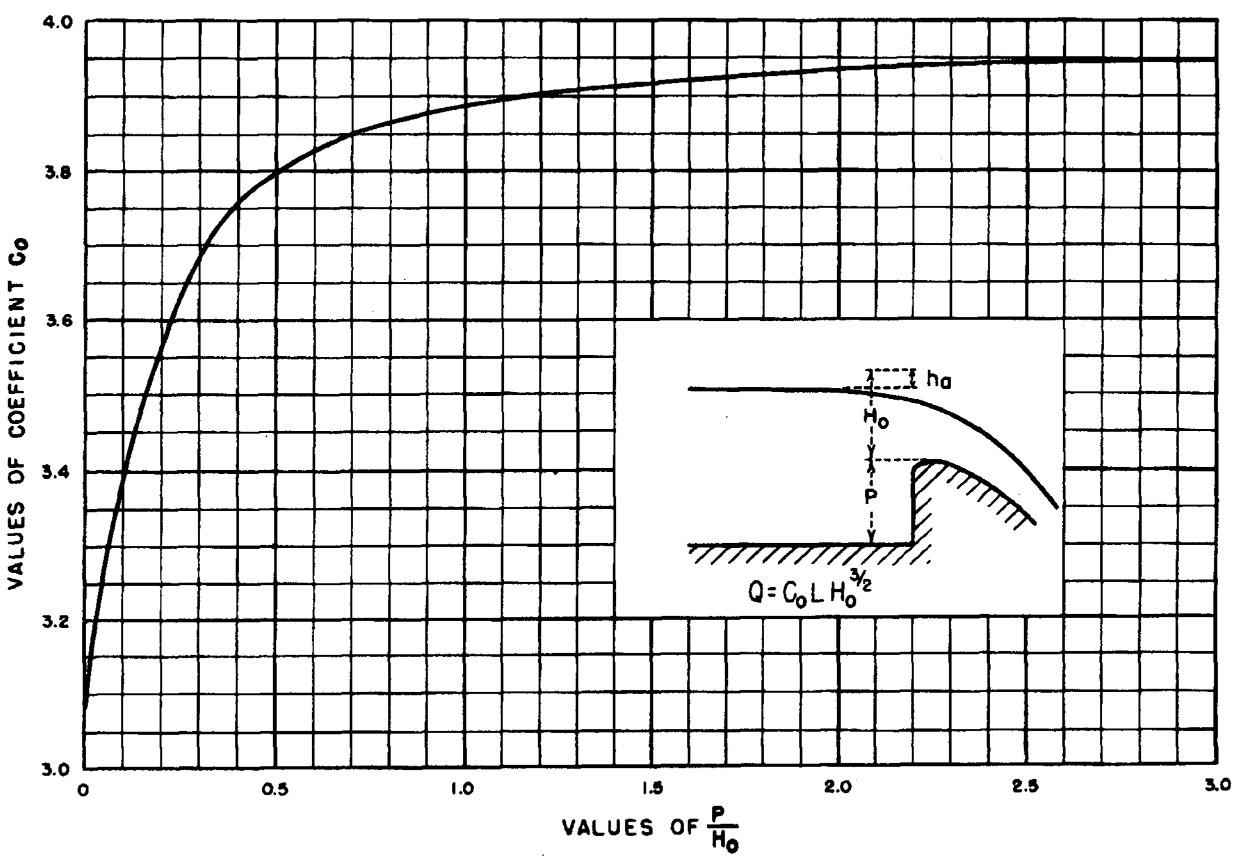


Figure 9-23.—Discharge coefficients for vertical-faced ogee crest. 288-D-2409.

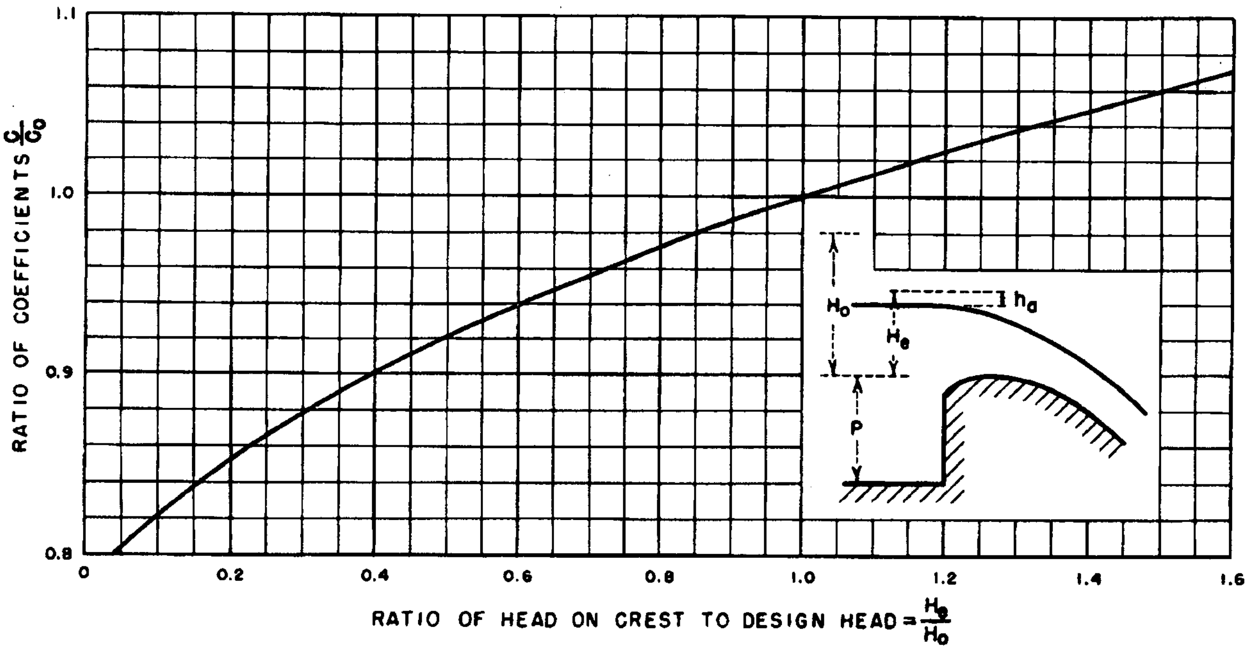


Figure 9-24.—Discharge coefficients for other than the design head. 288-D-2410.

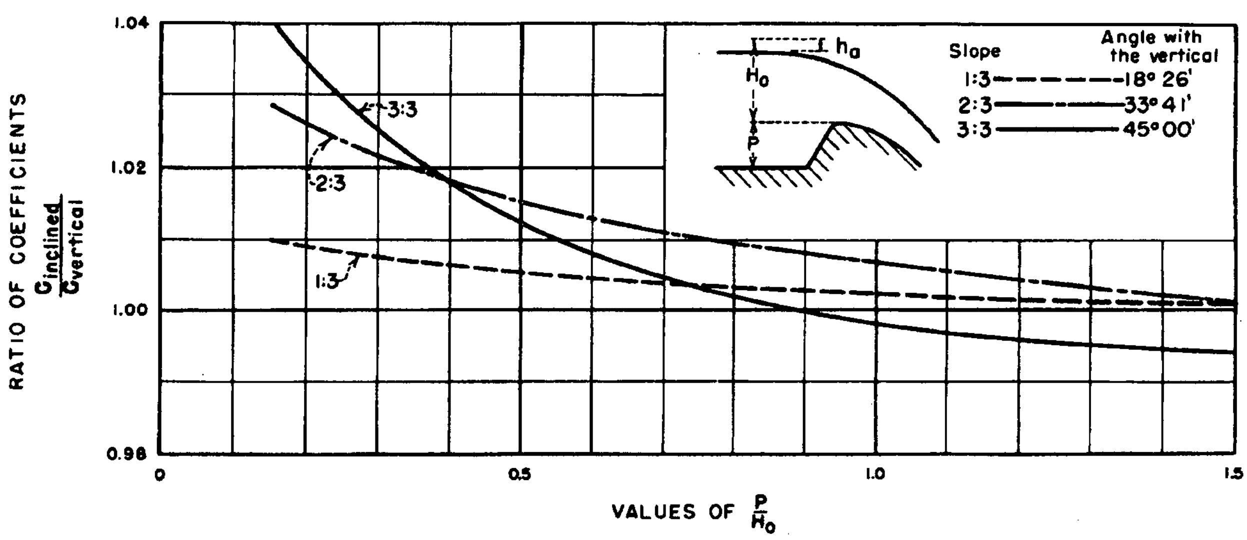
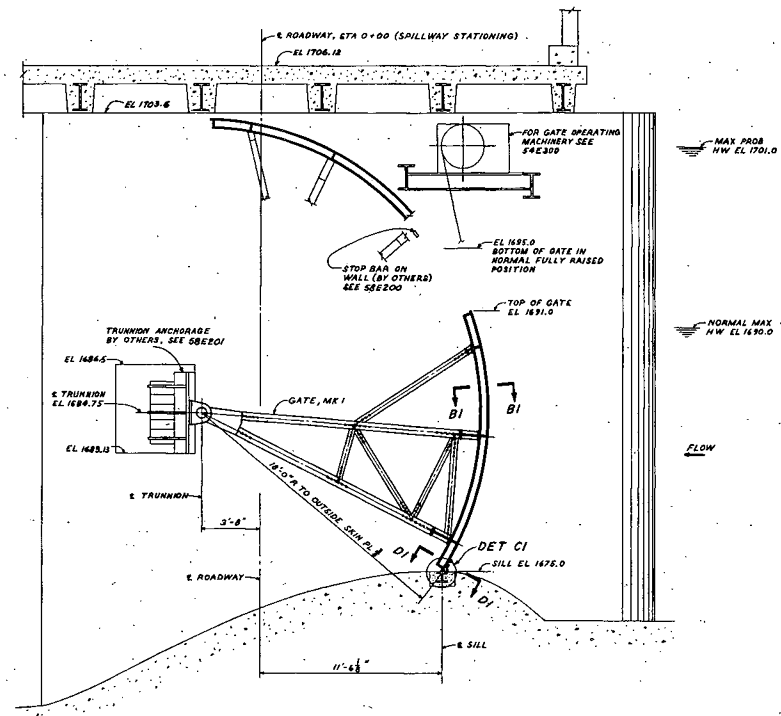


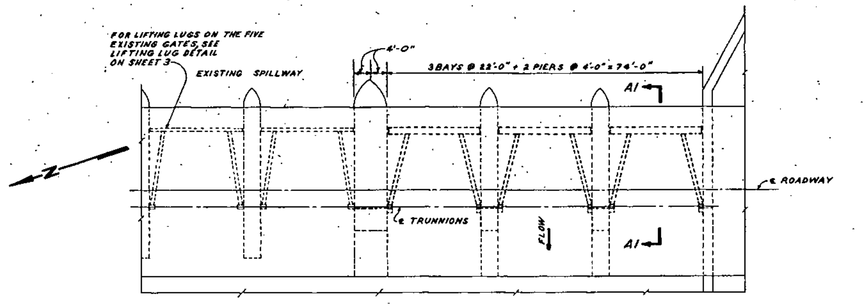
Figure 9-25.—Discharge coefficients for ogee-shaped crest with sloping upstream face. 288-D-2411.

crest is sloped 1:1, and the entrance channel is 100 feet long. A bridge is to span the crest, and 18-inch-wide bridge piers with rounded noses are to be provided. The bridge spans are not to exceed 20 feet. The abutment walls are rounded to a 5-foot radius, and the approach walls are to be placed at 30° with the centerline of the spillway entrance.

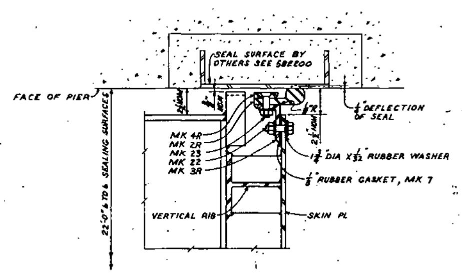
To solve the problem, either the approach depth and apron position with respect to the crest must be selected and the appropriate coefficient determined, or an arbitrary coefficient must be selected and the appropriate dimensions determined. The



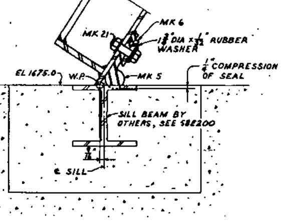
A1-A1
$\frac{3}{8}$"=1'-0"



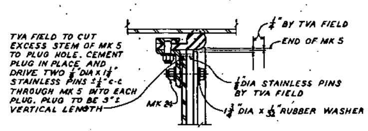
KEY PLAN
1"=10'-0"



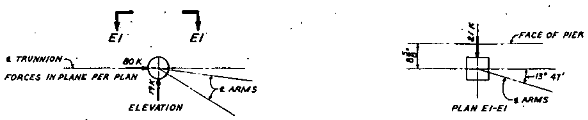
B1-B1



DET C1



D1-D1



TRUNNION LOADING DIAGRAM
MAX LOADS FOR ONE TRUNNION WITH H.W. @ EL 1690.0
NTS

GENERAL NOTES:

1. MARK NUMBERS ON DRAWINGS HAVE PREFIX 54E200.
2. QUANTITIES OF ITEMS SHOWN ON DRAWINGS ARE FOR THREE GATES.
3. STRUCTURAL STEEL ASTM A441 OR A588 UNLESS NOTED. SEE SPECIFICATION FOR SPECIFIC MATERIAL LISTING.
4. THREADS ANSI COURSE-THREAD SERIES CLASS 2A FIT FOR BOLTS AND CLASS 2B FIT FOR NUTS UNLESS OTHERWISE NOTED.
5. GATE WATERTIGHT AGAINST HW PRESSURE.
6. WELD METAL AWS 5.1, E70 SERIES.
7. BOLT HEADS AND NUTS ANSI REGULAR SEMI FINISHED HEXAGON, UNLESS OTHERWISE NOTED

FIELD NOTES:

1. TVA FIELD TO FURNISH AND INSTALL ALL NORDBAK, ASPHALT FELT, FILLER PLATES MK 27, AND ALL STEEL BARS AND STRIPS SHOWN IN SECTIONS A5-A5, C5-C5, AND D5-D5.
2. TRUNNIONS SET ACCORDING TO SKIN PLATE CLEARANCE DIMENSIONS AND SIDE SEAL DEFLECTION SHOWN IN SECTION B1-B1.
3. STEEL STRIPS FOR RETAINING NORDBAK WELDED TO TRUNNION SHOE, MK 8, AS SHOWN IN SECTION C5-C5.
4. AFTER HARDENING OF NORDBAK FILLER, SETSCREWS (MK 9) TO BE BACKED OUT SLIGHTLY AND BOLTS (MK 15) RE-TIGHTENED TO ADJUST FOR NORDBAK SHRINKAGE.
5. FILLER PLATE, MK 27, TO BE AGITATED WHEN NORDBAK IS IN LIQUID STATE TO ELIMINATE FORMATION OF VOIDS.

FOR MANUFACTURERS DETAILS REFER TO LAKESIDE BRIDGE AND STEEL CO. FILE, TVA CONTRACT NO. 83K70-833540.

COMPANION DWGS:
54E200-2 THRU -5

REV	DESCRIPTION	DATE
2	FINAL FIELD REVISIONS	6-20-86
1	NOTES 3 & 6 REVISED	4-6-83

SCALE: 3"=1'-0" EXCEPT AS NOTED

SPILLWAY ADDITION

SPILLWAY GATE GENERAL ARRANGEMENT

BLUE RIDGE PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED | RECOMMENDED | APPROVED

INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE 11-10-82 48 H 54E200-1 R2

RECORD DRAWING AS CONSTRUCTED Frank Van Meter 9-24-85 R1