51520

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BOARDMAN COAL PLANT
CARTY RESERVOIR
FINAL PROOF REPORT
AND
CLAIM TO BENEFICIAL USE

PERMIT R 6276

PORTLAND GENERAL ELECTRIC COMPANY
PORTLAND, OREGON

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R 6276

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"	HC-1079
"	HC-102
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"	D10820

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BOARDMAN COAL PLANT
CARTY RESERVOIR FINAL PROOF REPORT
AND CLAIM TO BENEFICIAL USE
Application No. 51520, Permit No. R 6276

1. Name of Registrant: Portland General Electric Company (PGE)

   Mailing Address: 121 SW Salmon Street
   Portland, Oregon 97204
   Attention: Robin Tompkins
   Telephone No.: 503-464-8850

2. Source of Water: Columbia River

3. Reservoir Location: The reservoir is located approximately 12 miles southwest of Boardman, Oregon, just south of the Columbia River in Morrow County.

4. General Description

The Boardman Plant is a nominal 540 MW coal-fired-electric generating plant located about 12 miles southwest of Boardman, Oregon, and about 10 miles south of the Columbia River. The major plant components include the power building complex, the coal unloading/handling facility, and the cooling reservoir. The 1450 acre cooling reservoir (Carty Reservoir) provides all the cooling and process water for the plant. This includes water for condenser cooling, service water, fire protection, coal dust suppression, ash handling, and boiler makeup. Water for the reservoir is supplied by an existing farm irrigation system through a pumping plant located on Willow Creek Cove, an arm of the Columbia River. The Boardman Plant was constructed during the years 1976 through 1979 and cost approximately $500 million to build. Drawing D-10728 (included under reference drawings) shows the locations of the diversion point, pumping plant, pipelines, reservoir, and plant site.

The following paragraphs describe the various components of Carty Reservoir.

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A. CARTY RESERVOIR

Carty Reservoir is a 1450 acre cooling pond for the Boardman Plant. The Reservoir occupies a low-lying area formed by the junction of Sixmile and Fourmile Canyons. It is bounded on the west and north by the West Dam, the principal structure, which includes an outlet works and an overflow spillway. The reservoir is contained on the east end by the Saddle Dam. Running west from about the midpoint of the Saddle Dam is a Divider Dike. The warm water entering the reservoir from the condenser is discharged to the south side of the Divider Dike where it must flow a longer path around the end of the dike before returning to the intake structure. This longer flow path improves the efficiency of cooling in the reservoir by maximizing the length of time for evaporative cooling.

The spillway is located at the east end of the West Dam. The outlet works, located through the deepest section of the West Dam, provides for emergency dewatering of the reservoir, should that be required. The dewatering flow would travel down Sixmile Canyon where it would discharge into the Columbia River. A 9-foot diameter culvert was tunneled under Interstate Highway I84 and the Union Pacific Railroad to carry the estimated maximum dewatering flow of 435 cfs to the Columbia.

The reservoir was constructed under Water Resources Department Permit R 6276 issued January 12, 1976, with addendum. The reservoir and related structures cost about $26 million to build in 1976. The water to fill and maintain the reservoir was and is supplied by the Taggares pumping plant under Water Resource Department Permit No. 39188. Taggares subleases the land from Boeing Agri-Industrial Co.(Boeing) who have a long term lease from the State of Oregon for these state-owned lands. PGE has an agreement with Boeing authorizing use of the pump station and the pipeline.

At the normal high water surface elevation of 677 ft. (MSL) Carty Reservoir has a surface area of approximately 1450 acres and a volume of about 38,300 AF. At normal low water, elevation 667 ft.(MSL), the surface area is reduced to about 1100 acres and the volume to 26,000 AF. The area-capacity

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curve is shown on drawing HC-1079 (included under reference drawings).

Carty Reservoir and the related dams and spillway are located in the following parcels of property.

Township	Range	Section	Tract	Description
2 North	24 East	2	W/2 of NW/4	Reservoir/dams
		2	SE/4 of NW/4	Reservoir/dams
		2	N/2 of SW/4	Reservoir/dams
		3	All	Reservoir/dams
		4	All	Reservoir/dams
		8	N/2 of S/2	Reservoir/dams
		8	E/2 of NE/4	Reservoir/dams
		8	SW/4 of NE/4	Reservoir/dams
		9	N/2 of NW/4	Reservoir/dams
		9	SW/4 of NW/4	Reservoir/dams
		10	E/2 of NW/4	Reservoir/dams
		10	W/2 of NE/4	Reservoir/dams
3 North	24 East	33	S/2 of S/2	Reservoir/dams
		33	N/2 of SE/4	Reservoir/dams
		34	S/2 of SW/4	Reservoir/dams

A plan of the reservoir is shown on drawing D-10820 (Final Proof Map) and HC-102 (included under reference drawings). The following is a detailed description of the hydraulic structures of Carty Reservoir.

a. West Dam

The West Dam is a 6,863 foot long, compacted-earthfill-embankment dam with a central, impervious clay core (Zone I). The outer shell of the dam is a compacted random earth embankment, Zone II. A nearly vertical chimney sand drain was placed in the embankment fill (Zone II) just downstream of the central core. This drain collects any seepage passing through the core and transports it downward to a horizontal sand drainage blanket that

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daylights in a drainage ditch at the downstream toe of the dam. This drainage system helps reduce the phreatic pressures in the downstream embankment. The upstream and downstream side slopes of the dam are 3 horizontal to 1 vertical. A 3 foot thick layer of riprap is placed on the upstream face to protect against wave erosion. The dam is approximately 88 feet above ground at the deepest section. The crest elevation is 688 feet (MSL).

The dam was founded on a combination of bedrock and cemented gravels. There was a concern about excessive settlement at the deepest section of the dam (where the total dam height from the bottom of the foundation to the crest was 118 feet - excavated 30 feet below ground level) so the foundation was excavated all the way down to the Pomona basalt bedrock. The portion of the bedrock directly under the core was throughly hand cleaned and open joints and fractures were filled with dental concrete. Just prior to placing the core material a layer of slush grout was applied to the foundation rock. The foundation under the zone II shells was machine cleaned prior to placing the embankment fill. At the shallower portions of the dam where settlement was not a concern, the foundation was excavated down to The Dalles Formation, a cemented gravel material.

To reduce seepage under the dam a 7,423 foot long grout curtain was installed for the entire length of the dam and spillway. The holes were on a maximum of 10 foot centers and varied in depth from 25 feet to nearly 100 feet deep at the deeper sections of the dam.

The minimum safety factor for the West Dam is 2.5 for the steady state seepage case. Details of the West Dam are shown on drawings HC-103 and HC-104 (included under reference drawings).

b. Saddle Dam

The Saddle Dam is a compacted-earthfill-embankment dam approximately 4,128 feet long. It has a maximum height above the ground of 53 feet. The crest elevation is 687.0 feet (MSL). The design is similar to the West Dam with a central, impervious core (Zone 1), drainage chimney and

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blanket, and outer random earth (Zone II) compacted shells. The upstream and downstream side slopes of the dam are 2.5 horizontal to 1 vertical. A 3 foot thick layer of riprap is placed on the upstream face to protect against wave erosion.

The dam is founded on The Dalles Formation, a cemented gravel. The foundation was excavated through 6 to 12 feet of loess and 15 to 20 feet of loose Dalles Formation. Excessive settlement was not a concern here since the dam is much lower than the West Dam.

To reduce seepage under the dam a 4,500 foot long grout curtain was constructed along the centerline of the entire length of the dam. The holes were on a maximum of 10 foot centers and varied in depth from 25 feet at the abutments to 50 feet in the channel section.

The minimum safety factor for the Saddle Dam is 2.1 for the steady state seepage case. Details of the Saddle Dam are shown on drawings HC-106 and HC-107 (included under reference drawings).

c. Divider Dike

The approximately 8,300 foot long, compacted-earth-embankment Divider Dike runs east-west down the center of the reservoir. There is equal water pressure on each side. Since there was no concern with public safety the design was based on slope stability and settlement of a totally saturated structure. Also since seepage was not a concern, the dam was founded directly on the natural loess materials occurring on the bottom of the reservoir. The base of the dam is very wide, sloping upward from the base on a 3 horizontal to 1 vertical to a bench at elevation 662 feet (MSL). From the bench the dike cross section steps inward 45 feet on each side and rises to the crest elevation of 686 feet (MSL) on a 2.5 horizontal to 1 vertical slope. The crest width is 24 feet. A 3 foot layer of riprap is placed on both side slopes beginning at elevation 662 feet (MSL) and extending to the crest to protect against wave erosion.

Details of the Divider Dike are shown on drawings HC-105

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and HC-106 (included under reference drawings).

d. Outlet Works

The outlet works is constructed through the lower portions of the West Dam and is designed to drain the reservoir in the event of an emergency. The works consists of an inlet gate located on the upstream slope of the dam, a 48 inch diameter concrete encased steel pipe running under the dam, and an outlet structure discharging into Sixmile Canyon. Any discharge would flow down the 10 miles of the canyon, eventually reaching the Columbia River. The upstream gate is a 4 foot by 4 foot slide gate with a stainless steel stem running up the upstream face of the dam to an operator located at the dam crest. The outlet structure is a square vertical concrete box extending approximately 45 feet upward from the downstream end of the 48 inch diameter steel pipe to above the ground surface. Two 5 feet by 7 feet vertical slide gates are mounted at the discharge of the outlet structure to control discharge. These gates provide an alternate way to shut off the flow through the 48 inch diameter discharge pipe should the upstream slide gate fail to close.

Details of the outlet works are shown on drawings HC-201 and HC-202 (included under reference drawings).

e. Spillway

The reinforced concrete spillway is located at the east abutment of the West Dam. It consists of an uncontrolled overflow labyrinth crest and a concrete chute. The spillway entrance is a 120 foot wide by 17.5 feet high rectangular concrete structure with a 361 foot labyrinth overflow weir constructed in a sawtooth pattern within the 120 foot width. The crest elevation of the spillway is 677.5 feet (MSL). The spillway chute extends about 580 feet down the slope to a flip bucket/plunge pool type of energy dissipator. The plunge pool is riprapped. The chute is 120 wide at the beginning and reduces to 50 feet

about half way down the chute. The spillway is designed to pass the probable maximum flood (PMF) which is estimated at 13,200 cfs.

Details of the spillway are shown on drawings HC-209 (included under reference drawings).

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B. HISTORY OF THE BOARDMAN SITE PLANT DEVELOPMENT AND RESERVOIR MAKEUP

In the early 1970's PGE planned to construct up to two coal fired plants and up to two additional 1260-MW thermal plants at the then named Thermal Power Generation Facility (now called the Boardman Coal Plant). A 5000 acre reservoir was to be constructed adjacent to the plants for cooling water. Four 2,500 HP pumps, located in a pumping plant on the Columbia River near Threemile Canyon, would pump the required initial fill and makeup to Carty through a 11-mile, 51-inch diameter pipeline. However, shortly after the initial water permit applications were submitted, the demand for new generation eased and PGE investigated ways to reduce costs to both the ratepayers and stockholders. A more conservative development plan was followed and ultimately resulted in the construction of only one 540-MW coal fired plant. Additional plants were to be added as the economics of new generation construction turned favorable.

With only one plant at the site there was no longer an immediate need for a 5000 acre cooling reservoir. Therefore, PGE decided to construct the reservoir in two stages. The first stage would consist of building the 1450 acre reservoir and the 540 MW coal plant. When there was a sufficient need for economical power, PGE planned to proceed with stage 2 which would expand the reservoir to 5000 acres and add up to two 1260 MW thermal plants to the site. This staged development is also described in the addendum to the permit to construct the reservoir, Permit No. R 6276.

With smaller demands PGE could save additional money if the pumping plant and pipeline construction at Threemile Canyon could be deferred until the full reservoir was constructed. Boeing agreed to allow use of the existing Willow Creek Cove

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pump station and pipeline. As a result the initial water permit application was amended (Permit No. 39188, with addendum) to address the plan to develop Carty in two stages and the change in the point of diversion.

The smaller reservoir has been constructed and the Boardman Plant went into commercial operation in 1980. The reservoir was initially filled and is being maintained using the irrigation piping and the pumping plant at Willow Creek Cove.

C. CLAIM TO BENEFICIAL USE

PGE has constructed the hydraulic structures for the 1450 acre reservoir. Initial fill was started in late 1977. The completion notice for the reservoir was sent to the Water Resources Department in October 1978. The reservoir elevation reached the minimum pool elevation of 667 feet (MSL) on March 13, 1979 and the maximum pool elevation of 677 feet (MSL) about April 1, 1980.

PGE has been submitting estimated annual water balance tables to the Water Resources Department (included in the annual "Ecological Monitoring Program for the Boardman Coal-Fired Plant" reports)for Carty reservoir since the initial filling of the reservoir. These water balance reports show that the reservoir reached the 677 elevation in April of 1980. In addition, a PGE letter dated June 6, 1980 (R. Halicki to J. E. Sexson, Attn. Al Petska) was sent to the Water Resources Department stating that the 677 foot elevation was reached on March 27, 1980.

The estimated reservoir volume at the maximum elevation of 677 feet (MSL) is 38,300 acre feet. The area at that elevation is estimated at 1450 acres. At the minimum reservoir elevation of 667 feet (MSL) the estimated volume is 26,000 AF and the area is 1100 acres. These values are obtained from the area-capacity curves prepared by Bechtel (drawing HC-1079) at the completion of construction of the Boardman Plant.

Annual water requirements to fill the reservoir have varied from a low of about 7,000 acre feet (AF) when the plant was idle and the reservoir was at the minimum elevation, to nearly 13,000 AF when the plant operated and/or the reservoir was near the maximum elevation. During extremely hot years with

full year plant operation annual water supply needs approach 15,000 acre feet.

This claim to beneficial use is for the 1450 acre, 38,300 AF reservoir including all related hydraulic structures; the West Dam with outlet works and spillway, Saddle Dam, and Divider Dike. The reservoir, dams, outlet works and spillway were constructed and are in service. The reservoir has been filled to the maximum elevation of 677 feet (MSL). Water stored in the reservoir under permit R6276 is stored for use in the operation of the Boardman Plant.

Water will continue to be diverted from Willow Creek Cove, a backwater of the Columbia River, via the Taggares/Boeing pump stations and the 72 inch/60 inch pipeline to Carty Reservoir and to the plant. A flow meter, installed in the 60 inch diameter line just upstream of reservoir, measures flows into Carty Reservoir.

Since the Boardman Plant went into commercial operation in 1980, it has produced 23,926,189 MWH's of economical electrical power for the citizens of the State of Oregon.

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The final proof survey and inspection of the use as found to be completed under the terms and conditions of permit number R 6276 was completed by me on March 14, 1996, and the facts contained in this report and accompanying final proof map, Drawing Number D-10820, are correct to the best of my knowledge.

Certified Water Right Examiner
158
Harold J. Csergei
May 17, 1938
STATE OF OREGON

I, Robin Hopkins, having been duly sworn, depose and say that I am the Asst. General Counsel of Portland General Electric Company, agree to the findings of the Certified Water Rights Examiner and do submit this site report and map as my Claim of Beneficial Use of the water as provided under the terms and condition of my permit number R 6276.

hjc/cartypro.rpt
May 8, 1996

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CARTY RESERVOIR FILL METER READINGS TAKEN ON 8/11/95

Date - Time	Flow Meter Readings (1)		Totalizer Readings (2)	
	ft/sec	ft^3/sec (3)	gal/day	ft^3/sec (4)
08/11/95-0850	4.060	79.17	53,827,000	83.28
08/11/95-0900	4.362	85.02	53,827,000	83.28
08/11/95-0910	4.255	82.97	53,764,000	83.19
08/11/95-0920	4.251	82.89	53,813,000	83.26
08/11/95-0930	4.376	85.33	53,398,000	82.62
08/11/94-0940	4.278	83.42	53,574,000	82.89
08/11/95-0950	4.215	82.19	53,447,000	82.70

(1) Reading from the velocity dial on the flow meter.
(2) Reading obtained from totalizer on flow meter.
(3) Calculated by multiplying the area of the 5 ft diameter flow pipe by the velocity.
(4) Calculated by converting the gallons per day into cubic feet per second.

carmeter.tab

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CARTY RESERVOIR FILL PIPE METER READINGS TAKEN ON 3/14/96

Date - Time	Meter Reading (1)	Meter Reading converted to GPM
	ft^3/sec	gal/min
03/14/96-0838	0.4	186
03/14/96-0853	6.1	2741
03/14/96-0908	60.3	27069
03/14/96-0923	78.9	35426
03/14/96-0938	107.6	48294
03/14/96-0953	120.8	54219
03/14/96-1008	126.0	56553
03/14/96-1023	131.4	58977
03/14/96-1038	135.2	60682
03/14/96-1038.3	134.8	60503
03/14/96-1038.45	136.4(2)	61211

(1) Reading were taken from the Accusonic 4 path, ultra-sonic, digital flow meter located in the 60" diameter Carty fill pipeline just upstream of the meteorological tower.

(2) During the fill exercise a total of 6-1250 hp pumps were pumping at the Willow Creek Cove pumping station and 8-1250 hp pumps pumping at the Booster pump station. All water being pumped from the Willow Creek pumping station was being pumped to Carty Reservoir.

ctyaccmr.135

BOARDMAN CO. PLANT
CARTY RESERVOIR MONTHLY WATER BALANCE

Description	1994 JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Reservoir Elevation: End	667.5	667.9	668.9	669.5	670.7	669.8	667.3	665.7	666.4	667.5	669.2	669	
Reservoir Elevation: start	667.9	667.5	667.9	668.9	669.5	670.7	669.8	667.3	665.7	666.4	667.5	669.2	
Elevation Difference,Ft	-0.4	0.4	1	0.6	1.2	-0.9	-2.5	-1.6	0.7	1.1	1.7	-0.2	
Reservoir Area: End,Acre	1095	1118	1155	1172	1215	1183	1100	1045	1070	1095	1162	1155	
Reservoir Area: Start,Acre	1118	1095	1118	1155	1172	1215	1183	1100	1045	1070	1095	1162	
Average Area,Acre	1107	1107	1137	1164	1194	1199	1142	1073	1058	1083	1129	1159	
Volume= Elev. x Area,AF	-443	443	1137	698	1432	-1079	-2854	-1716	740	1191	1918	-232	
Fill:													
Boeing Fill, AF (digital)	0	939	1942	1903	2295	276	122	165	2351	1998	2943	617	15551
PGE Fill,AF	65	65	65	65	65	65	65	65	65	65	65	65	780
Total Fill= PGE + Boeing,AF	65	1004	2007	1968	2360	341	187	230	2416	2063	3008	682	16331
Withdrawal:													
Boeing Irrigation,AF	0	0	37	69	0	199	1681	547	0	12	0	0	2545
PGE Plant Use, AF	2	2	2	2	2	2	2	2	2	2	2	2	
Total Withdrawl,AF	2	2	39	71	2	201	1683	549	2	14	2	2	
Net Fill=Fill - Withdrawl	63	1002	1968	1897	2358	140	-1496	-319	2414	2049	3006	680	13762
Losses:													
Net Fill,AF	63	1002	1968	1897	2358	140	-1496	-319	2414	2049	3006	680	
Change in Volume,AF	-443	443	1137	698	1432	-1079	-2854	-1716	740	1191	1918	-232	
Total Loss= Fill-Volume,AF	-506	-559	-832	-1199	-926	-1219	-1358	-1397	-1674	-858	-1088	-912	-12526

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Oregon

WATER
RESOURCES
DEPARTMENT

July 29, 1996

GEORGE M HUTCHERSON
MANAGER CIVIL ENGINEERING & CONTRACT CONSTRUCTION
PORTLAND GENERAL ELECTRIC COMPANY
121 SW SALMON STREET
PORTLAND OR 97204

REFERENCE: File R-51520 and 51521

This will acknowledge that your claim of beneficial use and map in the name of PGE were received on May 21, 1996. These will be reviewed in the future to insure they are complete and correct.

Please contact me if you have any questions.

Sincerely,

DON KNAUER
Program Representative

Commerce Building
158 12th Street NE
Salem, OR 97310-0210
(503) 378-3739
FAX (503) 378-8130

CAPACITY (X 1000 ACRE-FEET)

WATER SURFACE ELEVATION (FEET)

SURFACE AREA (X 100) ACRES

CAPACITY

SURFACE AREA

VOLUME PUMPED
(Per Dosing Flowmeter)

MATCH LINE
FOR CONTINUATION OF PUMPING
INPUT CURVE, SEE DWG SK-HC-1080

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No.	DATE	REVISIONS	BY	CHKD	PROJ ENGR	ENGR MGR	APPR
1	5/JA-16	ISSUED FOR COSTA REPORT-RESERVOIR SEEPAGE	UN	F.P.			
2	27 FE-80	SUPERSEDES SK-HC-1036; REMOVED SK-; ISSUED FOR PGE USE	UN	F.P.			

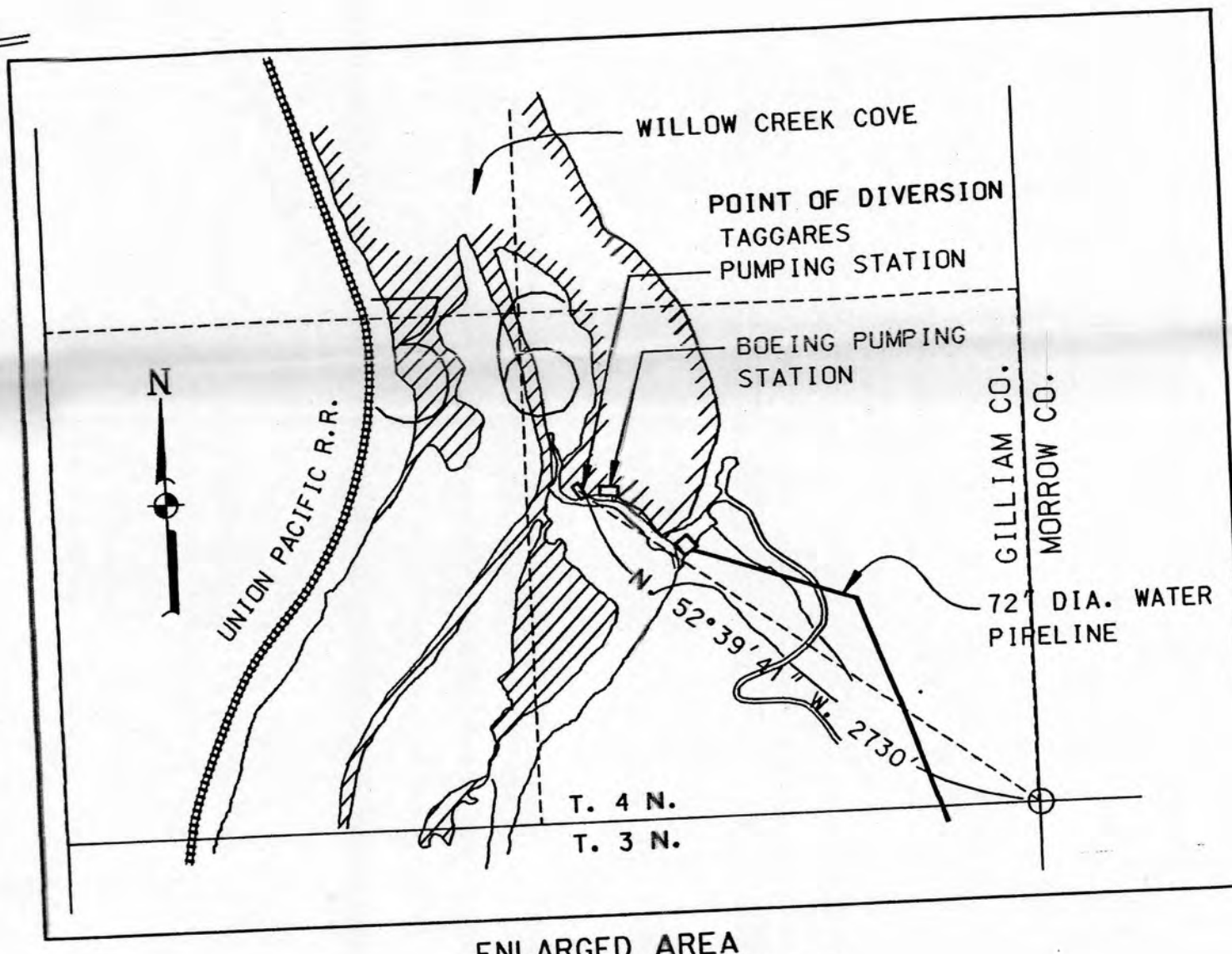
SCALE | DESIGNED UN | DRAWN UN | CHK'D DATE

BECHTEL
SAN FRANCISCO

BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. PORTLAND, OREGON

CARTY RESERVOIR - STAGE I
AREA-CAPACITY CURVES
& PUMPING INPUT CURVE

JOB No.	DRAWING No.	REV.
10411-002	HC-1079	1



ENLARGED AREA
SCALE: 1 INCH = 1000 FT

LEGEND

▨ – AREA OF BENEFICIAL USE

REFERENCE DRAWING

BOARDMAN COAL PLANT
D10820 SHEET 1 OF 1

CARTY RESERVOIR
FINAL PROOF MAP
PERMIT NUMBER R6276

OSE OF THIS MAP IS TO IDENTIFY
TION OF THE WATER RIGHT. IT
NTENDED TO PROVIDE INFORMATION
TO THE LOCATION OF PROPERTY
P BOUNDARY LINES.

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Certified Water Right Examiner
158
Harold J. Cserger
May 17, 1988
STATE OF OREGON

REV	DATE	DESCRIPTION	BY	CHK	SUPV	ENG
0	5/5 1996	ISSUED FOR WATER RIGHTS PERMIT NUMBER 39188	JAV			HJC

REVISIONS

PORTLAND GENERAL ELECTRIC
PORTLAND, OREGON

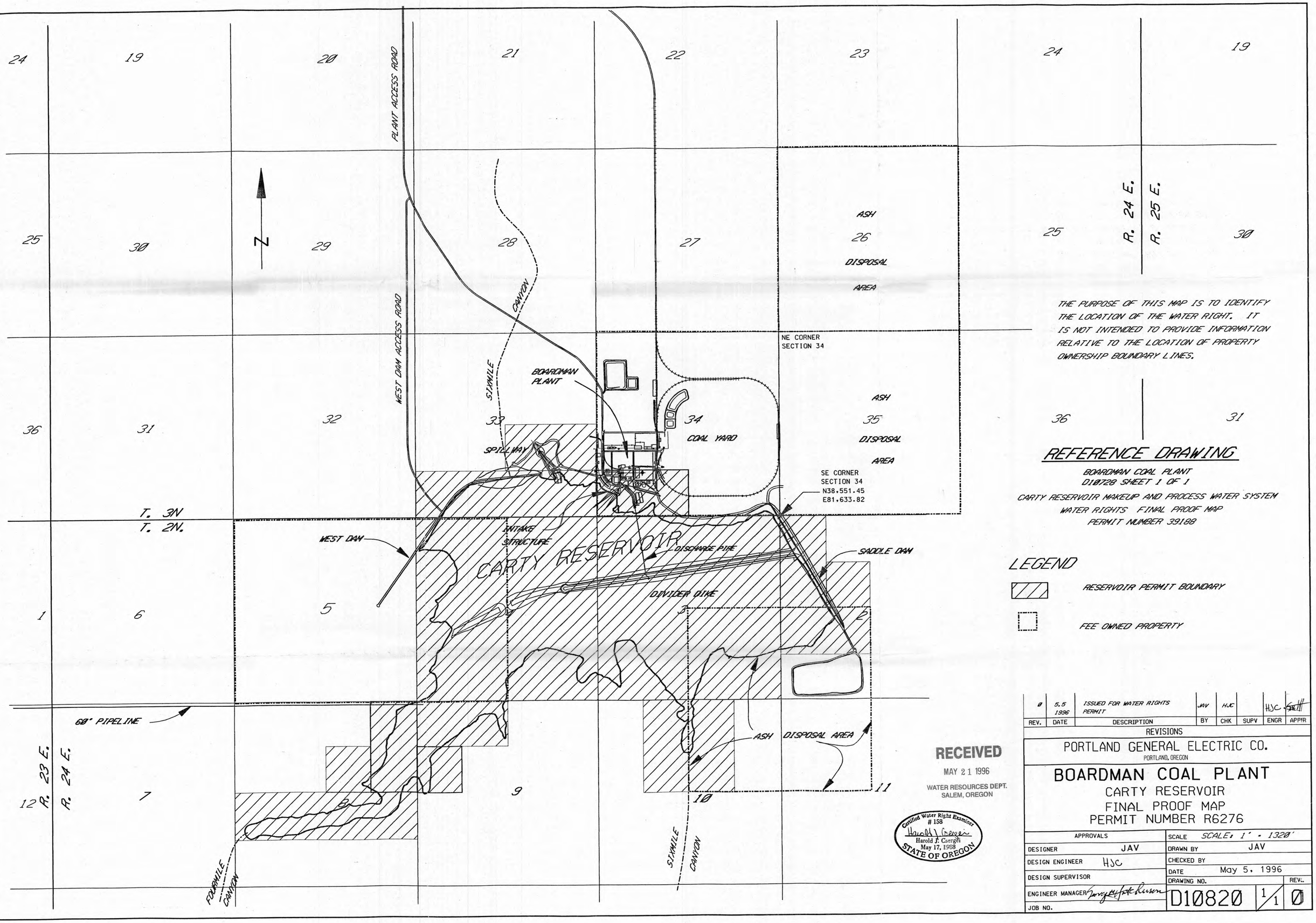
BOARDMAN COAL PLANT

CARTY RESERVOIR MAKEUP
AND PROCESS WATER SYSTEM
WATER RIGHTS FINAL PROOF MA

PERMIT NUMBER 39188

APPROVALS	
DESIGNER	JAV
DESIGN ENGINEER	HJC
DESIGN SUPERVISOR	
ENGINEER MANAGER	
JOB NUMBER	

SCALE	1" = 1 M
DRAWN BY	JAV
CHECKED BY	
DATE	MAY 5, 1996
DRAWING NUMBER	D10728 1



THE PURPOSE OF THIS MAP IS TO IDENTIFY THE LOCATION OF THE WATER RIGHT. IT IS NOT INTENDED TO PROVIDE INFORMATION RELATIVE TO THE LOCATION OF PROPERTY OWNERSHIP BOUNDARY LINES.

REFERENCE DRAWING

BOARDMAN COAL PLANT
D10728 SHEET 1 OF 1
CARTY RESERVOIR MAKEUP AND PROCESS WATER SYSTEM
WATER RIGHTS FINAL PROOF MAP
PERMIT NUMBER 39188

LEGEND

RESERVOIR PERMIT BOUNDARY

FEE OWNED PROPERTY

REV.	DATE	DESCRIPTION	BY	CHK	SUPV	ENGR	APPR
0	5.5 1996	ISSUED FOR WATER RIGHTS PERMIT	JAV	HJC		HJC	

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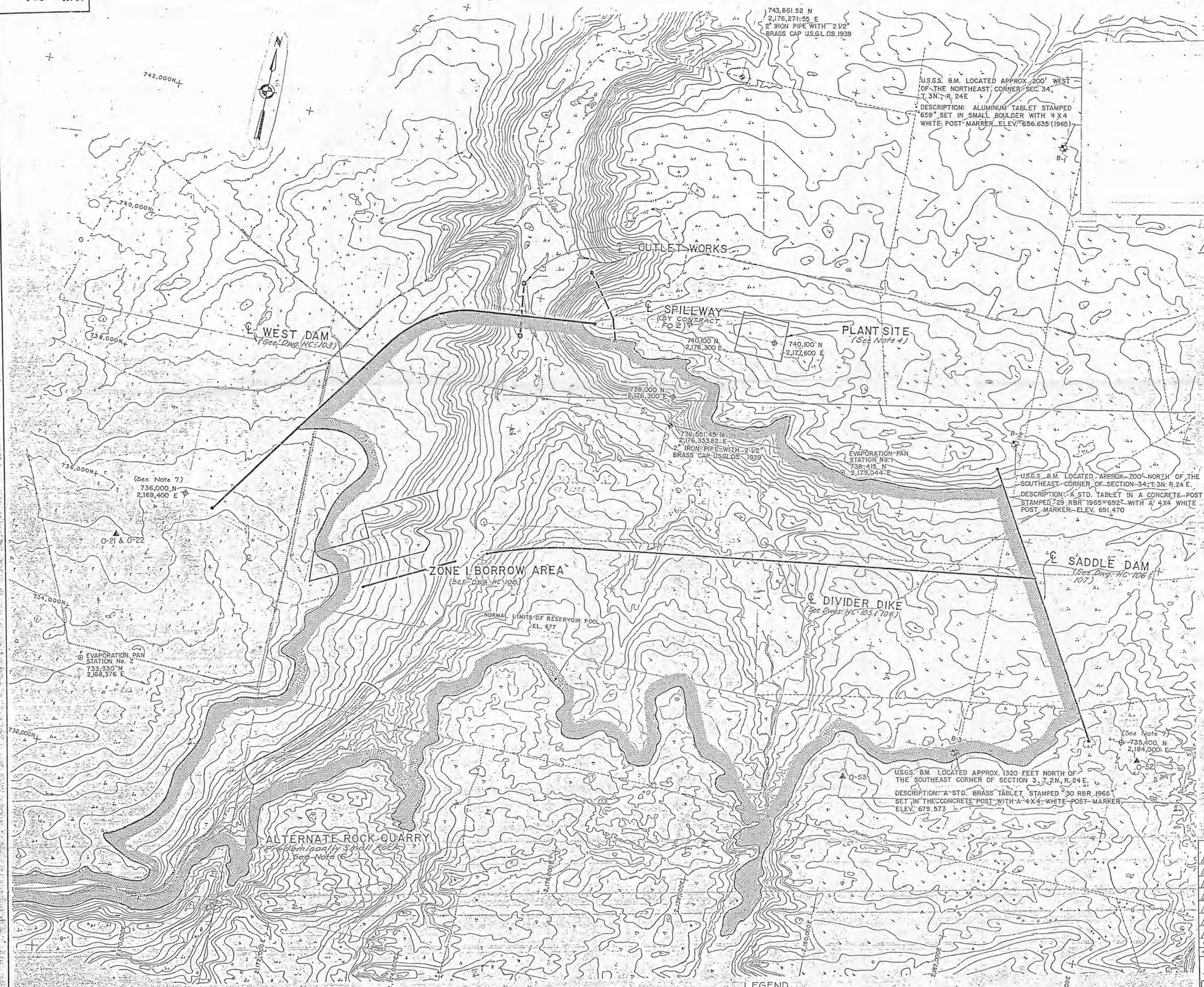
Certified Water Right Examiner # 158
Harold J. Caergeri
May 17, 1988
STATE OF OREGON

PORTLAND GENERAL ELECTRIC CO.
PORTLAND, OREGON

BOARDMAN COAL PLANT
CARTY RESERVOIR
FINAL PROOF MAP
PERMIT NUMBER R6276

APPROVALS		SCALE	SCALE: 1" = 1320'
DESIGNER	JAV	DRAWN BY	JAV
DESIGN ENGINEER	HJC	CHECKED BY	
DESIGN SUPERVISOR		DATE	May 5, 1996
ENGINEER MANAGER		DRAWING NO.	D10820 1/1 0
JOB NO.			

10411 - 002



NOTES

1. Grid system is based on Oregon Coordinate System, North Zone.
2. Topography is from aerial surveys by CH2M-Hill, 1975.
3. See Dwg. I-C-001 for location of Riprap Quarry.
4. See Dwg. I-C-0006 for plant site excavation available for use in selected zones of the Dams and Dike.
5.
6. The quarry may be expanded horizontally within the reservoir area but shall not extend deeper than 15 Ft. below the floor of the existing canyon.
7. Values are Lambert corrected.
8. For Lambert corrected values of construction coordinates, see Pettijohn Eng. Co. dwg. 75-148-4.
9. See Dwg. HC-1079 for Area-Capacity Curves.

MONUMENT LEGEND

- New Survey Control Monuments
- B-1 — USGS Bench Mark Monuments
- Existing USGLOS Monument

(Construction coordinate except as noted).

LEGEND

▲ Observation Well

GENERAL PLAN & TOPOGRAPHY OF DAMS & DIVIDER DIKE

REGISTERED PROFESSIONAL ENGINEER 8421 OREGON DEC. 22, 1975 R. H. TUBINA

Graphic Scale in Feet
0 500 1000 1500
1" = 500'
5' Contour Interval

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WATER RESOURCES DEPT.
SALEM, OREGON

No.	Date	Revisions	By	Chkd	Project Engr	Exec	Proj. Engr.	Appr
6	5/24/01	Added Evap Pans; Observ Wells Incorporating SK-HC-1079; Deleted Area-Capacity Curves. Issued for Constr Report Reservoir Steppage	JN	FP				
5	1/10/96	Revised as Built	FP	JN	GH	GH	GH	
4	9/7/94	Issued for Construction		GH	GH	GH	GH	
3	11/12/93	Issued for Add. # 3	REM	GH	GH		GH	
2	4/21/93	SURVEY MONUMENTS	KF	GH			GH	
1	10/17/75	Issued for Add #1	MD	GH	GH		GH	
0	4/4/75	Issued for Bid	YN	RHL	GH	GH	GH	

SCALE 1" = 500' | DESIGNED RHL | DRAWN Y. N. | CHKD

BECHTEL
SAN FRANCISCO

BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. PORTLAND, OREGON

GENERAL PLAN AND TOPOGRAPHY OF WEST DAM, SADDLE DAM AND DIVIDER DIKE

JOB No. 10411-002 | DRAWING No. HC-102 | REV. 6

34 x 44 "E" SIZE

10411 - 002

CP-1

O-18, (BEYOND)
744,300.3 N
2173,500.7 E

2,172,000E

2,170,000 E

2,174,000E

740,000 N

738,000 N

736,000 N

739,520N PI.
2,172,380E

See Dwg HC-1065 for Seepage Collection System

See Detail Lateral Drains (2/109)

Ditch (See Note 4)

See Detail (Lateral Drains) (2/109)

Approximate Alignment of Drainage Trench of edge of Basalt Flow. See Detail (1/109)

Approximate Alignment of Drainage Trench of edge of Basalt Flow. See Detail (1/109) and Note 3.

Approximate D/S Toe of Dam on Acceptable Foundation

Approximate U/S Toe of Dam on Acceptable Foundation

CURVE DATA
Δ = 48°30'14"
T = 638'
R = 1415.13'
L = 1198.21'

@ Outlet Works (See Dwg. HC-201)

15' Berm Elev. 657.0

Start West Dam
Station 10+00
El. 685.0
739,512 N
2,174,860 E

For Typical Section on Dam Where the Drains Pass Under the Embankment, See Detail (16/110)

Spillway Sta. 16+50

Spillway Sta. 13+75

Spillway Sta. 13+00

℄ Spillway (64 contrast FOZ)

℄ Access Road See Ref. Dwg. HC-370 for Details.

℄ WEST DAM
Crest Elev. 688.0 (without camber)

Toe of Dam on Existing Ground

Intersection of West Dam Shoulder & Access Road N738,060.94 E 2,171,348.39

West Dam Sta. 52+06 & Access Road Sta. 102+65.06 (See Reference Dwg. HC-370)

End West Dam
Station 78+63
El. 688.0
735,870 N
2,169,845E

20' Crest Width

30' Crest Width

300' Transition

1:30

B-B

A-A

P.I.

S-1 S-2 S-3 S-4 S-5 S-6 S-7 S-8 S-9 S-10 S-11 S-12

M-1 M-2 M-3 M-4

V-1

H-1 H-2 H-3 H-4 H-5 H-6 H-7 H-8

O-1 O-2 O-3 O-4 O-5 O-6 O-6A O-7 O-8 O-9 O-10 O-11 O-12, 13 & 14 O-15, 16 & 17 O-5A

CP-2 CP-3 CP-4 CP-5

R.P.

1087 656.71

1086 642.58

1028 624.62

1418 617.10

NOTES:

1. See Dwg. HC-102 for general notes.
2. See Dwg. HC-104 for profile and Sections for the West Dam.
3. The drainage trench shall be field located along the edge of the upper basalt flow. This intra trench shall be excavated as far back from the edge of the basalt as it is possible to dig with a hydraulic backhoe having a minimum weight of 30 tons, but no further than 20 Feet. See Detail (1/109)
4. Excavate an unlined 3 foot bottom width ditch on a 0.5% slope from the downstream toe of the West Dam to daylight. See Detail (6/109) Alignment was determined by the engineer to assure drainage away from dam.
5. Settlement monuments will be used for dam settlement and horizontal movement observations.
6. PIEZOMETERS
   a. Piezometers shall consist of a 2-inch diameter Montgomery-Ward Clayton Mark brass jacket farm wellpoint Bic-2161M, 3 feet long or approved equal, connected to a 2-inch diameter heavy duty pipe.
   b. The piezometer arrangements shall be driven into the embankment at the locations shown.
   c. The top of the 2-inch pipe shall be surveyed to determine its elevation.
7. See Dwg. HC-1065 for locations of pneumatic piezometers, additional ground water observation wells, exploration holes, and dewatering well.

SETTLEMENT MONUMENTS (TOP OF DAM (ON LINE M-1 TO M-2 EXTENDED) / (D/S FACE OF DAM (ON LINE M-3 TO M-4)) / SET-UP MONUMENTS AND BENCH MARK

No.	STA.	No.	STA.	No.	STA / LOCATION
S-1	10+00	S-9	16+90	M-1	739,992.62 N 2,176,300.00 E
S-2	14+00	S-10	18+80	M-2	5+00
S-3	16+90	S-11	20+80	M-3	13+00
S-4	18+80	S-12	22+70	M-4	28+59.13
S-5	20+80				
S-6	22+70				
S-7	25+80				
S-8	28+59.13				

MONUMENT LOCATION TABLE

PIEZOMETER

No.	ELEVATION TOP	ELEVATION BOTTOM	LOCATION NORTHING	LOCATION EASTING
P-1	675.52	651.52	739,837.28	2,174,528.80
P-2	675.96	647.96	739,827.52	2,174,455.93
P-3	663.16	647.16	739,863.46	2,174,451.53
P-4	688.22	643.22	739,780.50	2,174,459.98
P-9	668.50	567 ±	739,754.90	2,173,655.90
P-10	610.91	567 ±	739,934.00	2,173,637.50

SECTION A-A
1" = 20'

SECTION B-B
1" = 20'

SECTION C-C
1" = 40'

Graphic Scale in Feet
0 200 400 600
1" = 200"
5' Contour Interval

LEGEND

- Type "A" Relief Wells See Detail (3/109)
- Type "B" Relief Wells See Detail (4/109)
- Observation Wells See Detail (13/110)
- Settlement Monument See Detail (6&10/109)
- Set-Up Monument and Bench Mark See Detail (9/109)
- Control Pt. Monument by PGE
- Reference Point by PGE
- Piezometer

See PGE Dwg. C-15469

REGISTERED PROFESSIONAL ENGINEER OREGON AUG. 22, 1972 R. H. LUBINA

RECEIVED
MAY 21 1996
WATER RESOURCES DEPT.
SALEM, OREGON

NO.	DATE	REVISIONS	BY	CHKD	PERSON ENGR	DATE	PROJ ENGR	APPR.
0	1/06/81	ISSUED FOR CONSTRUCTION REPORT RESERVOIR SEEPAGE	JN	F.P.				
1	7/10/80	ADDED PIEZ. INCORPORATING DWG SK-HC-1048 & 1073	JN	F.P.				
2	9/18/78	ADDED WELLS O-15 THRU O-18 & MODIFIED LATERAL DRAINS FOR CONSULTANT MEETING	F.P.	JN	GH			
3	1/10/78	INCORP. SK-HC-1026; ADDED LAT. DRAIN No.; REV. AS BUILT	F.P.	JN	GH			
4	6/8/77	INCORP. DCN No. 5	JN	F.P.	GH			
5	3/3/77	INCORP. DCN No. 3 & 4	JN	F.P.	GH			
6	8/4/76	INCORP. DCN No. 1 & 2	JN	F.P.	GH			
7	12/1/75	Issued for Construction		RM	GH			
8	11/4/75	Issued for add. #3	RSH	DM	GH			
9	10/31/75	Issued for add #1	MD	DM	GH			
10	9/1/75	Issued for Bid	E.W.	DM	VLT	F.G.		

SCALE 1"=200' DESIGNED R. LUBINA DRAWN M.P.

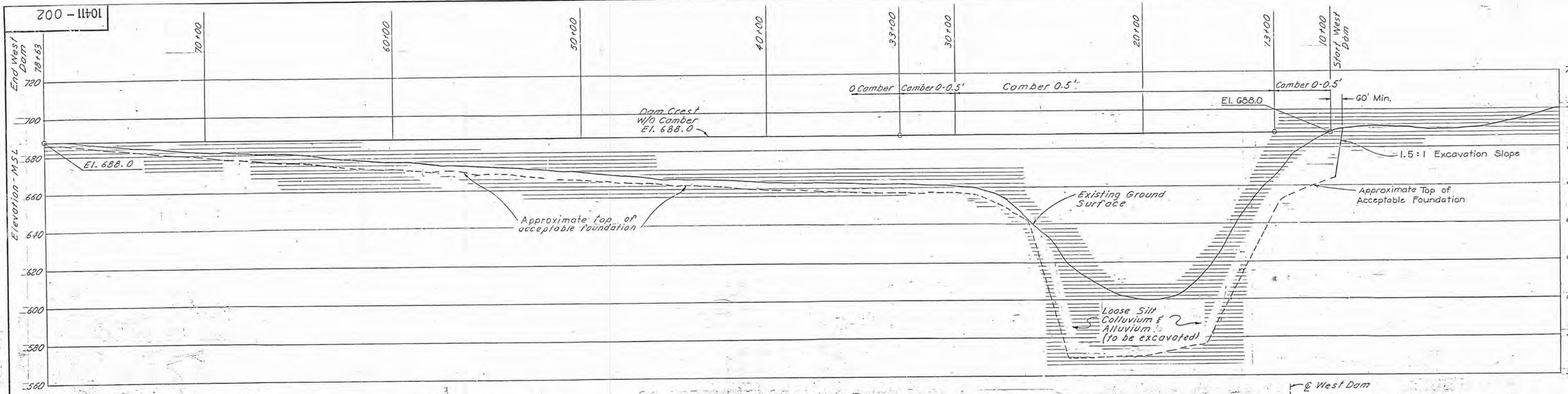
BECHTEL
SAN FRANCISCO

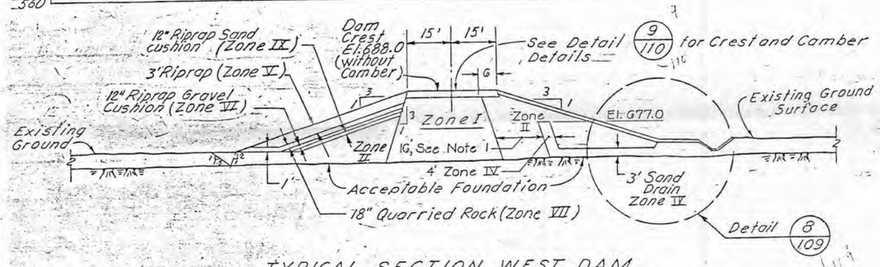
BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. PORTLAND, OREGON

WEST DAM PLAN

JOB No. 10411-002 DRAWING No. HC-1.03 REV. 10

10411 - 002





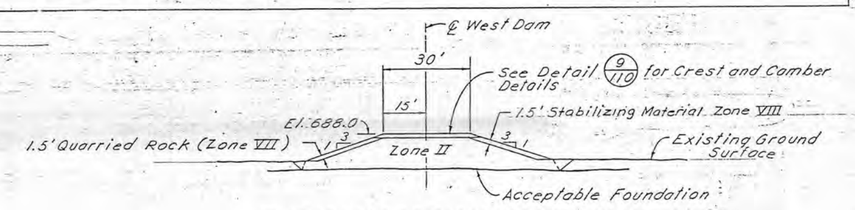
TYPICAL SECTION WEST DAM

STATION 28+00 to 65+00

Scale 1" = 20'

CENTERLINE PROFILE-WEST DAM

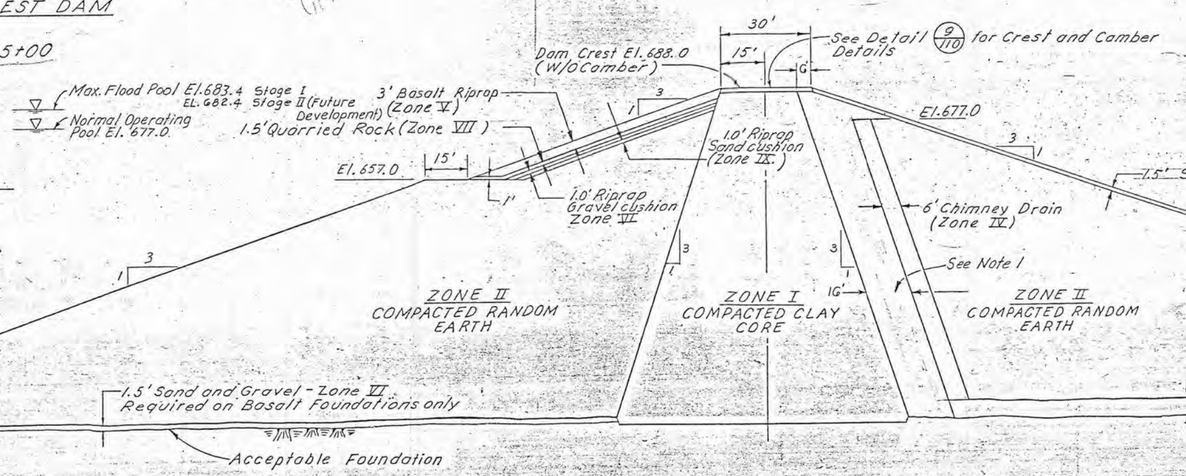
Scale: Horizontal 1" = 200'
Vertical 1" = 20'



TYPICAL SECTION WEST DAM

STATION 65+00 to 78+63

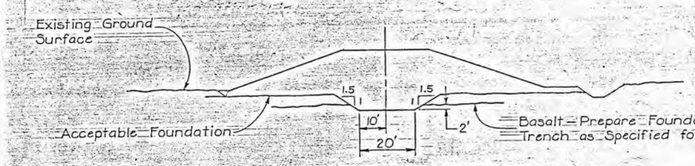
Scale: 1"=20'



TYPICAL WEST DAM EMBANKMENT SECTION

STATION 14+00 to 28+00

Scale: 1"=20'



TYPICAL SECTION WEST DAM

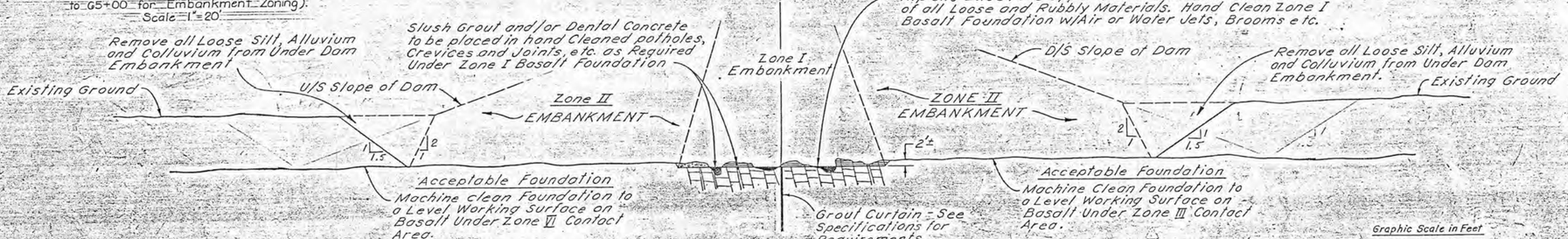
STATION 9+40± to 14+00

(See Typical Section Station 28+00 to 65+00 for Embankment Zoning).

Scale 1"=20'

Notes:

1. The Zone II material located between the Zone I Core and the Zone IV Chimney Drain shall be loess containing not more than 85 percent by dry weight of particles passing the no. 200 sieve



TYPICAL EXCAVATION AND FOUNDATION TREATMENT SECTION FOR DAM FOUNDATIONS ON BASALT

Scale: None

Graphic Scale in Feet

0 10 20 40 60
1" = 20'

0 200 400 600
1" = 200'

REGISTERED PROFESSIONAL ENGINEER 8431 OREGON JUNE 22, 1979 R. H. LUBINA

RECEIVED
MAY 21 1996
WATER RESOURCES DEPT
SALEM, OREGON

No.	DATE	REVISIONS	BY	CHKD	DESIGN ENGR	ENGR	PROJ ENGR	APP
6	1/10/78	Incorp. SK-HC-1006, 1007 & 1026; Rev. as Built	FP	JN	BH			
5	10/24/96	Incorp. DCN No. 182	JN	FP				
4	5/21/76	West Abut. Core Trench	JN					
3	1/23/76	Issued for Construction	-					
2	11/21/75	Issued for add #3	REM					
1	10/17/75	Issued for add #1	MD					
0	10/1/75	Issued for Bid	PLT					

SCALE AS SHOWN | DESIGNED R. LUBINA | DRAWN YN | CHKD

BECHTEL
SAN FRANCISCO

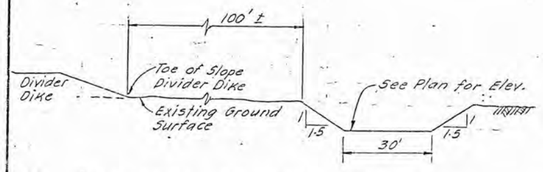
BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. — PORTLAND, OREGON

WEST DAM PROFILE & SECTIONS

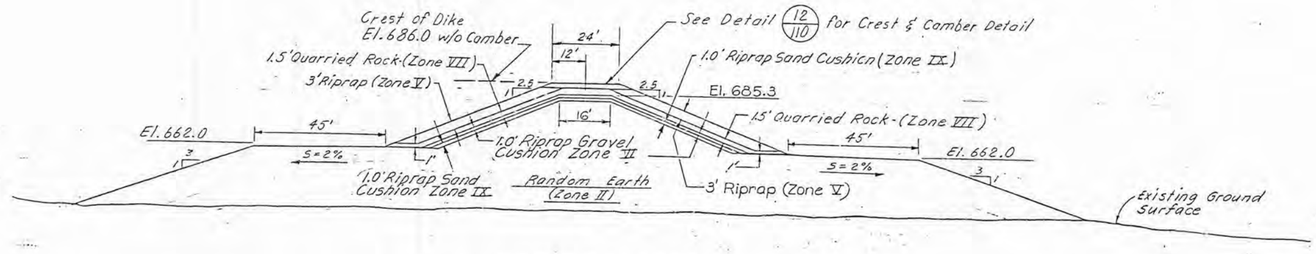
JOB No. 10411-002 | DRAWING No. HC-104 | REV 6

34 x 44 "E" SIZE

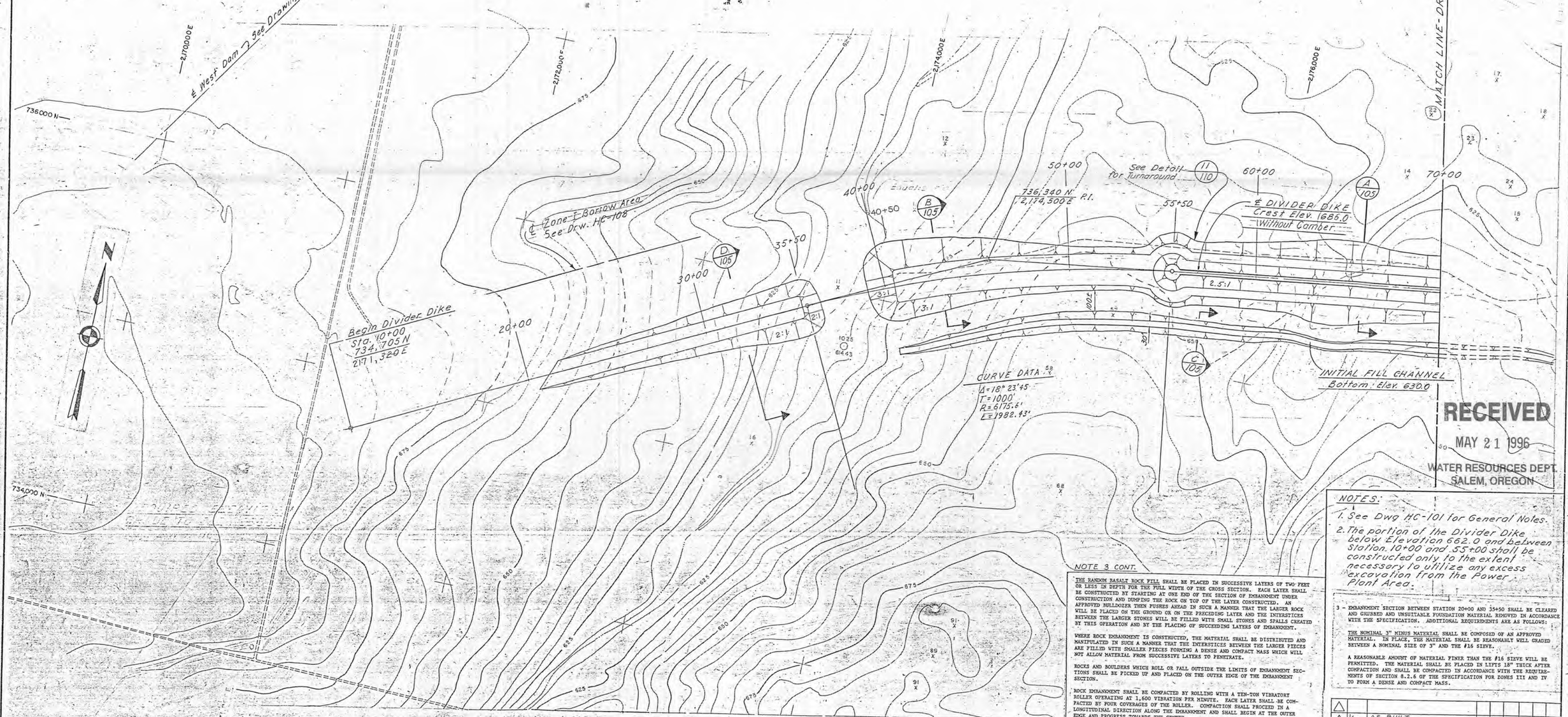
8 7 6 5 4 3 2 1

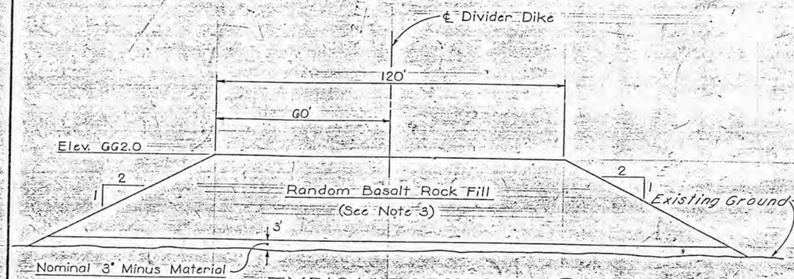


TYPICAL SECTION (C/105)
INITIAL FILL CHANNEL
Scale: 1" = 20'

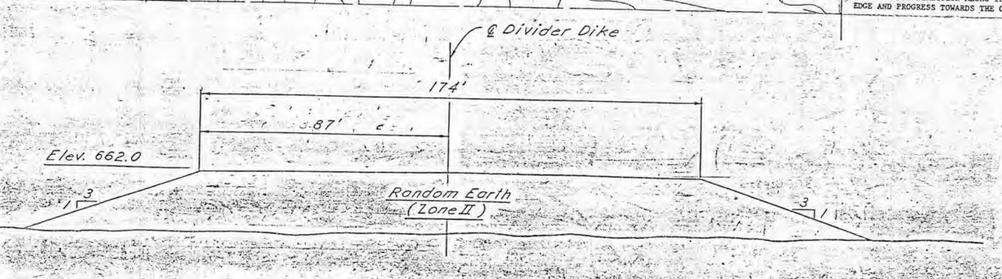


TYPICAL SECTION (A/105)
DIVIDER DIKE
Scale: 1" 20'





TYPICAL SECTION (D/105)
STATION 20+00 TO 35+50
Scale: 1" = 20'



TYPICAL SECTION (B/105)
DIVIDER DIKE
Scale: 1" = 20'

NOTE 3 CONT.

THE RANDOM BASALT ROCK FILL SHALL BE PLACED IN SUCCESSIVE LAYERS OF TWO FEET OR LESS IN DEPTH FOR THE FULL WIDTH OF THE CROSS SECTION. EACH LAYER SHALL BE CONSTRUCTED BY STARTING AT ONE END OF THE SECTION OF EMBANKMENT UNDER CONSTRUCTION AND DUMPING THE ROCK ON TOP OF THE LAYER CONSTRUCTED. AN APPROVED BULLDOZER THEN PUSHES AHEAD IN SUCH A MANNER THAT THE LARGER ROCK WILL BE PLACED ON THE GROUND OR ON THE PRECEDING LAYER AND THE INTERSTICES BETWEEN THE LARGER STONES WILL BE FILLED WITH SMALL STONES AND SPALLS CREATED BY THIS OPERATION AND BY THE PLACING OF SUCCEEDING LAYERS OF EMBANKMENT.

WHERE ROCK EMBANKMENT IS CONSTRUCTED, THE MATERIAL SHALL BE DISTRIBUTED AND MANIPULATED IN SUCH A MANNER THAT THE INTERSTICES BETWEEN THE LARGER PIECES ARE FILLED WITH SMALLER PIECES FORMING A DENSE AND COMPACT MASS WHICH WILL NOT ALLOW MATERIAL FROM SUCCESSIVE LAYERS TO PENETRATE.

ROCKS AND BOULDERS WHICH ROLL OR FALL OUTSIDE THE LIMITS OF EMBANKMENT SECTIONS SHALL BE PICKED UP AND PLACED ON THE OUTER EDGE OF THE EMBANKMENT SECTION.

ROCK EMBANKMENT SHALL BE COMPACTED BY ROLLING WITH A TEN-TON VIBRATORY ROLLER OPERATING AT 1,600 VIBRATION PER MINUTE. EACH LAYER SHALL BE COMPACTED BY FOUR COVERAGES OF THE ROLLER. COMPACTION SHALL PROCEED IN A LONGITUDINAL DIRECTION ALONG THE EMBANKMENT AND SHALL BEGIN AT THE OUTER EDGE AND PROGRESS TOWARDS THE CENTER.

Graphic Scale in Feet
0 10 20 40 60
1" = 20'
0 200 400 600
1" = 200'
5' Contour Interval

REGISTERED PROFESSIONAL ENGINEER
OREGON
AUG. 22, 1975
E. H. LUBINA

NOTES:

1. See Dwg HC-101 for General Notes.
2. The portion of the Divider Dike below Elevation 662.0 and between Station 10+00 and 55+00 shall be constructed only to the extent necessary to utilize any excess excavation from the Power Plant Area.

3 - EMBANKMENT SECTION BETWEEN STATION 20+00 AND 35+50 SHALL BE CLEARED AND GRUBBED AND UNSUITABLE FOUNDATION MATERIAL REMOVED IN ACCORDANCE WITH THE SPECIFICATION. ADDITIONAL REQUIREMENTS ARE AS FOLLOWS:

THE NOMINAL 3" MINUS MATERIAL SHALL BE COMPOSED OF AN APPROVED MATERIAL. IN PLACE, THE MATERIAL SHALL BE REASONABLY WELL GRADED BETWEEN A NOMINAL SIZE OF 3" AND THE #16 SIEVE.

A REASONABLE AMOUNT OF MATERIAL FINER THAN THE #16 SIEVE WILL BE PERMITTED. THE MATERIAL SHALL BE PLACED IN LIFTS 18" THICK AFTER COMPACTION AND SHALL BE COMPACTED IN ACCORDANCE WITH THE REQUIREMENTS OF SECTION 8.2.6 OF THE SPECIFICATION FOR ZONES III AND IV TO FORM A DENSE AND COMPACT MASS.

No.	DATE	REVISIONS	BY	CHKD	DESIGN SUPV.	ENGR.	ENGR MGR.	APPR.
5	1/10/78	AS BUILT	F.P.	UN	BH	GBH	AH
4	8/2/77	INCORP. FCN No. C-42	UN	F.P.	BH		AH
3	3/1/77	INCORP. FCR No. C-24 & C-25	UN	F.P.	BH	GBH	AH
2	1/6/76	REV. PLAN, ADDED SECT. D & NOTE 3. (DCN No. 1).	F.P.	UN	BH	GBH	AH
1	1/23/74	Issued for Construction	—	AH	BH	GBH	AH
0	11/9/73	Issued for add. #3	Y.N.	BH	AH	AH
0	9/1/73	Issued for Bid	PC	PHL	AH	GBH	AH

SCALE AS NOWN | DESIGNED A. LUBINA | DRAWN A.C. | CHKD ENGR

BECHTEL
SAN FRANCISCO

BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. — PORTLAND, OREGON

DIVIDER DIKE
PLAN AND SECTIONS
STATION 10+00 to 70+00

JOB No.	DRAWING No.	REV.
10411-002	HC-105	6

RECEIVED
MAY 21 1996
WATER RESOURCES DEPT.
SALEM, OREGON

34 x 44 "E" SIZE

10411 - 002

2,176,000E

2,178,000E

2,180,000E

2,182,000E

738,000N

736,000N

For Ash Haul Road, See Dwg 1-C-006

CP-6

M-11

Start of Saddle Dam Sta. 10+00 738,900 N. 2,181,350 E. Elev. 687.67' Top of Macadam by F22

Sta 10+00 Begin Guardrail Both Sides by F22

0-4

℄ SADDLE DAM

Crest Elevation 687.0' without camber - See Dwg. HC-107 for profile and sections.

℄ Ditch (See Note 3)

Divider Dike Sta. 123+14 Equals Saddle Dam Sta. 25+96 737,528 N. 2,182,164 E Elev. 688.17' Top of Macadam by F22

R=66.7'
R=45'

R=150'
R=100'

See Detail (18/107)

S 30° 04' E

24' Dam Crest

0-44 & 0-45 by F02

Approximate toe of Dam on Acceptable Foundation

Toe of Dam on Existing Ground

70+00
80+00
90+00
100+00
110+00
120+00
20+00
30+00
40+00
50+00

45' Berm
24' Crest
45' Berm
3:1 Slope
2.5:1 Slope
100'

℄ DIVIDER DIKE

Crest Elev. 686.0' without camber

MATCH LINE - DRAWING NO. HC-105

End of Saddle Dam 735,350 N. 2,183,456 E. Elev. 687.67' Top of Macadam by F22

Sta. 51+28

Sta 51+28 End Guardrail Both Sides by F22

For Ash Haul Road and Ash Disposal Area, See Dwg. 1-C-007

CP-7

M-12

667.40

SETTLEMENT MONUMENTS (ON LINE M-11 TO M-12)		SET-UP MONUMENTS AND BENCH MARK	
No.	STA	No.	STA
S-21	10+00	M-11	8+00
S-22	14+12.8	M-12	55+28
S-23	18+25.6		
S-24	22+38.4		
S-25	26+51.2		
S-26	30+64.0		
S-27	34+76.8		
S-28	38+89.6		
S-29	43+02.4		
S-30	47+15.2		
S-31	51+28.0		

MONUMENT LOCATION TABLE

Graphic Scale in Feet
0 200 400 600
1" = 200'
Contour Interval 5 Ft.

LEGEND

- ● - Settlement Monuments See Detail (10/109)
- ⊙ - Set-Up Monument and Bench Mark See Detail (9/109)
- △ - Control Point Monument by PGE. See PGE Dwg C-15469
- ▲ - Observation Well - See Detail (13/110)

NOTES:

1. See Dwg. HC-102 for General Notes.
2. See Dwg. HC-107 for Profile and Sections for Saddle Dam
3. Excavate an unlined 3 foot Bottom width ditch on a 0.5% slope from the downstream toe of the Saddle Dam to daylight. Alignment to be determined by the engineer to assure drainage away from the dam.
4. Settlement monument will be used for dam settlement and horizontal movement observations.
5. All work by FOI contractor, except as otherwise shown.

REGISTERED PROFESSIONAL ENGINEER 6420 OREGON AUG. 22, 1975 R. H. LUBINA

RECEIVED
MAY 21 1996
WATER RESOURCES DEPT.
SALEM, OREGON

No.	DATE	REVISIONS	BY	CHKD	DESIGN SUPV	ENGR	PROJ ENGR	APPR
6	1/06/81	AS BUILT-F22 ISSUED FOR CONSTR REPORT RESERVOIR SEEPAGE	JN	F.P.				
5	7/10/80	Issued for Construction - F-22 Contract	JN	F.P.				
4	9/28/79	ADDED DRWG NOS & INCORPORATING SPEC-10791, ISSUED FOR BIDS - F22	JN	F.P.				
3	9/4/79	Added Final Pavement; Issued for Client Approval F22 Work	JN	F.P.				
2	9/18/78	ADDED PGE'S CONTROL PT. MON.	F.P.	JN				
1	7/10/78	Incorp. SK-HC-1024; Rev. As Built	F.P.	JN				
0	11/8/77	Incorp. DCN No. 1	JN	F.P.				
A	9/12/75	Issued for Construction						
1	6/19/75	Issued for add #1	MD					
A	10/1/75	Issued for Bid - 11	RT					

SCALE 1"=200' DESIGNED R. LUBINA DRAWN R.L.T. CHKD

BECHTEL
SAN FRANCISCO

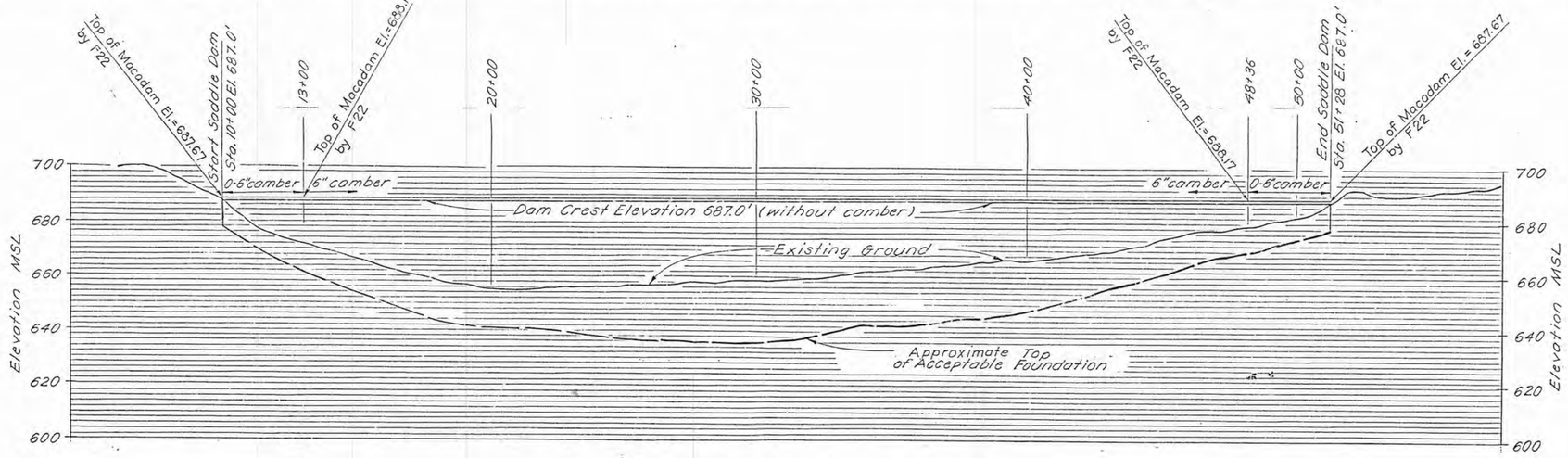
BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. PORTLAND, OREGON

PLAN OF SADDLE DAM AND DIVIDER DIKE STA. 70+00 to 122+90

JOB No. 10411-002 DRAWING No. HC-106 REV. 9

34 x 44 "E" SIZE

10411 - 002

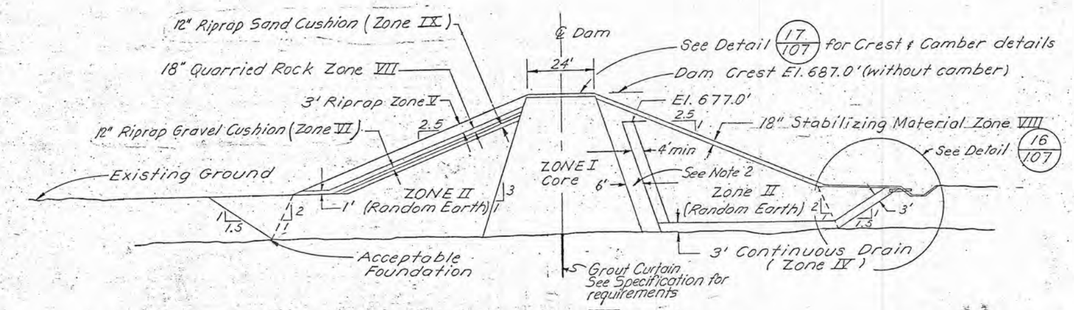


SADDLE DAM
℄ PROFILE

Scale: Vertical-1"=20'
Horizontal-1"=200'

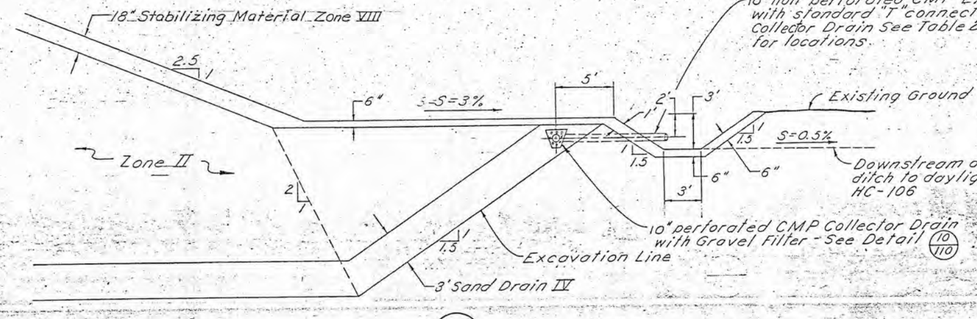
NOTE:

1. See Dwg. HC-102 for General Notes.
2. The Zone II material located between the Zone I Core and the Zone III Chimney Drain shall be loess containing not more than 85 percent by dry weight of particles passing the No. 200 Sieve.
3. All work by FOI contractor except as otherwise shown.
4. Guardrail shall be Type 2A with Type A End Pieces. Refer to State of Oregon, State Highway Division Standard Drawing No. 2126 and 2126A.



TYPICAL SECTION
SADDLE DAM

Scale 1"=20'



DETAIL 16/107
DOWNSTREAM TOE - SADDLE DAM

Scale 1"=5'

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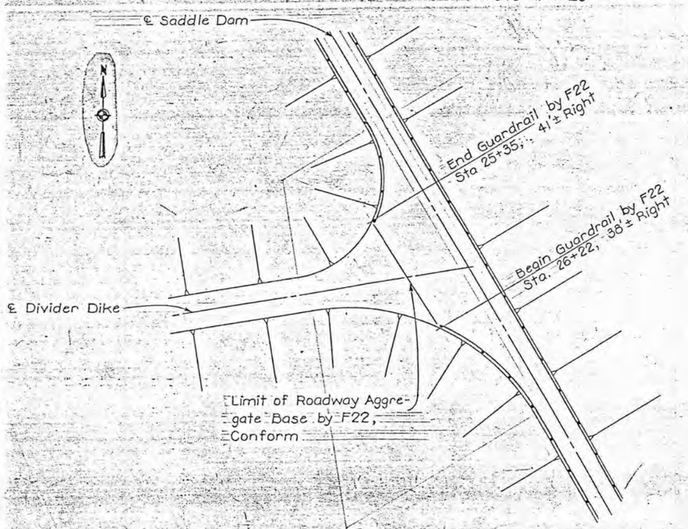
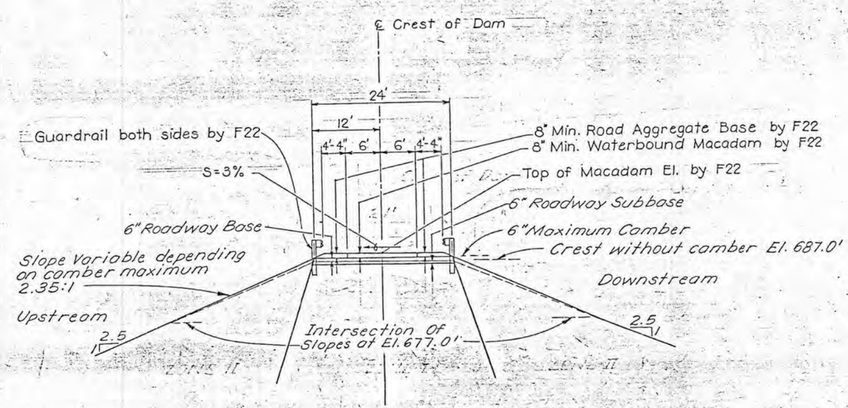
SALEM, OREGON



DETAIL 18/106
PLAN OF INTERSECTION

Scale 1"=40'



DETAIL 17/107
SADDLE DAM CREST & CAMBER

Scale 1"=10'

Graphic Scale in Feet

0 5 10 15 — 1"=5'
0 10 20 30 — 1"=10'
0 10 20 40 60 — 1"=20'
0 200 400 600 — 1"=200'
40' 0' 40' 80' — GRAPHIC SCALE 1"=40'

No.	DATE	REVISIONS	BY	CHK'D	DESIGN SUPV.	ENGR.	PROJ. ENGR.	APPR.
9	1/06/81	As Built-F22.	JN	F.P.				
8	6/10/80	Issued for Construction - F-22 Contract	JN	F.P.				
7	3/28/79	Issued for Bids - F22	JN	F.P.				
6	10/4/78	Added Final Pavement; Issued for Client Approval F22 Work	JN	F.P.				
5	1/10/78	Revised as Built	F.P.	JN				
4	11/8/76	Incorp. DCN No. 1	JN	F.P.				
3	1/27/76	Issued for Construction	—					
2	11/14/75	Issued for add. # 3	REM					
1	10/17/75	Issued for Addendum No. 1	JN					
0	10/1/75	Issued for Bid	RLT					

SCALE AS SHOWN | DESIGNED RL | DRAWN WCH | CHIEF ENGR.

BECHTEL
SAN FRANCISCO

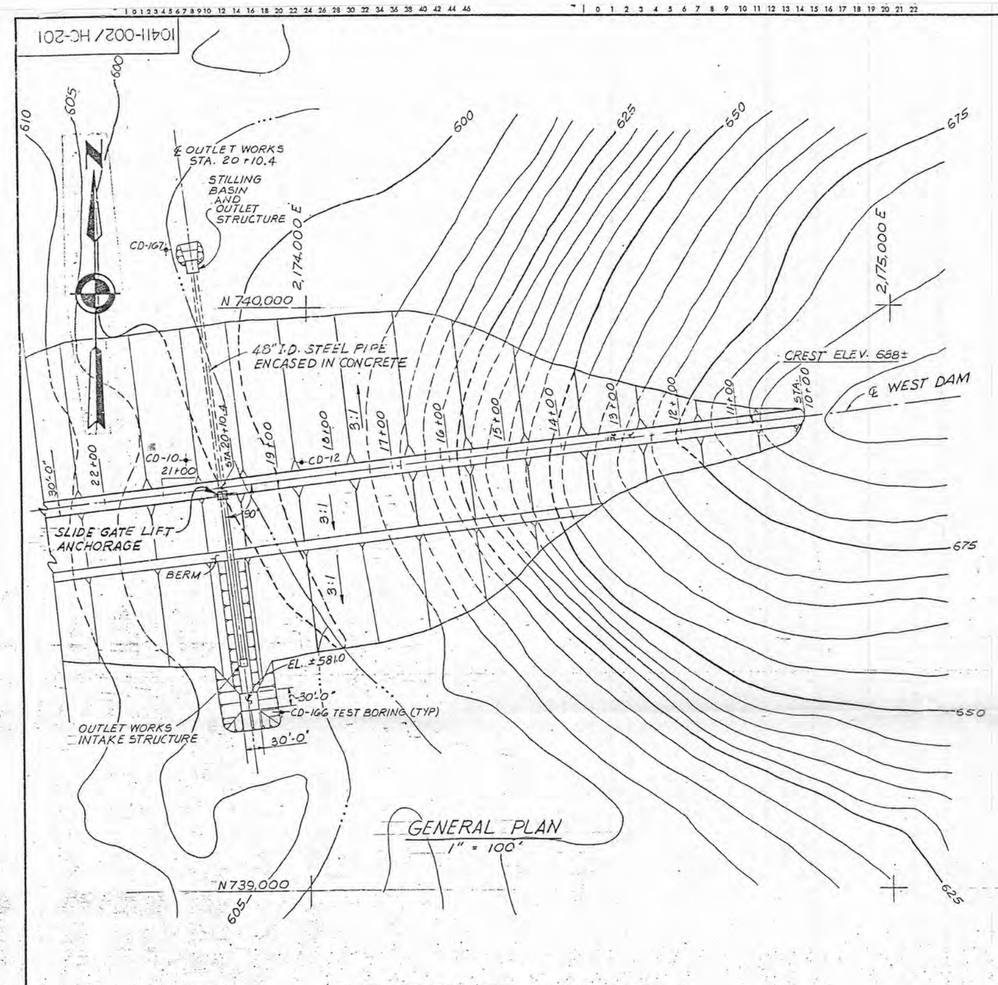
BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. PORTLAND, OREGON

SADDLE DAM
PROFILE & TYPICAL SECTION

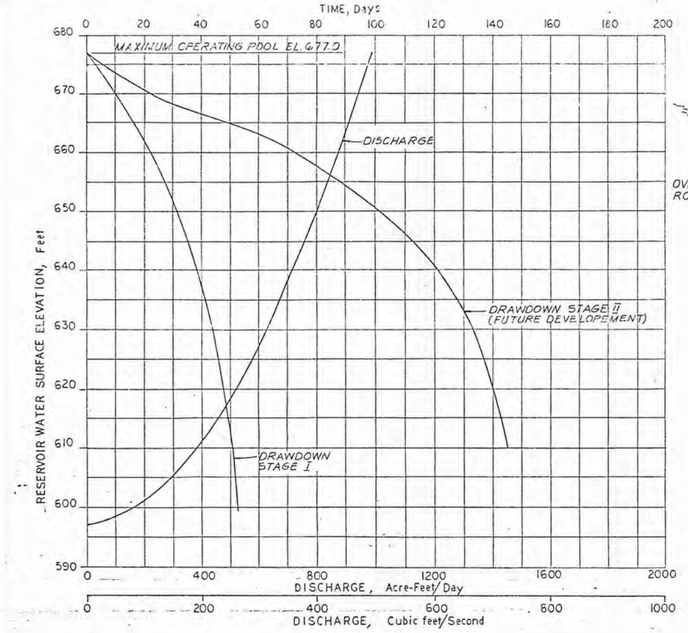
JOB No. 10411-002 | DRAWING No. HC-107 | REV. 9

34 x 44 "E" SIZE

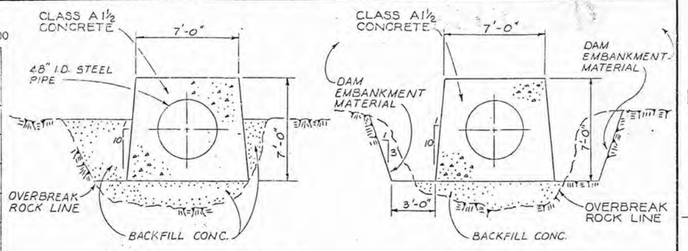
10411-002/ HC-201



GENERAL PLAN
1" = 100'



OUTLET RATING AND RESERVOIR DRAWDOWN CURVES

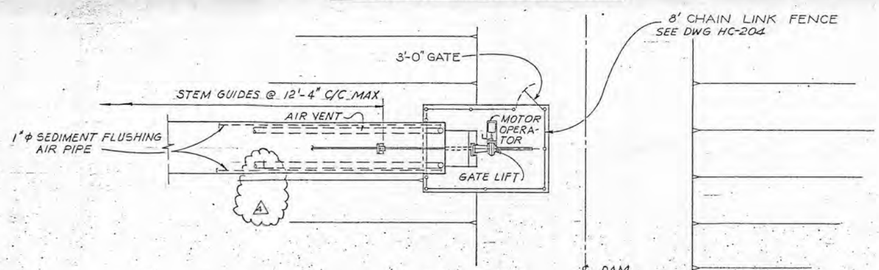


ACCEPTABLE SECTION "A"
N. T. S.

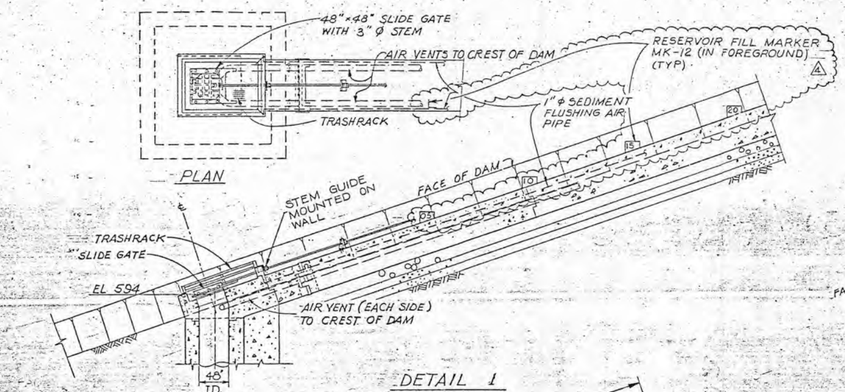
ACCEPTABLE SECTION "B"
N. T. S.

CONDUIT SECTIONS OUTSIDE OF DAM ZONE I CLAY CORE
(FOR CONDUIT IN ZONE I CLAY CORE SEE SECTION E-E DWG. HC-204)

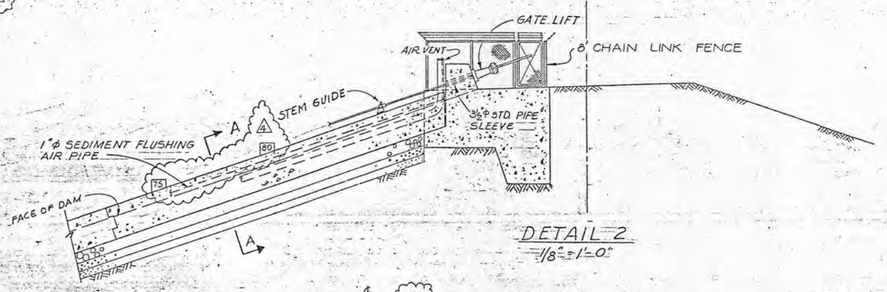
NOTES:
1. FOR GENERAL NOTES AND REFERENCE DRAWINGS: SEE DWG. HC-202.
2. FOR GENERAL LOCATION SEE DWG. HC-102.



PLAN
1/8"=1'-0"

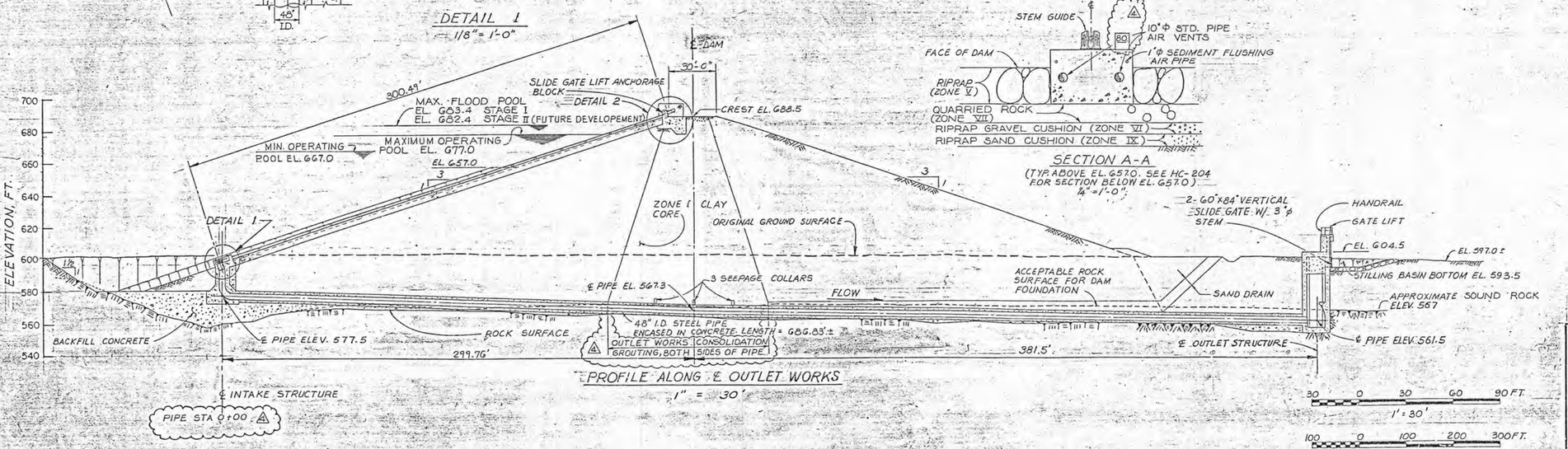


PLAN



DETAIL 2
1/8"=1'-0"

DETAIL 1
1/8"=1'-0"



PROFILE ALONG E OUTLET WORKS
1" = 30'

SECTION A-A
(TYP. ABOVE EL. 657.0. SEE HC-204 FOR SECTION BELOW EL. 657.0)
4"=1'-0"

30 0 30 60 90 FT.
1'=30'

100 0 100 200 300 FT.
1'=100'

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SALEM, OREGON

No.	DATE	REVISIONS	BY	CHKD	DESIGN SUPV.	ENGR	PROJ ENGR	APPR
4	1/10/96	REVISED AS BUILT.	F.P.	UN				
3	3/3/95	INCORP. DCN No. 1, 2, SK-HC-1002, REV. CONDUIT, ADDED JOINT	F.P.	UN				
2	1/23/95	REVISED RIPRAP CUSHION & ISSUED FOR CONSTRUCTION	J.N.					
1	9/19/95	Issued for Addendum No. 1	J.N.					
0	8/1/95	ISSUED FOR BID	F.P.	J.N.				

SCALE AS SHOWN | DESIGNED V.A.D. | DRAWN REM | CHIEF ENGR. CHARLEY

REGISTERED PROFESSIONAL ENGINEER OREGON 8233 EXPIRES: DEC. 31, 1996 CHRISTOPHER A. GARDNER

BECHTEL
SAN FRANCISCO

BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. PORTLAND, OREGON

OUTLET WORKS
GENERAL ARRANGEMENT

JOB No.	DRAWING No.	REV.
10411-002	HC-201	4

34 x 44 "E" SIZE

10411-002 / HC-202

SCALING RULES

NOZZLES SET AT 45°

FRAME MK 6 & TRASHRACK MK 7

48" I.D. PIPE

10" Φ AIR VENT PIPE

48" SQ. FLANGE ROUND OPENING TYPE "E" THIMBLE

1" Φ SEDIMENT FLUSHING AIR PIPES

VIEW A
INTAKE STRUCTURE
1/4" = 1'-0"

BACKFILL CONCRETE

SOUND ROCK

SECTION H-H
1/8" = 1'-0"

19 LADDER RUNGS MK 5 @ 1'-0" c/c BETWEEN EL. 614.08 & EL. 596.08

HANDRAIL MK 3

SAFETY GUARD MK 9

3½" Φ STD. PIPE SLEEVE

PLAN
OUTLET STRUCTURE
1/4" = 1'-0"

℄ DAM

1" Φ SEDIMENT FLUSHING AIR PIPES

FOR CHAIN LINK FENCE SEE DWG. HC-204

PROVIDE BOTTOM FENCE RAIL

10" Φ AIR VENT PIPE

PLAN
1/4" = 1'-0"

CONSTRUCTION JOINT @ 50'-0"± ALONG SLAB

APPROX. EXISTING GROUND EL. 603.0±

VIEW A

36'-0"

FACE OF DAM

3½" Φ STD. PIPE SLEEVE

℄ SLIDE GATE STEM

10" Φ AIR VENT PIPE

9" PVC WATER STOP TYPICAL ALL AROUND.

TYPE "E" THIMBLE

EL. 594.0

DETAIL 2

EL. 590.60

PIPE FLANGED END

DAM EMBANKMENT MATL.

SHEAR COLLARS: 4'-9" O.D., ⅜" PL. WELDED TO PIPE (TYP)

CONCRETE BACKFILL

STRUCTURAL BACK-FILL PAYLINES

SEE DET. 1 (SIMILAR)

CONSTRUCTION JOINT EVERY 50 FT.± ALONG CONDUIT

STRUCT. BACKFILL PAYLINES

EL. 577.5

CONC. PAYLINES

SEE DET. 1

PIPE STA 0+00

PIPE SUPPORT AND HOLD DOWN SEE DWG HC-204

BACKFILL CONCRETE

SOUND ROCK

SECTION A-A
1/4" = 1'-0"

STEP CONSTRUCTION JOINT IN SIMILAR DETAIL ONLY

OUTSIDE FACE

9" PVC WATER STOP

DETAIL 1
N.T.S.

DAM EMBANKMENT MATERIAL

7'-0"

ROCK ELEVATION VARIES

BACKFILL CONC.

SECTION B-B
1/4" = 1'-0"

RESERVOIR FILL MARKER MK 12

1" Φ SEDIMENT FLUSHING AIR PIPES

10" Φ STD. PIPE AIR VENTS

WATER STOP

CONSTRUCTION JOINT

FACE OF DAM

(VARIES FROM 3'-0" TO 3'-6" ABOVE EL. 278)

RIPRAP (ZONE V)

QUARRIED ROCK (ZONE VII)

RIPRAP GRAVEL CUSHION (ZONE VI)

RIPRAP SAND CUSHION (ZONE IX)

SECTION C-C
½" = 1'-0"

(TYPICAL ABOVE EL. 657.0. SEE DWG. HC-204 FOR SECTION BELOW EL. 657.0).

EL. 614.58

STEM GUIDE MOUNTED ON BOTTOM OF BEAM

60"x84" TYPE "E" THIMBLE W/ BOLTED CONC. ANCHORS IN DRILLED HOLES

EL. 604.5

℄ GATE STEM

APPROX. EXIST. GROUND EL. 597.0 ±

FRAME MK 1

TRASHRACK MK 2

EL. 594.5

EL. 593.5

EL. 586.0

C.J.

5'-0" (TYP)

STRUCTURAL EXCAVATION & BACKFILL PAYLINE, TYPICAL ALL SIDES

APPROX. SOUND ROCK EL. 567.0

FLANGE FOR FIELD HYDROSTATIC TESTING

PIPE

EL. 561.5

WATER STOP (TYP)

EL. 556.5

STRUCTURAL EXCAVATION PAYLINES IN SOUND ROCK

SHEAR COLLAR (SAME AS ON SECTION A-A).

SECTION D-D
1/4" = 1'-0"

LIFT ANCHORAGE

STEEL VENT CAP W/ SCREEN. PROVIDE MIN. 60 SQ. INCHES OF FREE AREA.

3½" Φ STD PIPE SLEEVE

℄ STEM

10" Φ AIR VENT PIPE

1" Φ SEDIMENT FLUSHING AIR PIPE W/ CAP AT TOP END.

FACE OF DAM

EL. 638.05

RIPRAP CUSHION

1" PREMOLDED JOINT FILLER

SECTION G-G
1/4" = 1'-0"

SECTION F-F
1/4" = 1'-0"

REFERENCE DRAWINGS

HC-201 OUTLET WORKS - GENERAL ARRANGEMENT
HC-203 OUTLET WORKS STEEL REINFORCEMENT
HC-204 OUTLET WORKS MISCELLANEOUS DETAILS
HC-205 OUTLET WORKS MISCELLANEOUS METAL
HC-103 WEST DAM PLAN

NOTES

1. ALL CONCRETE SHALL BE CLASS A1½ UNLESS OTHERWISE SHOWN OR DESCRIBED.
2. CHAMFER ALL PROJECTING AND RE-ENTRANT CORNERS ¾" UNLESS OTHERWISE SHOWN.
3. MISCELLANEOUS METAL WORK IS IDENTIFIED BY MARK NUMBERS I.E. ITEM MK3. ALL DETAILS ARE SHOWN ON DWG. HC-205.
4. ANCHOR BOLT SIZE, LENGTH AND LOCATION FOR GATES AND ANCILLARY EQUIPMENT SHALL BE VERIFIED BY GATE MANUFACTURER. NOT ALL EMBEDDED ITEMS ARE SHOWN ON THE CONCRETE OUTLINE DRAWINGS. BEFORE PLACING CONCRETE SEE APPROPRIATE CIVIL AND VENDOR DRAWINGS.
5. CONSTRUCTION JOINTS SHOWN ARE SUGGESTED LOCATIONS ONLY. ALL CONSTRUCTION JOINTS SHALL BE SUBJECT TO APPROVAL OF THE ENGINEER.
6. FOR REINFORCING DETAILS SEE DWGS. HC-203 AND HC-204.
7. THE CONCRETE SUPPORT SLAB FOR THE GATE STEM GUIDES ON THE FACE OF THE DAM SHALL NOT BE PLACED UNTIL THE DAM EMBANKMENT HAS BEEN CONSTRUCTED TO FULL HEIGHT.
8. ALL STEEL PIPE AND REINFORCEMENT TEMPORARILY EXPOSED DURING CONSTRUCTION SHALL BE PROTECTED FROM CORROSION AS REQUIRED.

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MAY 21 1996
WATER RESOURCES DEPT.
SALEM, OREGON

No.	DATE	REVISIONS	BY	CHKD	DESIGN SUPV.	ENGR	PROJ ENGR	APPR
6	1/10/96	REVISED AS BUILT	F.P.	JN				
5	3/5/96	INCORP DCN No. 6, 7; ADDED C.J.; REV. SECT. B-B	F.P.	JN				
4	9/24/96	INCORP. DCN No. 1 THRU 5; REV. C.J.	JN					
3	1/21/96	REVISED RIPRAP CUSHION & ISSUED FOR CONSTRUCTION	JN					
2	10/1/95	Issued for Addendum No. 1	JN					
1	9/1/95	ISSUED FOR BID	F.P.	JN				

SCALE AS SHOWN | DESIGNED V.A.D. | DRAWN REM | CHIEF ENGR. C. Gates

BECHTEL
SAN FRANCISCO

BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. — PORTLAND, OREGON

OUTLET WORKS CONCRETE OUTLINE

JOB No. 10411-002 | DRAWING No. HC-202 | REV. 5

REGISTERED PROFESSIONAL ENGINEER 8233 OREGON JULY 20, 1971 EDWARD C. GARDNER

SECTION M-M
1/4" = 1'-0"

20'-0"

16'-0"

8'-0"

48" I.D.

CONSTRUCTION JOINT

CONCRETE BACKFILL

COVER MK-10 (SEE DWG. HC-205)

EXPOSED PORTION OF SEDIMENT FLUSHING AIR PIPE SHALL BE 1" COPPER TUBING BENT AS SHOWN WITH ISOLATING UNION AT CONNECTION TO STEEL PIPE. COPPER SHALL BE EMBEDDED 4" INTO THE CONCRETE.

BLOCK OUT 9" WIDE SECTION OF CONC. AT CORNER

PIPE COUPLING

LONG SLEEVE COUPLING ON AIR VENT PIPE ("SMITH-BLAIR" NO. 412-IG-1075 OR APPROVED EQUAL).

STAINLESS STEEL PIPE 2'-0" LONG

GALV. STEEL PL 8" x ¼" x 7'-0"

GALV. STEEL PL 2'-4" x ⅜" x 4'-6" BOTH SIDES

DETAIL 2
½" = 1'-0"

FILLET (TYP)

9 SPA. @ 1'-4" = 12'-0"

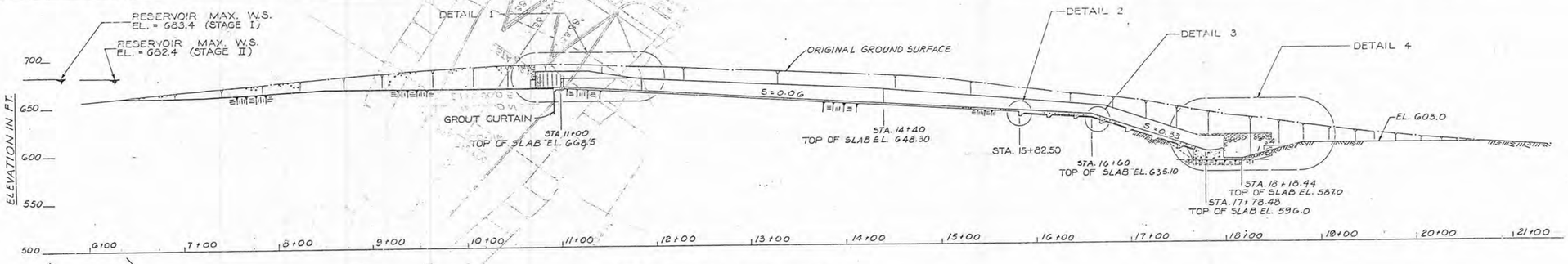
SECTION E-E
1/4" = 1'-0"

SECTION F-F
1/4" = 1'-0"

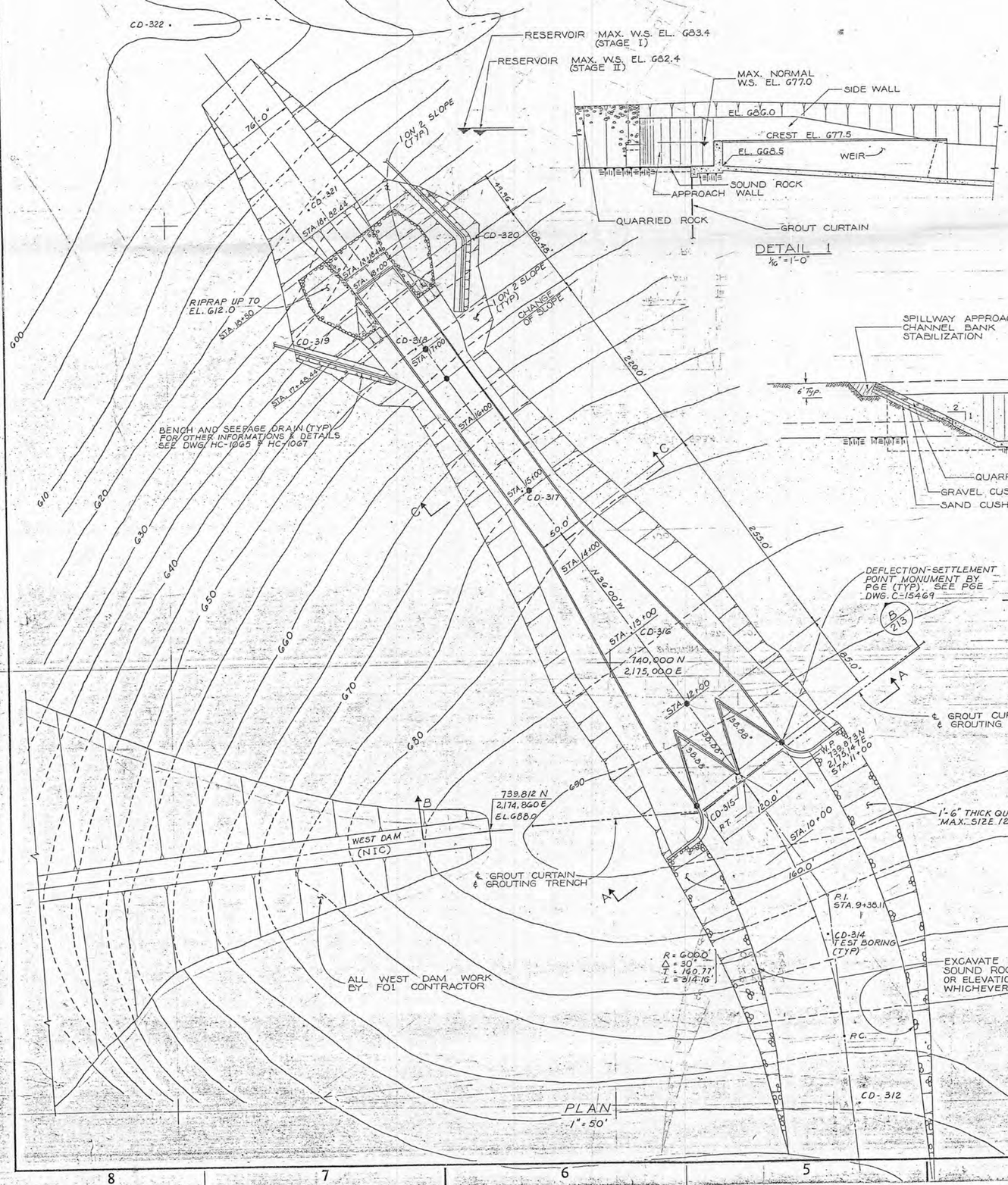
8 7 6 5 4 3 2 1

34 x 44

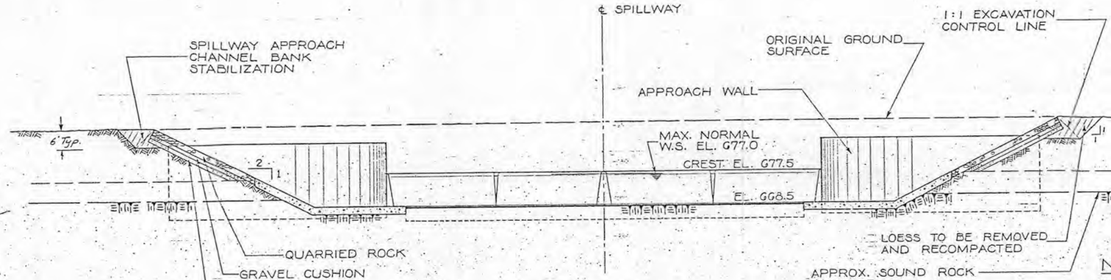
10411-002/HC-209



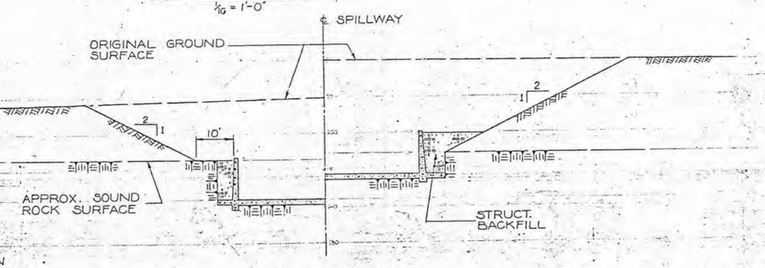
PROFILE ALONG ℄ SPILLWAY
1" = 50'



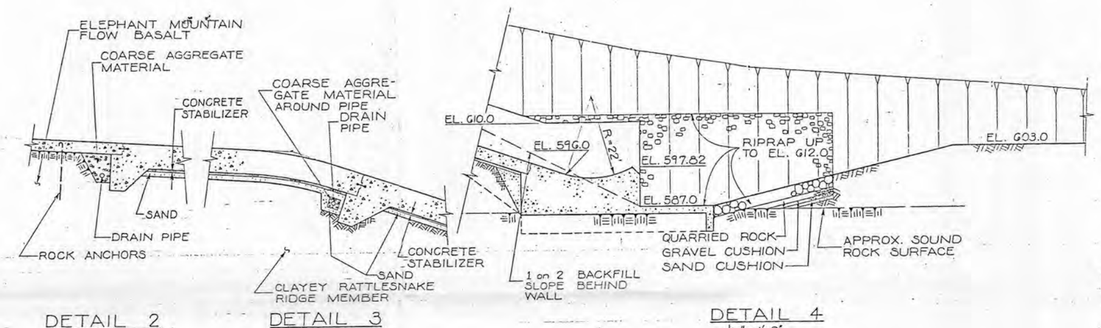
PLAN
1" = 50'



SECTION A-A
1/16" = 1'-0"



SECTION C-C
1/16" = 1'-0"



DETAIL 1
1/16" = 1'-0"

DETAIL 2
1/8" = 1'-0"

DETAIL 3
1/8" = 1'-0"

DETAIL 4
1/16" = 1'-0"

NOTES

1. FOR GENERAL NOTES AND REFERENCE DRAWINGS SEE DWG. HC-210.

0 10 50 100 200 FEET
1" = 50'

0 5 10 20 40 60 FEET
1/16" = 1'-0"

REGISTERED PROFESSIONAL ENGINEER
8233
OREGON
SEPT. 20, 1974
CHRISTOPHER A. GARDNER

RECEIVED
MAY 21 1996
WATER RESOURCES DEPT.
SALEM, OREGON

No.	DATE	REVISIONS	BY	CHKD	DESIGN ENGR	PROJ ENGR	APPR
6	1/06/81	ADDED BENCH & SEEPAGE DRAIN INCORPORATING DWG SK-HC-1040; ISSUED FOR CONSTR REPORT RES SEEPAGE	F.P.	JN			
5	7/10/78	ADDED PGE'S DEFLECTION-SETTLEMENT PT. MON.	F.P.	JN			
4	1/10/78	INCORP. DCN No. 1 & 2; AND REVISED AS BUILT	JN	F.P.			
3	9/13/76	ISSUED FOR CONSTRUCTION	JN	F.P.			
2	7/16/75	REV. APPR. CHANNEL, WALLS; ISSUED FOR DESIGN REPORT	F.P. JN				
1	3/3/75	ISSUED FOR BIDS	JN				

SCALE As Shown | DESIGNED R.P. | DRAWN F.P. | CHIEF ENGR

BECHTEL
SAN FRANCISCO

BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. PORTLAND, OREGON

DAM SPILLWAY
GENERAL ARRANGEMENT

JOB No.	DRAWING No.	REV.
10411-002	HC-209	5

34x44 "E" SIZE

CAPACITY (X 1000 ACRE-FEET)

WATER SURFACE ELEVATION (FEET)

SURFACE AREA (X 100) ACRES

CAPACITY

SURFACE AREA

VOLUME PUMPED
(Per Dosing Flowmeter)

MATCH LINE
FOR CONTINUATION OF PUMPING
INPUT CURVE, SEE DWG SK-HC-1080

RECEIVED
MAY 21 1996
WATER RESOURCES DEPT.
SALEM, OREGON

No.	DATE	REVISIONS	BY	CHKD	PROJ ENGR	ENGR MGR	APPR
1	5/JA-16	ISSUED FOR COSTA REPORT-RESERVOIR SEEPAGE	UN	F.P.			
2	27 FE-80	SUPERSEDES SK-HC-1036; REMOVED SK-; ISSUED FOR PGE USE	UN	F.P.			

SCALE | DESIGNED UN | DRAWN UN | CHK'D DATE

BECHTEL
SAN FRANCISCO

BOARDMAN PLANT
PORTLAND GENERAL ELECTRIC CO. PORTLAND, OREGON

CARTY RESERVOIR - STAGE I
AREA-CAPACITY CURVES
& PUMPING INPUT CURVE

JOB No.	DRAWING No.	REV.
10411-002	HC-1079	1