Mailing Address:
Water Resources Data System
University of Wyoming, Dept 3943
1000 E University Avenue
Laramie, WY 82071

Physical Address:
Wyoming Hall, Room 249
University of Wyoming
Laramie, WY 82071

Phone: (307) 766-6651
Fax: (307) 766-3785

Funding for WRDS and the creation of this electronic document was provided by the Wyoming Water Development Commission (http://wwdc.state.wy.us)

SUMMARY & ANALYSIS OF THE CITY OF CHEYENNE'S PROPOSED STAGE II WATER SYSTEM EXPANSION

PREPARED FOR
THE GOVERNOR'S
INTERDEPARTMENTAL
WATER CONFERENCE

PREPARED BY
WYOMING WATER PLANNING PROGRAM
STATE ENGINEER'S OFFICE

DECEMBER, 1978

SUMMARY AND ANALYSIS
OF THE PROPOSED STAGE II WATER SYSTEM EXPANSION

C O N T E N T S

TABLES

FIGURES

I - PRESENT WATER SUPPLIES, USES AND RELATED MATTERS

The City of Cheyenne, Douglas Creek and Little Snake River system, is a system to exchange water imported from the Little Snake River drainage into the North Platte drainage for water diverted from Douglas Creek out of the North Platte drainage to Cheyenne. This exchange is necessary due to restrictions on North Platte River storage under the U. S. Supreme Court Decree on the North Platte River.

A brief description of the existing Douglas Creek and Little Snake River facilities (as well as the Crow Creek and well field facilities) is included in the following subsections. The physical layout of these facilities is shown on Figure I-1.

Little Snake Diversion Pipeline, Tunnel and Hog Park Drop

The Little Snake Diversion Pipeline, a Transcontinental Divide Tunnel, and Hog Park Drop divert and convey water from the North Fork Little Snake River and its tributaries on the west side of the Continental Divide, into Hog Park Creek on the east side of the Continental Divide. Hog Park Creek, a tributary of the Encampment River, is in the North Platte River drainage.

The main line of the Little Snake Diversion Pipeline is a 36-inch diameter reinforced concrete pipeline that collects water from the North Fork Little Snake River and its tributaries by several in-channel diversion dams. The pipeline system also collects inflow from small streams and sidehill runoff by means of small inlet structures.

The water collected by the pipeline is transported under the Continental Divide by a nine by eight foot, unlined, horseshoe-shaped tunnel. The tunnel is 3,480 feet long with a 20-foot vertical drop from the west tunnel portal to the east tunnel portal. Maximum capacity of the tunnel is about 340 cubic feet per second (cfs).

The Transcontinental Divide Tunnel discharges into a 30-inch diameter reinforced concrete pipe called Hog Park Drop. Hog Park Drop carries the Little Snake water into Hog Park Creek, discharging near the backwaters of Hog Park Reservoir. The primary purpose of Hob Park Drop is to control erosion in the Hog Park Creek channel, which could result from the influx of additional water.

A Parshall flume, equipped with a recording gage, is located downstream of Hog Park Drop. This measures the amount of water transported across the Continental Divide. Monthly tunnel diversions for the period of operation (calendar years 1965-1978) are shown on Table I-2. The average annual diversion (or yield) from the west slope during this period has been 7,436 AF (acre-feet), with about 81 percent of the annual runoff coming during May through July. This water is collected from 3,800 acres of watershed above diversion structures and small inlets. This represents an average annual watershed yield of about 2.0 acre-feet per acre. As the

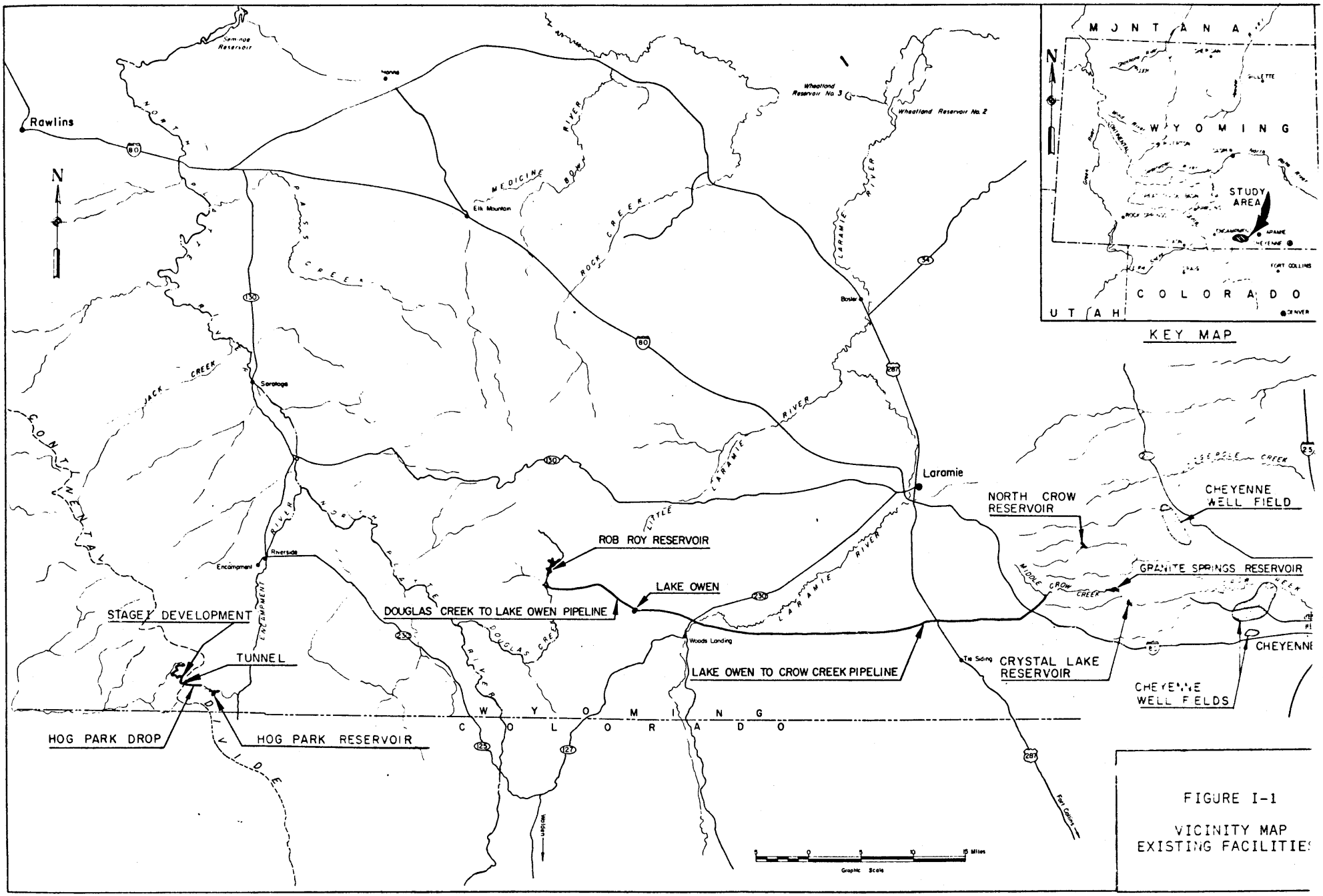


FIGURE I-1

VICINITY MAP
EXISTING FACILITIES

TABLE I-1

Summary of Cheyenne's Water Supply System, Sizes and Capacities

Reservoirs

Name	Capacity in AF (Acre-Feet)
Hog Park Reservoir	2,970
Rob Roy Reservoir	8,895
Lake Owen Reservoir	750
Granite Springs Reservoir	5,320
Crystal Lake Reservoir	3,410
North Crow Reservoir	1,865

Pipelines

Name	Type	Size	Cap. in CFS
Little Snake Diversion Pipeline (Capacity at Upstream Tunnel Portal)	Reinf. Concrete	18",27",36"	85
Tunnel	Rock	8'x9' Horseshoe	340
Hog Park Drop	Reinf. Concrete	30"	85
Douglas Creek to Lake Owen Pipeline	Reinf. Concrete	24" & 33"	23
Lake Owen to Middle Crow Creek	Steel	26"	17.7

Treatment Facilities

Name	Capacity in MGD
Roundtop Treatment Plant	6-12
New Treatment Plant	20

Treated Storage

Name	Capacity in MG
Roundtop	12
King	5
North Cheyenne Tank	5

system was operated at a level less than source yield during years 1966 and 1971, the average shown in the table exclude these years.

Hog Park Dam and Reservoir

Hog Park Reservoir, with a storage capacity of about 2,970 AF, was constructed for the primary purpose of controlling channel erosion in Hog Park Creek. Hog Park Dam is a 60-foot high, 500-foot long, compacted earthfill dam built on Hog Park Creek and located about 2.8 river miles upstream from Hog Park Creek's confluence with the Encampment River. Hog

Park Dam was completed in 1965, and has maintained a full reservoir during most of its operation. The reservoir has spilled every year except 1977 over an ungated, concrete-lined, chute spillway. Releases are regulated through the outlet works by means of two butterfly valves, one 18-inch and one 36-inch.

The spillway and outlet works discharge their combined flows into Hog Park Creek of the North Platte River Drainage. Releases into the North Platte River Drainage are adjusted daily to replace water taken from the North Platte River Drainage on Douglas Creek. West slope water is released from Hog Park Reservoir to match the daily depletion of Douglas Creek, resulting from storage at Rob Roy Reservoir and direct flow diversions into Lake Owen Reservoir. The natural inflows to Hog Park Reservoir are essentially released at the same time and rate as they enter the reservoir.

Hog Park Reservoir also has become a popular recreation site with extensive use by fishermen, campers, and picnickers. In addition, the reservoir is large enough to accommodate small boats and canoes. Hog Park Reservoir usually is accessible only between late spring and late autumn.

Rob Roy Dam and Reservoir

Rob Roy Reservoir, with a capacity of about 9,000 AF, impounds and regulates the flow of Douglas Creek, a tributary of the North Platte River. The location of Rob Roy Reservoir is shown on Figure I-1. Rob Roy Dam is a 95-foot high, 1,094-foot long, compacted earthfill dam located about 80 miles west of Cheyenne in the Medicine Bow Mountains. Rob Roy Dam is located on the upper reaches of Douglas Creek. It collects runoff from about 21 square miles of mountain watershed, with an average elevation of about 9,700 feet. The average inflow, by statistical extension of historical records, is 24,725 AF per year. About 84 percent of the annual inflow to Roy Roy Reservoir occurs during May and June in the form of snowmelt runoff.

Controlled releases from Rob Roy Reservoir may be made through the gated outlet works tunnel through the west abutment of the dam. An ungated Morning Glory spillway also discharges into the tunnel through the west abutment. Storage releases from Rob Roy Reservoir are diverted into the Douglas Creek to Lake Owen Pipeline at a point on Douglas Creek 1.5 miles downstream from Rob Roy Dam. Water is passed through Rob Roy Reservoir to maintain minimum downstream flows in Douglas Creek. The Special Use Permit issued by the U. S. Forest Service requires a minimum flow of one cfs, or the natural inflow into the reservoir, whichever is less, to be maintained at a point 100 feet below the Douglas Creek diversion dam.

Rob Roy Reservoir also has become a recreational attraction. Boat launches, camping, and picnic facilities are available. The reservoir is accessible from late spring to late fall.

TABLE I-2
MONTHLY AND ANNUAL SYSTEM DIVERSION
FROM LITTLE SNAKE TO NORTH PLATTE
(ACRE-FEET)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1965	93	84	93	90	2,369	3,699	2,072	279	186	179	180	186	9,510
*1966	93	84	93	150	192	1,940	172	0	0	33	75	62	2,894
1967	62	56	62	60	1,859	4,884	1,672	231	96	68	139	124	9,313
1968	109	87	89	183	1,419	4,228	962	240	150	155	150	155	7,927
1969	155	140	156	396	3,163	2,490	822	252	173	122	90	93	8,052
1970	93	84	93	101	1,995	3,476	1,309	246	253	165	155	155	8,125
*1971	155	140	155	396	441	592	1,620	295	123	117	120	124	4,278
1972	124	100	93	199	2,217	3,138	630	199	132	124	120	124	7,200
1973	124	112	124	138	2,277	3,141	1,312	342	186	155	150	155	8,216
1974	155	140	155	266	2,549	2,118	851	189	82	99	86	169	6,859
1975	54	56	62	108	1,104	1,911	1,123	315	99	88	74	70	5,064
1976	93	87	89	159	2,255	3,261	1,123	218	107	104	73	58	7,627
1977	62	56	62	335	2,053	1,565	7	2	0	31	94	92	4,359
1978	93	58	42	196	1,421	2,596	1,855	335	120	104	81	83	6,984
Total	1,217	1,060	1,120	2,231	21,681	36,507	13,738	2,848	1,584	1,394	1,392	1,464	89,236
Average	102	88	93	186	2,057	3,042	1,145	237	132	116	116	122	7,436

*System operated below capacity during several months of year. These two years are not included in monthly and annual averages.

Douglas Creek to Lake Owen Pipeline

The Douglas Creek to Lake Owen Pipeline diverts Douglas Creek and Horse Creek water into Lake Owen Reservoir. This pipeline was constructed using two miles of 24-inch and nine miles of 33-inch reinforced concrete pipe. The capacity of the pipeline is 23 cfs (16,650 AF per year).

Rob Roy Reservoir releases are diverted into the pipeline by means of a small diversion dam on Douglas Dam. A diversion dam also is located on Horse Creek, a tributary of Douglas Creek, near the Douglas Creek Diversion Dam. The diversion dams are designed so water can be collected year round. The diversion dams also can bypass flows when necessary.

A provision has been made for the installation of six additional feeder pipelines. Blind flanges for 18-inch feeder lines are located along the pipeline on the bottoms of siphons adjacent to creeks. It will be necessary to extend the feeder lines to collection structures located above the hydraulic grade line of the main pipeline. The six feeder lines would collect water from the North Branch Muddy Creek, East Branch Camp Creek, Middle Branch of Camp Creek, Camp Creek, Beaver Creek, Nugget Gulch Branch of Beaver Creek, Gold Crater Creek, and Podunk Creek.

Lake Owen Reservoir

Lake Owen is a natural lake which was enlarged by construction of a small earthfill dam to provide a regulating reservoir and also a reduction in pressure between the Douglas Creek to Lake Owen Pipeline and the Lake Owen to Middle Crow Creek Pipeline. The reservoir, with a capacity of 750 AF, receives the discharge from the Douglas Creek to Lake Owen Pipeline.

Lake Owen to Middle Crow Creek Pipeline

The Lake Owen to Middle Fork Crow Creek Pipeline is a 39-mile long (205,800 linear feet), 26-inch, steel pipeline. Extremely high pressures, up to 625 pounds per square inch (psi), occur in the line. Regulatory constraints limit pipeline capacity to 17.7 cfs (12,800 AF per year) to avoid damage to mechanical couplings. However, operational experience has shown that the practical pipeline capacity is about 11,000 AF per year. The reduced pipeline capacity is due to maintenance work and limitations in water availability.

The Douglas Creek water flows by gravity into Middle Crow Creek near Turtle Rock in the Veedauwoo area. The pipeline discharge into Middle Crow Creek is measured at a meter house near Ames Monument.

Existing Douglas Creek Facility Yields

Rob Roy Reservoir and Douglas Creek	11,500 AF per year
Horse Creek	1,500 AF per year
Existing Douglas Creek Yield	13,000 AF per year

(It should be noted that the capability of the existing features of the Little Snake Diversion System to provide replacement water is limited to

an average of about 7,400 AF per year, thus limiting the overall ability to deliver water to Cheyenne to an amount less than could be produced from Douglas Creek.)

Crow Creek Surface Water Supply Facilities

Surface water supplies are obtained from the North, Middle, and South Forks of Crow Creek, and Brush Creek in the Crow Creek Drainage. The North Fork facilities include North Crow Reservoir, the North Crow Diversion Dam, and the Brush Creek Diversion Dam. The Middle Crow Creek facilities include Granite Springs Reservoir, Crystal Lake Reservoir, and the Middle Crow Diversion Dam. The South Fork facilities include the South Crow Diversion Dam.

The Douglas Creek water that is transported from Lake Owen to Middle Crow Creek eventually flows, together with the Middle Crow's natural flow, into Granite Springs and Crystal Lake Reservoirs. Water can be released from Crystal Lake Reservoir into Middle Crow Creek and diverted to the Cheyenne water treatment plants. This water is diverted into the treatment plant pipelines by means of the North Crow, Brush Creek, Middle Crow, and South Crow diversion dams.

The Crow Creek Drainage has yielded an average annual flow of about 5,000 AF. Table I-3 includes a tabulation of yields of the Crow Creek Drainage for the period 1941-1978. The drainage basin has yielded in excess of 6,000 AF for several years. However, the recent drought has reduced yield in the Crow Creek Drainage significantly.

It can be seen in Figure I-2 that annual precipitation in Cheyenne has been at or below average for over 25 years. The 5-year moving average, indicated by the dotted line, illustrates this trend. This would explain, to a large degree, the declining yields from both the Crow Creek Drainage and Cheyenne's well fields.

Cheyenne's Well Fields

The Cheyenne well fields include 44 wells west and northwest of the city. These well fields tap aquifers in the White River and Ogallala Formations. The system includes 25 wells in the Main Well Field, 10 wells in the Bell Field, and 9 wells in the Federal Well Field. The Main Well Field is about 6 miles west of Cheyenne and extends north and south 5 miles from Interstate 80 to a little north of the Happy Jack Road. The Bell Field is directly north of the Main Well Field and extends north and south about 2 miles. The wells in the Federal Well Field are about 12 miles northwest of Cheyenne and are spaced in a north-south alignment 5 miles in length.

Pipelines are available to deliver the well water to the Roundtop Water Treatment Plant and to the King Underground Storage Reservoir. The carrying capacity of the pipelines is adequate to deliver the maximum yield of the wells.

In order to have a reserve supply which can be relied upon to provide water in unexpected or emergency situations, the Board of Public Utilities

TABLE I-3

Annual Yields from the Crow Creek Drainage and the Cheyenne Well Fields

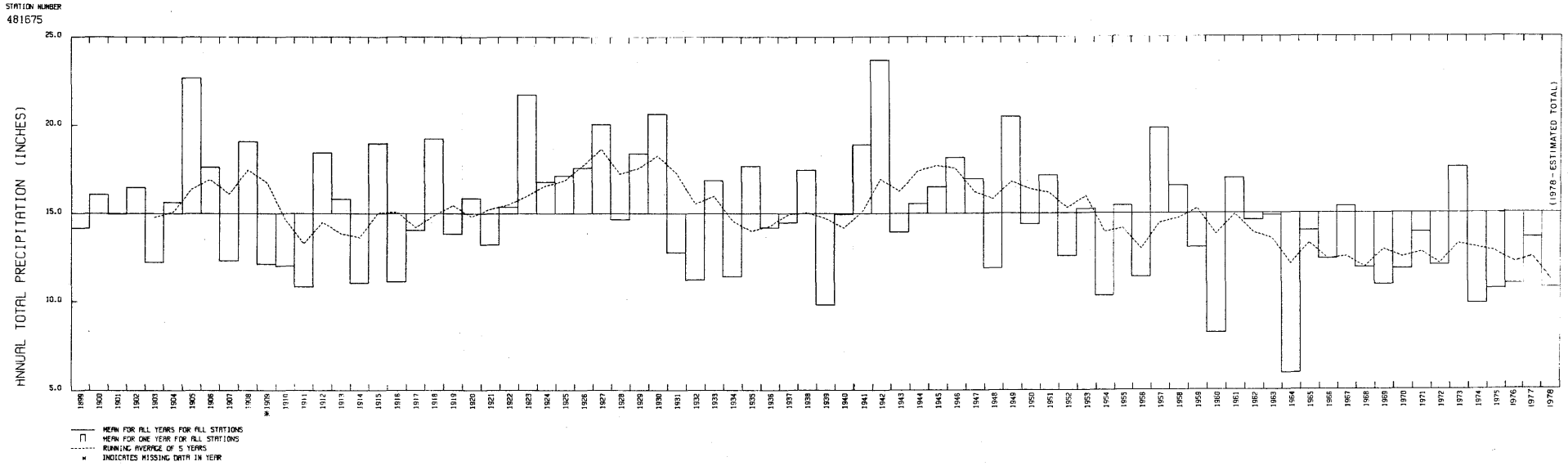
(All Values in AF)

Calendar Year	Crow Creek Yield	Cheyenne Well Fields Yield
1941	4398	2689
1942	6359	1876
1943	6853	1722
1944	7620	2042
1945	7175	2388
1946	6512	2051
1947	6626	1523
1948	7359	1308
1949	7761	525
1950	5972	2321
1951	4895	2392
1952	6982	3635
1953	3268	5081
1954	4649	5244
1955	2507	7347
1956	4781	6840
1957	5220	3871
1958	6515	2775
1959	6681	3263
1960	6334	4912
1961	N.A.	4472
1962	N.A.	3422
1963	N.A.	3606
1964	N.A.	4576
1965	N.A.	2514
1966	N.A.	4677
1967	6243	2860
1968	6548	2723
1969	2943	3570
1970	5020	3529
1971	4985	2784
1972	2076	3001
1973	6744	3443
1974	4983	4171
1975	1708	2291
1976	-800*	2035
1977	92	8115
1978	3200	4990
Average	5069	3436
Last 12 yr Avg	3645	3626

*Evaporation and seepage from onstream reservoirs were greater than the drainage basin yield.

FIGURE I-2

ANNUAL HISTORIC PRECIPITATION AT CHEYENNE AP



has attempted to reserve the wells and use them sparingly under ordinary conditions. During 1977, however, it was necessary to pump the wells heavily in order to keep up with the demand. During this year, over 8,000 AF of water was taken from the well fields. Yields of this magnitude cannot be expected on a regular basis.

Water Rights

The original water right applications to divert water from Douglas Creek and the tributaries of the Little Snake River were submitted by the City of Laramie to the Wyoming State Engineer's Office in 1954. The City of Cheyenne filed applications for essentially the same water rights in 1960. Cheyenne and Laramie reached an agreement relative to the use of the water rights by the two cities. The agreement was formalized by the signing of City Contract No. 912 on August 17, 1960. Under this agreement Laramie amended their applications to include Cheyenne as an applicant for the water rights. After reviewing the amended applications, the State Engineer's Office issued permits to develop the water rights. The original permits were issued in 1961 and are listed in Tables I-4 and I-5. Additional filings are listed in Table I-6.

The original water right applications made by Laramie in 1954 proposed a collection and diversion system to develop all of the water rights at the same time. The 1954 system was not built as proposed. Instead, in 1961, Cheyenne decided to build the facility to keep pace with the water requirements of the City of Cheyenne. Construction of Stage I began in 1963 and was completed in 1964.

TABLE I-4

Summary of Water Rights on the Little Snake River Drainage

	Permit #	Name	Source	Use	Priority Date	Appropriation In CFS
Stage I Permits	22117	Little	N.F. Little Snake	Municipal,	3/12/54	12.49
	22122	Snake	Ted Creek	Industrial,	"	40.7
	22123	Diversion	Dale Creek	Irrigation	"	7.92
	22124	Pipeline	Ellis Creek	"	"	1.79
	22125	"	Rodine Creek	"	"	19.59
	22126	"	Happy Creek	"	"	3.0
	22127	"	Green Timber Creek	"	"	5.92
	22128	"	Tinker Creek	"	"	0.93
Addn. Stage I Permits	23193	Little	Grunt Gulch	Municipal,	8/26/64	3.0
	23194	Snake	Henry Creek	Industrial,	"	3.0
	23195	Diversion	Needle Creek	Irrigation,	"	9.26
	23196	Pipeline	Granite Gulch	Res. Supply	"	3.0
	23197	"	Quartz Gulch	"	"	3.0
	23198	"	Madre Gulch	"	"	20.0
	23199	"	S.F. Green Timber	"	"	7.42
Stage I Enl. Permits	6294E	1st Enl.	N.F. Little Snake	Res. Supply	8/26/64	12.49
	6295E	Little	Ted Creek	"	"	40.7
	6296E	Snake	Dale Creek	"	"	7.92
	6297E	Diversion	Ellis Creek	"	"	1.79
	6298E	Pipeline	Rodine Creek	"	"	19.59
	6299E	"	Happy Creek	"	"	3.0
	6300E	"	Green Timber Creek	"	"	5.92
	6301E	"	Tinker Creek	"	"	0.93
Stage II Permits	22118	Little	Deadman Creek	Municipal,	3/12/54	48.2
	22119	Snake	First Creek	Industrial,	"	6.1
	22120	Diversion	Second Creek	Irrigation	"	7.6
	22121	Pipeline	Third Creek	"	"	25.3
	22129	"	Rose Creek	"	"	15.93
	22130	"	Harrison Creek	"	"	13.6
	22131	"	Solomon Creek	"	"	11.1
	22132	"	E.B. Solomon Creek	"	"	11.0
	22134	"	Rabbit Creek	"	"	32.8
	22138	W. Branch L.S.D.P.	W.B. N.F. Little Snake	"	"	101.19
Stage II Enl. Permits	6284E	1st Enl.	Deadman Creek	Res. Supply	8/26/64	48.2
	6285E	Little	First Creek	"	"	6.1
	6286E	Snake	Second Creek	"	"	7.6
	6287E	Diversion	Third Creek	"	"	25.3
	6288E	Pipeline	Rose Creek	"	"	10.52
	6289E	"	Harrison Creek	"	"	13.6
	6290E	"	Solomon Creek	"	"	11.1
	6291E	"	E.B. Solomon Creek	"	"	11.0
	6292E	"	Rabbit Creek	"	"	32.8
	6293E	1st Enl. W. Branch L.S.D.P.	W.B. N.F. Little Snake	"	"	101.9
Res. Const. Permit	7235R	Hog Park Res.	N.F. Little Snake & Tributaries	Flood Prot. Fish Culture Mun., Ind. Irrigation	8/26/64	Capacity 2972.3 AF

NOTES

1. Original Stage I, Permit Nos. 22117-22128, and Additional Stage I, Permit Nos. 23193-23194, Completed and Put to Beneficial Use in 1964
2. Additional Stage I, Permit No. 23195: Commencement of Construction Extended to 10-31-79; Completion and Beneficial Use Extended to 12-31-79
3. Additional Stage I, Permit Nos. 23196-23199, and Stage I Enlargement of the Original, Permit Nos. 6294E-6301E, Completed and Put to Beneficial Use in 1964
4. Original Stage II, Permit Nos. 22118-22138: Commencement, Completion, and Beneficial Use Extended to 12-31-78
5. Stage II Enlargement on the Original, Permit Nos. 6284E-6293E: Commencement Extended to 10-31-79; Completion and Beneficial Use Extended to 12-31-79

TABLE I-5

Summary of Water Rights on Douglas Creek and its Tributaries Held by the Cities of Cheyenne and Laramie

Permit Number	Name	Source	Use	Priority Date	Appropriation In CFS
22094	Douglas Creek Diversion Pipeline	Douglas Creek	Municipal, Industrial, & Irrigation	3-12-1954	227.83
22095		W.B. Muddy Ck.			1.0
22096		Nugget Gulch Br.			1.9
22097		Podunk Creek			1.7
22098		Gold Crater Ck.			1.6
22099		Spring Branch			12.3
22100		Beaver Creek			1.4
22101		Spring Creek			4.6
22102		Camp Creek			2.0
22103		M.B. Camp Ck.			1.2
22104		E.B. Camp Ck.			1.0
22105	Lake Creek to Laramie River Canal No. 2	Lake Creek			34.6
22106		Hay Creek			6.0
22107		E.B. Hay Ck.			4.0
22108		W.B. Hay Ck.			3.0
22109	Lake Creek to Laramie River Canal No. 1	Lincoln Gulch			16.6
22110		Joe Creek			2.6
22111		Banner Creek			4.7
22112		H.T. Creek			13.4
22113	Keystone Ck. to Douglas Ck. Diversion P.L.	Nelson Branch		3-3-1961	4.2
22114		Keystone Ck.			10.2
22115		Horse Creek			25.5
22116	Berg Res. to Middle Crow Ck. Pipeline	Douglas Ck.		2-29-1960	17.46
6536 R	Rob Roy Res.			6-2-1955	5,489.2 AF Capacity
6537 R	Berg (Lake Owen) Res.			5-8-1956	750.68 AF Capacity
6888 R	Enl. Rob Roy Res.			1-4-1967	3,405.21 AF Capacity

Notes

1. Permits 22094, 22101, 22115, and 22116 have been constructed and put to beneficial use in 1963.
2. Reservoir Permit 6537 R has been constructed and put to beneficial use in 1963.
3. Reservoir Permits 6536 R and 6888 R have been constructed and put to beneficial use in 1966.
4. Permits 22095 to 22100, 22102 to 22114, date of commencement, completion of construction, and beneficial use extended to December 31, 1978.

TABLE I-6
Additional Filings by Cheyenne on
Little Snake River Tributaries for Stage II

Temporary Filing Number	Name	Source	Priority Date	Capacity cfs
23 4/19	Little Snake Div. Pipeline	Garrett Creek	5/2/78	47.16
23 5/19		Roaring Fork	5/2/78	47.16
23 6/19		Sherard Creek	5/2/78	16.0
23 1/20		Standard Creek	5/2/78	47.16
23 2/24		M. Fk. Deadline Cr.	5/16/78	2.52
23 3/24		Deadline Creek	5/16/78	7.43
23 4/24		N.F. Deadline Cr.	5/16/78	7.43
23 5/24		S. Br. Rabbit Cr.	5/16/78	16.0
23 6/24		Baggs Creek	5/16/78	47.16
23 1/25		Dowdy Draw	5/16/78	47.16
23 2/25		Dubois Creek	5/16/78	2.52
23 3/25		Northcutt Creek	5/16/78	47.16
23 4/25		Columbine Creek	5/16/78	16.0
23 5/25		S.F. Columbine Cr.	5/16/78	16.0
23 6/25		Gage Creek	5/16/78	16.0
23 1/26		Daisy Creek	5/16/78	16.0
23 2/26		Orchid Creek	5/16/78	16.0
23 3/26		Violet Draw	5/16/78	16.0
23 4/26		S.F. Rose Creek	5/16/78	16.0

A summary of the City's well permits is listed in Table I-7.

TABLE I-7

Summary of Well Field Permits

MAIN WELL FIELD

Permit No.	Name	Location	Depth	G.P.M.	Appropriator
S.C. 265	Holman #1	24-14-68	290	500	C.B.P.U.
S.C. 266	Elkar #1	25-14-68	349	500	C.B.P.U.
S.C. 267	Bailey #1	25-14-68	180	500	C.B.P.U.
S.C. 268	Bailey #5	26-14-68	183	300	C.B.P.U.
S.C. 269	Eddy #2	23-14-68	250	500	C.B.P.U.
S.C. 270	Koppes #1	34-14-68	235	500	C.B.P.U.
S.C. 271	Koppes #2	27-14-68	250	500	C.B.P.U.
S.C. 273	Happy Jack #1	36-14-68	152	500	C.B.P.U.
S.C. 274	Happy Jack #2	36-14-68	184	500	C.B.P.U.
S.C. 275	Happy Jack #3	36-14-68	180	500	C.B.P.U.
S.C. 280	Koppes #3	34-14-68	190	500	C.B.P.U.
S.C. 281	Koppes #4	34-14-68	190	500	C.B.P.U.
S.C. 282	Elkar #5	4-13-68	255	500	C.B.P.U.
S.C. 283	King #1	4-13-68	200	500	C.B.P.U.
S.C. 284	King #2	3-13-68	187	600	C.B.P.U.
S.C. 285	Elkar #7	14-13-68	222	500	C.B.P.U.
S.C. 286	Finnerty #2	14-13-68	210	500	C.B.P.U.
S.C. 287	King #4	35-14-68	235	485	C.B.P.U.
S.C. 288	Koppes #5	33-14-68	230	480	C.B.P.U.
S.C. 289	King #5	4-13-68	230	500	C.B.P.U.
S.C. 290	Koppes #6	33-14-68	230	230	C.B.P.U.
S.C. 291	Borie #1	16-13-68	300	520	C.B.P.U.
W.R. 13	Weber #1	24-13-68	200	500	C.B.P.U.
W.R. 14	Conrey #1	32-14-68	300	450	C.B.P.U.
43987	Weber #1	24-13-68	270	800	C.B.P.U.

BELL WELL FIELD

W.R. 474	Bell #5	13-14-68	187	200	C.B.P.U.
W.R. 475	Bell #6	18-14-67	225	400	C.B.P.U.
W.R. 476	Bell #8	14-14-68	163	400	C.B.P.U.
W.R. 477	Bell #10	24-14-68	250	300	C.B.P.U.
W.R. 478	Bell #11	13-14-68	212	950	C.B.P.U.
W.R. 479	Bell #12	14-14-68	208	400	C.B.P.U.
W.R. 480	Bell #17	13-14-68	225	400	C.B.P.U.
43	Bell #16	7-14-67	311	633	C.B.P.U.
44	Bell #24	7-14-67	310	450	C.B.P.U.
45	Bell #25	12-14-68	314	550	C.B.P.U.
37524	Riser #1	24-14-67	341	100	C.B.P.U.

FEDERAL WELL FIELD

S.C. 276	Merritt #1	9-15-69	308	500	C.B.P.U.
S.C. 277	Tax #1	8-15-69	375	500	C.B.P.U.
S.C. 278	Merritt #5	6-15-69	195	1000	C.B.P.U.
S.C. 279	Merritt #6	5-15-69	185	500	C.B.P.U.
W.R. #256	Merritt #8	27-15-69	236	700	C.B.P.U.
W.R. #257	Merritt #15	33-15-69	238	700	C.B.P.U.
W.R. #258	School #2	28-15-69	294	300	C.B.P.U.
W.R. #340	School #1	16-15-69	351	600	C.B.P.U.
W.R. #341	Merritt #9	34-15-69	312	320	C.B.P.U.
W.R. #342	Merritt #14	21-15-69	223	150	C.B.P.U.

Present Water Demand

Average daily water use for Cheyenne is listed in the following table.

TABLE I-8
Average Daily Water Uses
1961 Through 1976

Year	Population	Total Water Use MGD	Cheyenne Urban Industrial Demand MGD	Domestic Water Use MGD	Domestic Water Use GPCD
1961	43,250	10.41	3.46	6.95	161
1962	42,290	10.15	3.62	6.53	152
1963	42,730	10.85	2.61	8.24	193
1964	42,470	12.45	2.61	9.84	231
1965	42,210	9.62	2.26	7.36	175
1966	41,950	11.35	2.45	8.90	212
1967	41,690	12.14	2.25	9.89	237
1968	41,430	10.63	2.59	8.04	194
1969	41,170	10.13	2.70	7.43	180
1970	41,194	11.17	2.84	8.33	204
1971	45,800	10.77	2.73	8.04	176
1972	47,750	12.09	2.70	9.39	197
1973	49,600	12.25	2.89	9.36	189
1974	51,350	12.13	3.01	9.12	178
1975	52,800	11.80	2.93	8.87	168
1976	55,600	11.10	2.33	8.77	158
				Average	188 GPCD

Domestic water use includes water for golf courses, parks and other uses by the city.

Total municipal consumption for 1977 was 9.48 MG. A voluntary water conservation program initiated by the city was responsible for the reduction in consumption.

Table I-9 is a list of major water users and their average annual water use.

TABLE I-9
Major Water Users

Name	Average Annual Consumption	
	MG	Acre-Feet
Husky Oil	600.0	1840
Warren Air Base	312.0	957
South Cheyenne	150.0	460
V.A. Hospital	14.4	44
Hitching Post	9.6	29
Little America	39.6	122
School District #1	18.0	55
Cheyenne Country Club	24.0	74
Union Pacific Railroad	88.8	273
Wyott Manufacturing	36.0	110
Municipal Golf Courses	75.0	230
Residential	2,500.0	7,672
Other	200.0	614
Total	4,066.4	12,480

Monthly and annual total water usage for the period 1967-1978 is listed in Table I-10. These values represent the metered water from Cheyenne's two treatment plants.

The South Side Water District began purchasing water from the city in July, 1971. This district then resells this water to its members at a rate set by the district.

TABLE I-10

MONTHLY AND ANNUAL CHEYENNE
WATER USAGE
(ACRE-FEET)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1967	952	870	980	1,119	1,073	1,165	1,925	1,650	1,221	1,062	862	828	13,707
1968	856	903	1,078	1,095	933	1,442	1,366	1,319	880	672	705	670	11,919
1969	672	575	716	966	1,113	1,255	1,618	1,294	867	818	777	773	11,444
1970	758	696	746	857	1,005	1,677	1,876	1,668	1,035	746	730	753	12,547
1971	748	693	788	786	1,113	1,897	1,809	1,515	789	801	770	442	12,151
1972	735	751	944	1,030	1,181	1,457	1,722	1,527	1,233	1,112	933	943	13,568
1973	940	834	911	850	1,319	1,569	1,670	1,647	1,131	1,055	923	871	13,720
1974	887	802	897	960	1,546	1,540	1,753	1,703	1,180	896	725	701	13,590
1975	781	638	723	753	1,046	1,116	1,572	1,579	1,201	944	847	613	11,813
1976	877	769	650	806	964	1,510	1,873	1,526	1,208	790	723	733	12,429
1977	723	699	771	710	847	1,089	1,197	1,117	1,195	851	690	732	10,621
1978	736	733	842	960	1,049	1,519	1,805	1,250	1,325	837	773	*733	12,562
Total	8,929	8,230	9,204	9,932	12,140	15,717	18,381	17,795	13,265	10,584	9,458	8,792	150,071
Average	744	686	767	828	1,012	1,310	1,532	1,483	1,105	882	788	733	12,506

*Estimated

Water Works Revenues and Expenditures

The following table lists operating revenue generated by the water works for the past ten fiscal years.

	Year Ending June 30				
Operating revenue	1969	1970	1971	1972	1973
Sale of water:					
Consumers	$1,235,956	$1,169,808	$1,288,472	$1,293,135	$1,239,180
Districts for resale	--	--	--	--	--
Surplus water	--	--	--	--	--
Consumers installation	2,286	1,420	--	--	3,809
Connection fees	10,119	9,700	9,875	40,358	58,370
Miscellaneous	8,069	4,372	8,564	61,679	51,516
	$1,256,430	$1,187,715	$1,308,733	$1,410,025	$1,373,283

	Year Ending June 30				
Operating revenue	1974	1975	1976	1977	1978
Sale of water:					
Consumers	$1,343,961	$2,164,180*	$2,324,424	$2,146,195	$2,039,631
Districts for resale	34,379	67.411	82,697	84,454	85,304
Surplus water	240	--	50,000	4,572	--
Consumers installation	4,898	4,063	8,299	17,830	29,645
Connection fees	80,466	68,358	60,791	98,728	231,475
Miscellaneous	27,060	19,726	16,257	20,516	8,346
	$1,491,004	$2,323,738	$2,542,468	$2,372,295	$2,394,401

*Water rate increase went into effect

Water sale revenues are generated using the following rate schedule:

Monthly Use	Charge per 1,000 Gallons
First 4,000 gallons	Minimum Charge
Next 246,000 gallons	$0.82
Over 250,000 gallons	$0.52

Meter Size	Minimum Charge
5/8 in	$4.10
3/4 in	4.35
1 in	4.75
1¼ in	5.00
1½ in	6.00
2 in	9.00
3 in	13.00
4 in	22.00
6 in	30.00
8 in	40.00
10 in	50.00
12 in	

Water is sold to the South Side District for $0.75/1000 gallons.

Connection and consumer installation revenues are now being calculated according to the schedule listed in Table I-11. These fees are allocated to specific accounts to offset the cost of providing service to new consumers.

Operating revenues have, in the past, been sufficient to meet the expenses of the water department. Rate increases in 1975 and July 1, 1978, have helped revenues keep pace with expenses as the system is expanded.

Operation and Maintenance

Operation and maintenance expenses for the Cheyenne waterworks for the past 10 fiscal years are as follows:

	Year Ending June 30				
	1969	1970	1971	1972	1973
Operation and maintenance expenses:					
Source of supply	$59,335	$55,204	$44,975	$51,351	$52,121
Power and pumping	31,174	35,553	31,002	37,670	34,915
Purification	65,000	67,911	68,563	69,943	79,238
Transmission and distribution	96,484	112,746	124,755	132,589	139,401
Customer accounting	68,551	63,050	56,745	67,900	73,537
Administrative and general	49,283	62,651	66,335	63,103	103,033
Data processing	--	--	--	--	--
Total	$369,827	$397,115	$392,375	$422,556	$482,245

	1974	1975	1976	1977	1978
Operation and maintenance expenses:					
Source of supply	$60,234	$54,423	$59,770	$60,103	$60,498
Power and pumping	30,470	45,829	36,112	34,487	53,010
Purification	83,468	111,934	192,105	215,677	186,826
Transmission and distribution	158,100	263,552	247,217	313,509	313,972
Customer accounting	69,822	80,128	58,501	64,170	57,931
Administrative and general	162,047	166,211	173,687	277,096	351,761
Data processing	--	43,057	27,363	32,269	28,105
Total	$564,141	$765,134	$794,755	$997,311	$1,052,103

TABLE I-11

Connection Installation Fees

Tap Size	Tap Fee	If Metered Service Line → Account Fee	Const. Water Fee	Meter Pit At Time Tap Inst.	Just Meter Pit	Water Planning & Eng Fee	Sewer Planning & Eng Fee	No. Of Living Units
3/4"	$ 300.00	$5.00	$ 5.00	$110.00	$185.00	$ 250.00	$ 150.00	1
1"	350.00	5.00	5.00	135.00	205.00	420.00	250.00	2
1¼"	400.00	5.00	5.00	140.00	215.00	625.00	375.00	3-4
1½"	450.00	5.00	5.00	200.00	280.00	830.00	500.00	5-10
2"	500.00	5.00	5.00	220.00	300.00	1,330.00	800.00	11-20
Tapping Tee And Valve Required For Sizes Greater Than 2"								
(?)X 3"--Same As 4"		5.00	10.00	450.00	500.00	2,915.00	1,750.00	21-50
4"X 4"	1,130.00	5.00	10.00	450.00	500.00	5,000.00	3,000.00	51-90
6"X 4"	1,150.00	5.00	10.00	450.00	500.00	5,000.00	3,000.00	51-90
6"X 6"	1,200.00	5.00	15.00	450.00	500.00	11,915.00	7,150.00	91-200
8"X 4"	1,190.00	5.00	10.00	450.00	500.00	5,000.00	3,000.00	51-90
8"X 6"	1,260.00	5.00	15.00	450.00	500.00	11,915.00	7,150.00	91-200
8"X 8"	1,350.00	5.00	15.00	450.00	500.00	20,830.00	12,500.00	201-360
10"X 4"	1,370.00	5.00	10.00	450.00	500.00	5,000.00	3,000.00	51-90
10"X 6"	1,420.00	5.00	15.00	450.00	500.00	11,915.00	7,150.00	91-200
10"X 8"	1,530.00	5.00	15.00	450.00	500.00	20,830.00	12,500.00	201-360
10"X 10"	1,675.00	5.00	20.00	450.00	500.00	33,000.00	20,000.00	201-360
12"X 4"	1,360.00	5.00	10.00	450.00	500.00	5,000.00	3,000.00	51-90
12"X 6"	1,415.00	5.00	15.00	450.00	500.00	11,915.00	7,150.00	91-200
12"X 8"	1,525.00	5.00	15.00	450.00	500.00	20,830.00	12,500.00	201-360
12"X 10"	1,710.00	5.00	20.00	450.00	500.00	33,000.00	20,000.00	201-360
12"X 12"	1,930.00	5.00	20.00	450.00	500.00	48,330.00	29,000.00	360- +

Where street cuts are necessary an additional $20.00 will be added to the tap fee for street repair.

A price of $20.00 will be charged to install all Read-A-Matic water meters. If wire is not installed an additional $10.00 will be charged.

A price of $40.00 will be charged when two Read-A-matic readouts are required on compound meters.

Tap fees, meter pit fees, etc. will be payed for at the time such are requested.

The Planning and Engineering Fees will be determined by the tap size or the number of living units served, whichever results in the greater fee.

Motel-Hotel complexes will be charged at 70% of the Planning and Engineering Fees.

Planning and Engineering Fees shall be payed to the Board of Public Utilities before any water meter is installed on the serviceline.

Property which has a water tap and/or a building permit prior to July 1, 1978 and taps for fire lines shall be exempt from the planning and engineering fees.

The tap fee for 3" taps will be determined the same way as for a 4" tap, then a 4" by 3" reducer will be installed.

For meters 3" and larger, a 5' diameter manhole (with ring and cover) will be used for a meter pit.

Bonded Debt

During 1973 and 1974 the City of Cheyenne, Wyoming, sold two general obligation bond issues for the purpose of improving and extending the City's water system. Both issues provide for the levy and collection of property taxes to pay the bonds; however, both the bond ordinance and the Wyoming Statutes allow the payment of these bonds from the net revenues derived from the operations of the system. Further, it is the intent of both the Board of Public Utilities and the City Council of the City of Cheyenne that waterworks system revenues be used to pay both the principal and interest on these bond issues. To date the net revenue has been sufficient to meet the debt service requirements. The annual payment required to service this debt is $1,377,400. Outstanding general obligation bonds as of June 30, 1978 totaled $22,250,000 and will be retired by 1995.

Capital Accounts and Depreciation

The budgeted expenses, capital accounts and depreciation are maintained for the purpose of replacement of plant and equipment on a scheduled basis.

The budgeted amounts for these accounts are as follows:

Fiscal Year	Capital Accounts	Depreciation
1978	$197,000	$87,000
1979	197,000	174,000
1980-On	To increase at the current inflation rate	174,000

II - FUTURE WATER REQUIREMENTS

Population Projections

Population forecasts were made in the report entitled "The Genesis Project - A Regional Solid Waste Management Plan for Laramie County, Wyoming - September, 1974". This report was prepared under a Solid Waste Planning Grant received by Laramie County, Wyoming, from the Environmental Protection Agency and supported in part by the Department of Community Development under the Metropolitan Cities Act of 1966, with Donald C. Carson as Project Director. In the report, Laramie County was divided into 138 planning zones. Population forecasts were developed for each zone based on a minimum growth rate, a stable growth rate, and a phenomenal growth rate to the year 2020. These three population projections for the sum of the Cheyenne urban and suburban areas are shown in Figure II-1 for the years 1973 to 2020. The stable growth projection is most probable, however, and is used in this study. The population projections in Figure II-1 also include Warren Air Force Base. Past records indicate that the population of Warren Air Force Base is fairly stable at about 5,000. Water requirements for Warren Air Force Base are included in the urban industrial demand. Therefore, to determine the Cheyenne domestic demand, the stable growth rate shown on Figure II-1 minus 5,000 was used in this report to estimate future Cheyenne domestic water requirements.

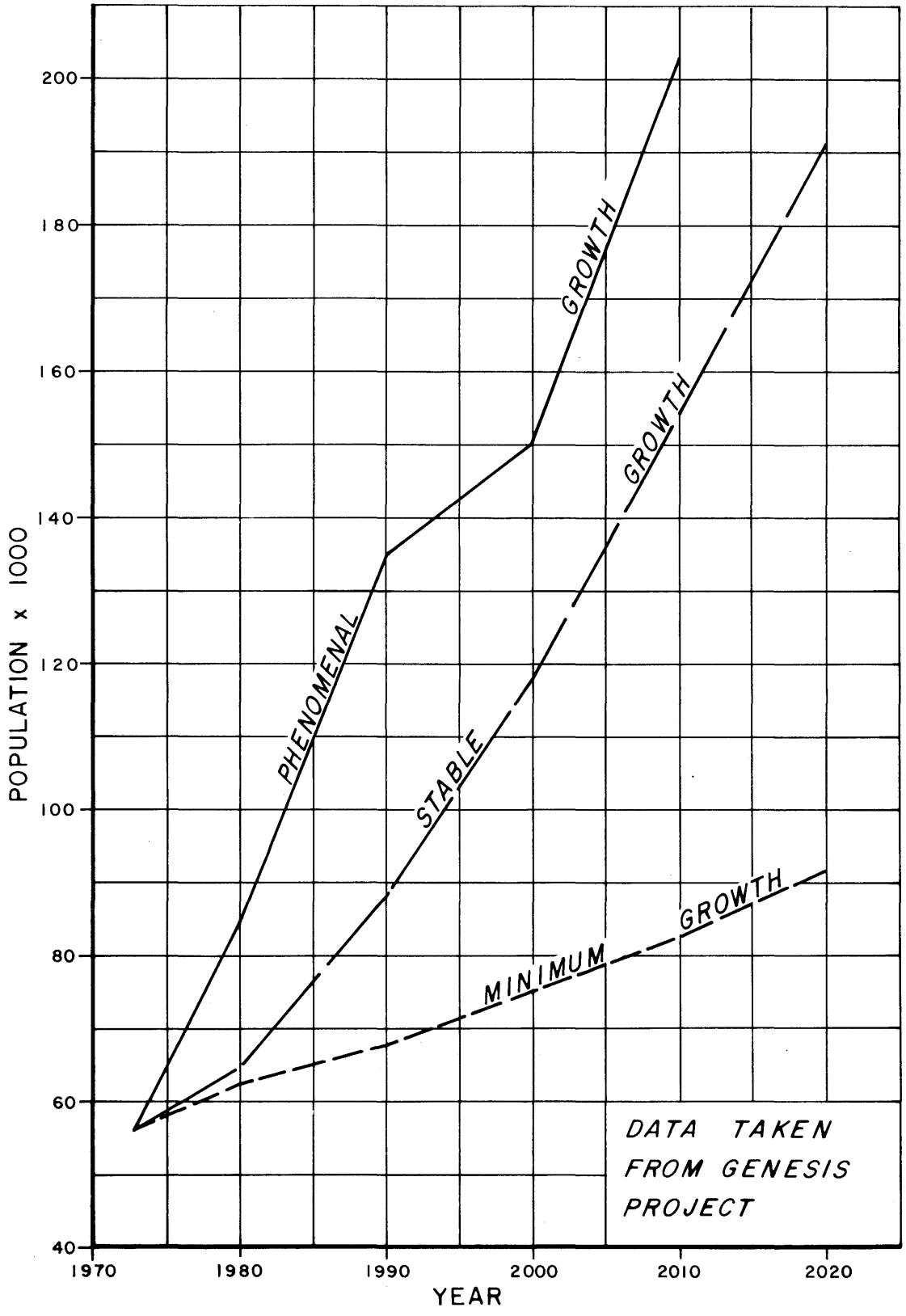
Water Use Projections

Average domestic water use for Cheyenne for the period 1961-1977 was calculated to be 188 gpcd. This average includes water use for golf courses, parks and other non-revenue generating uses. It was assumed that these uses will remain at a relatively constant amount in the future with residential per capita consumption increasing as population increases.

The per capita water use does not account for urban industrial water. During this 16-year period, the three large urban industrial water users were the Union Pacific Railroad, the Husky Refinery, and Warren Air Force Base. Water supplied to the three industries has been relatively constant at approximately 3.0 million gallons per day. It is expected that the demand from these three industries will remain relatively constant and not exceed 3 million gallons per day (MGD). However, additional industrial development is expected in the Cheyenne urban area because of energy resource development in the state. It is assumed that this future development will increase the urban industrial water demand at a constant rate of about 0.1 MGD for each year. This rate was used also in the projected water demands made in the April, 1974, Banner report. Therefore, urban industrial water demands used for operations studies performed hereinafter start with 3 MGD in 1978 and increase by 0.1 MGD at the beginning of each additional year of the study period.

To estimate the number of taps, projected population was divided by 4.0.

FIGURE II-1
CHEYENNE POPULATION PROJECTION



Domestic water demand was determined by multiplying the estimated population at the beginning of each year by the projected use of 190 gpcd* for that year. The constant amount of non-revenue generating water was then subtracted from the domestic use to produce a residential consumption that increases as population increases. The following table is an estimate of the projected annual water needs for Cheyenne.

Year	Estimated Population	Number of Taps	Residential Demand (MG)	No Charge Uses (MG)	Industrial Demand (MG)	Total Use MG	Total Use Ac-Ft
1980	59,860	14,956	3,486.3	665.0	1,241.0	5,392.3	16,548
1985	71,425	17,856	4,288.3	665.0	1,423.5	6,376.8	19,570
1990	82,990	20,748	5,090.4	665.0	1,606.0	7,361.4	22,591
1995	98,240	24,560	6,147.9	665.0	1,788.5	8,601.4	26,397
2000	113,490	28,373	7,205.5	665.0	1,971.0	9,841.5	30,202
2005	130,765	32,691	8,403.6	665.0	2,171.8	11,240.4	34,496
2010	148,040	37,010	9,601.6	665.0	2,372.5	12,639.1	38,788

Cheyenne is supplied with an average of about 5,000 acre feet per year from the Crow Creek drainage west of Cheyenne and an average of 7,436 acre feet from the Douglas Creek drainage. Demand has exceeded the supply from these two sources several times in the past 15 years. The excess demand was satisfied by withdrawal from reservoir storage in the Crow Creek drainage and groundwater supplies. The projected available groundwater supply is estimated to be 2,000 acre feet per year. Cheyenne has reserved the groundwater supply to be used as a backup in the event of severe shortages.

*190 was assumed to be the 1978 average per capita domestic use rate.

III - PROPOSED CHEYENNE STAGE II ENLARGEMENT

Stage II Lake Owen to Crow Creek Pipeline

The theoretical capacity of the existing 26-inch diameter steel pipeline from Lake Owen to Middle Crow Creek Pipeline is about 17.7 cfs (12,800 AF per year). In actual practice this line has yielded only about 11,000 AF per year. This pipeline should be adequate to meet Cheyenne's increasing demands until about 1982. In order to take advantage of the Stage II Little Snake Diversion Pipeline expansion, it will be necessary to construct an additional pipeline from Lake Owen to Crow Creek. To provide a reasonable assurance that Cheyenne's needs will be met beyond 1982, it is necessary to include an additional pipeline from Lake Owen to Crow Creek in the proposed Stage II expansion.

Stage II of the Lake Owen to Crow Creek Pipeline should be a relatively easy segment of the Stage II expansion because the existing right-of-way will be used and no significant time delays are anticipated. Planning and design activities should be carried out so Stage II construction of the Lake Owen to Crow Creek Pipeline can be completed around 1982.

It is proposed that Stage II of the Lake Owen to Crow Creek Pipeline be sized to accommodate total yield of the combined Stage I and Stage II, the Little Snake Diversion Pipeline, minus the capacity of the existing Lake Owen to Middle Crow Creek Pipeline. Total Stage I and Stage II yield of the Little Snake Diversion Pipeline is estimated to average 26,000 AF per year. Capacity of the existing Lake Owen to Middle Crow Creek Pipeline is 12,800 AF per year. Stage II of the Lake Owen to Crow Creek Pipeline has been sized to carry about 18,200 AF per year. This would result in a pipeline capacity from Lake Owen to Crow Creek of 31,000 AF, or, the original yield before allowances for streamflows. Hydraulic computations indicate a 30-inch, steel pipeline built on the same slope as the existing pipeline could carry 25.7 cfs (18,600 AF per year). A new 30-inch pipeline and the existing 26-inch pipeline combined could carry a total capacity of 43.4 cfs (31,400 AF per year). The two pipelines could meet Cheyenne's water demands from the Douglas Creek Drainage until the turn of the century.

Stage II Rob Roy Reservoir Enlargement

Rob Roy Reservoir at present has a capacity of 8,895 AF. It is proposed that Rob Roy Dam and Reservoir be raised by about 50 feet. This would increase the reservoir storage, at normal high water line, to about 35,000 AF. A mass diagram study indicates that a reservoir on Douglas Creek with a capacity of 35,000 AF can maintain an average annual release of 20,250 AF (this considers evaporation as part of the release).

Figure III-1 shows normal high water lines for both the existing and proposed reservoir. The proposed reservoir would inundate about 805 acres of land at a normal high water line of 9,470 feet. The existing reservoir inundates about 314 acres of land at a normal high water line of 9,420 feet.

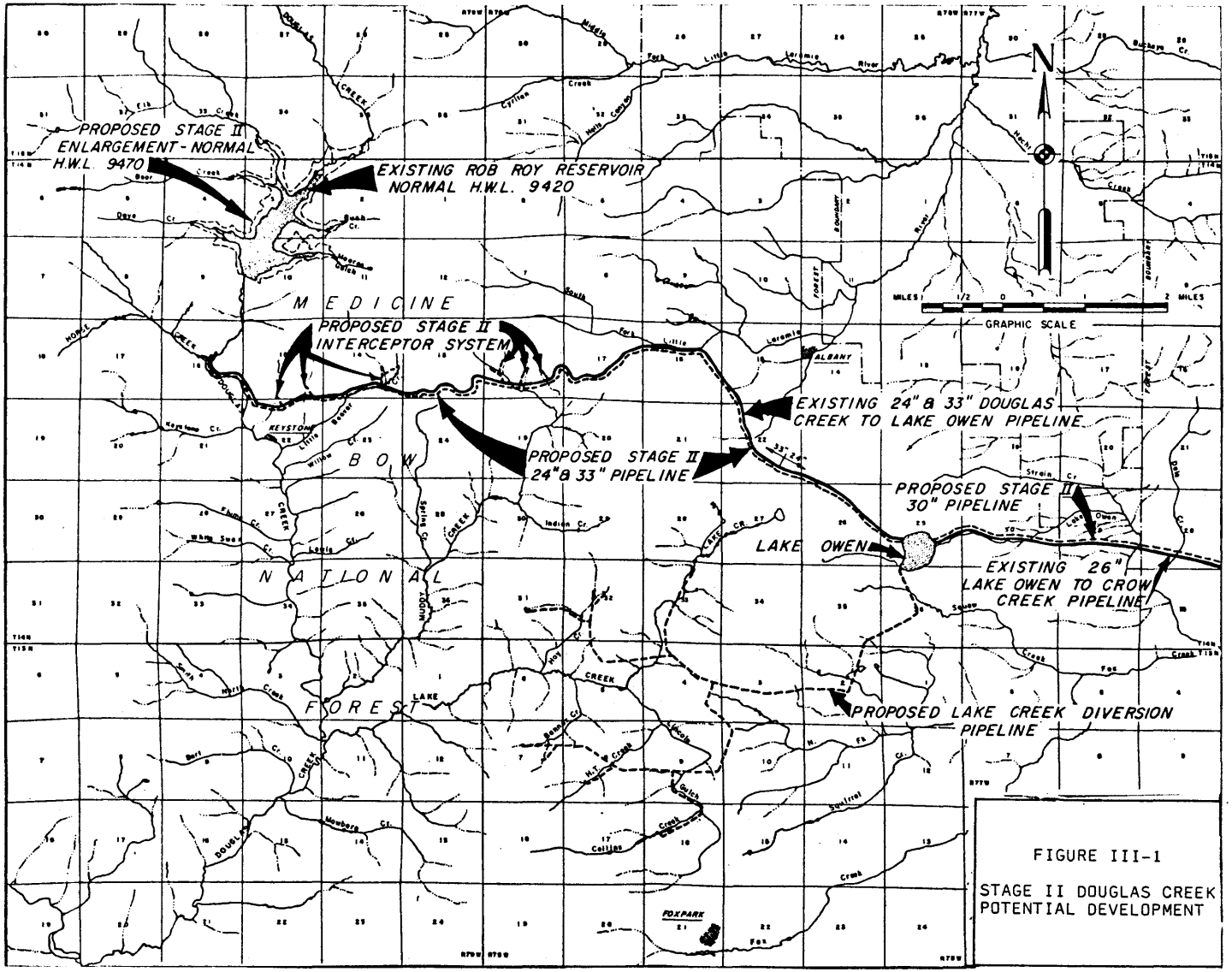


FIGURE III-1

STAGE II DOUGLAS CREEK
POTENTIAL DEVELOPMENT

Current plans propose that enlargement of Rob Roy Dam be made by extending the toe of the downstream slope farther downstream and restricting additional embankment construction to the downstream portion of the dam. A new spillway also will be included in the Stage II enlargement. The new spillway will be either an ungated, ogee crest spillway or a side channel spillway. Final selection of spillway type cannot be made until further geotechnical and economic investigations are made. Also, some additional work on the outlet works would be required.

Stage II Douglas Creek to Lake Owen Pipeline

Capacity of the existing Douglas Creek to Lake Owen Pipeline is about 23 cfs (16,650 AF per year). This pipeline should be adequate to meet Cheyenne's demands until about 1989.

In order to take advantage of increased yields made possible by the proposed Stage II Rob Roy Reservoir Enlargement and to provide peak flow period diversion capability, additional pipeline capacity from Rob Roy Reservoir to Lake Owen will be necessary. Stage II of the Douglas Creek to Lake Owen Pipeline presently is envisioned as running parallel to the existing Douglas Creek to Lake Owen Pipeline and occupying the same right-of-way.

It also is proposed that an identically sized pipeline be built parallel to the existing Douglas Creek to Lake Owen Pipeline, as part of the Stage II Douglas Creek Development Plan. Figure III-1 shows the existing and proposed Stage II Douglas Creek to Lake Owen Pipelines. Construction of the Stage II pipeline would require about 9 miles of 33-inch diameter, reinforced concrete pipe and about 2 miles of 24-inch diameter, reinforced concrete pipe. Point of diversion would be either the Douglas Creek Diversion Dam (with modifications) or the enlarged Rob Roy Reservoir. Additional economic analysis is required to decide which point of diversion would be more favorable.

Capacity of the proposed Stage II Douglas Creek to Lake Owen Pipeline would be the same as the existing pipeline. Capacity of the existing Douglas Creek to Lake Owen Pipeline is 23 cfs (16,650 AF per year). Total combined capacity of the two pipelines would be 46 cfs (33,300 AF per year).

Stage II of the Little Snake Diversion Pipeline

Stage II of the Little Snake Diversion Pipeline will require about 24 miles of various sized reinforced concrete pipe, about 15 diversion dams, and a number of smaller collection structures The Stage II collection system will intercept runoff from 10,800 acres of watershed. The anticipated annual watershed yield should be about 23,000 AF. Of this, approximately 5,000 AF/Yr will be released as instream flow, thereby reducing the yield to 18,000 AF. Combined with Stage I, the total average annual yield of the Little Snake Diversion facilities will, therefore, be about 26,000 AF, rather than 31,000 AF, from a combined watershed area of 14,600 acres west of the Continental Divide.

Proposed Hog Park Reservoir Enlargement

The proposed plan would enlarge Hog Park Reservoir, 2,970 AF capacity, to about 28,600 AF. The existing Hog Park Dam would be raised by about 60 feet and two dikes south of the main embankment would be constructed. The normal high water line of the proposed reservoir enlargement would be 8,460, as shown on Figure III-2. Studies have shown that the 28,600 AF reservoir can maintain an annual release of 26,000 AF. The 26,000 AF can be maintained through severe drought periods, similar to those of the mid-1950's. The reservoir would be operated to release natural runoff from the Hog Park Creek Drainage at the same rate as it enters the reservoir.

Yields of Total Project

An overall look at the existing and planned facilities produces the following yields.

Existing Douglas Creek Water Yields	13,000 AF per year
Proposed Stage II Douglas Creek Development Plan Water Yields	
Additional Rob Roy Reservoir Yield	8,750 AF per year
Lake Creek Diversion Pipeline	4,450 AF per year
Stage II Douglas Creek Yield	13,200 AF per year
Total Potential Douglas Creek Water Yield	26,200 AF per year

The potential combined water yield of Stage I and Stage II of the Little Snake Diversion Facilities will be about 26,000 AF per year The expected Douglas Creek water yield will be about 26,200 AF per year. The difference in the two yields will be about 200 AF per year, assuming an average runoff in both basins. Due to seasonal and annual variability in streamflows the 200 AF per year difference is insignificant.

A total average annual yield of 26,200 AF from the Douglas Creek Drainage plus 5,000 AF per year from Crow Creek and the well field can meet Cheyenne's water demands until beyond the turn of the century.

Stage II Expansion Cost Estimates

A breakdown of the project cost is given below. These costs are 1978 estimates.

Hog Park Dam Enlargement	$ 7,500,000
Collection System - All of Stage II	20,310,000
Lake Owen to Crow Creek Pipeline	18,788,000
Rob Roy Dam Enlargement	14,318,000
Douglas Creek to Lake Owen Pipeline	4,119,000
Total	$65,035,000

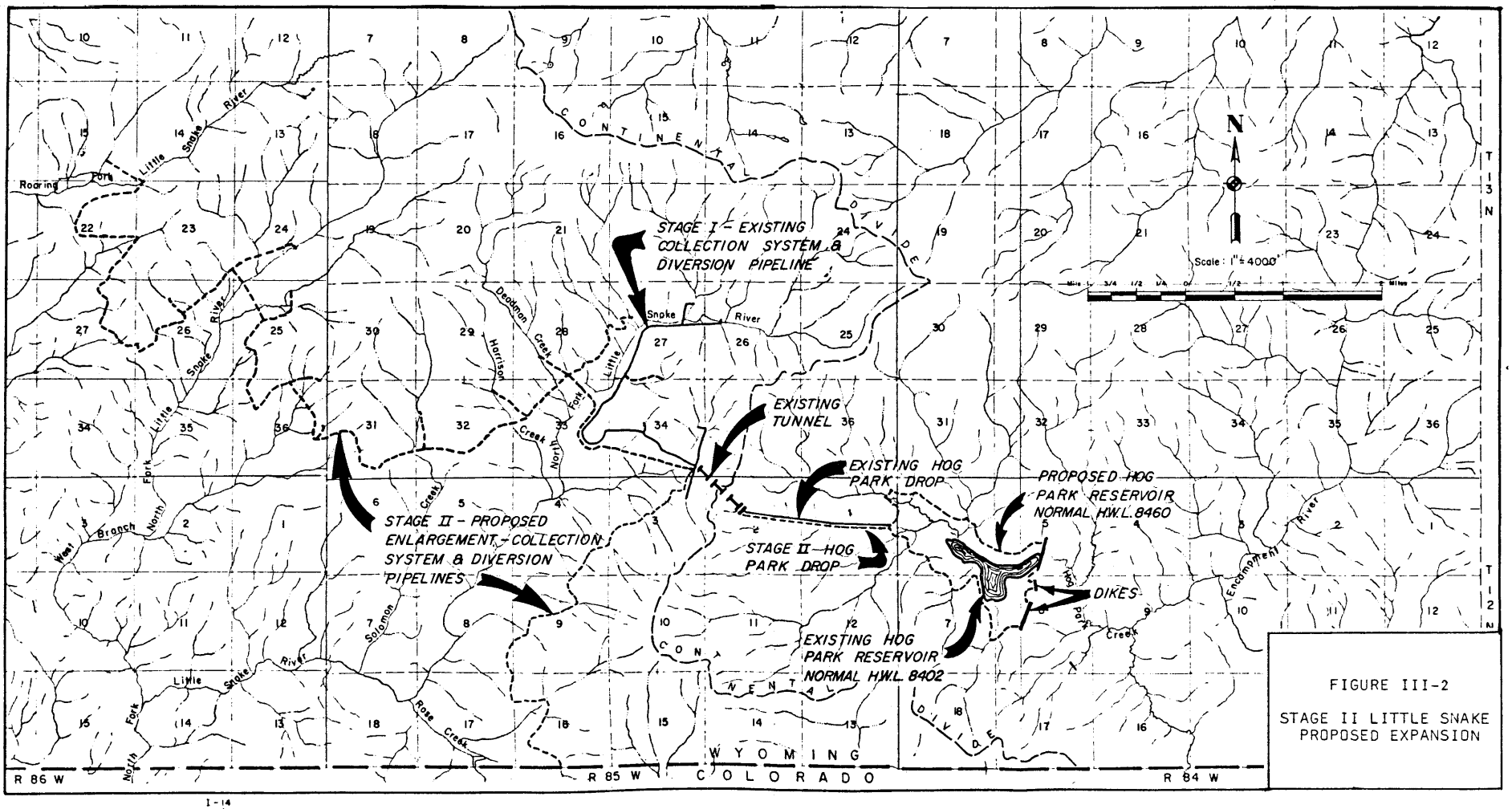


FIGURE III-2

STAGE II LITTLE SNAKE PROPOSED EXPANSION

Assuming construction would begin in 1980 with completion in 1982, the project costs inflated to a 1981 level at 7% per annum are:

Hog Park Dam Enlargement	$ 9,075,000
Collection System - All of Stage II	24,575,100
Lake Owen to Crow Creek Pipeline	22,733,480
Rob Roy Dam Enlargement	17,324,780
Douglas Creek to Lake Owen Pipeline	4,983,990
Total	$78,692,350

Financial Analysis

Projected Expenses

To determine the annual cost of the project, expenses for the current system must be estimated. Figure III-3 shows the actual and projected expenses of the Water Works for the individual expense items. It can be seen that the retirement of current bonded debt will be accomplished in 1995 and it is reflected in the projected total expenses in that year.

It is assumed that operation and maintenance of an expanded system will not increase these expenses beyond what has been projected for the present system. In other words, projected O&M expense increases are sufficient to meet the added expense of the expanded system.

Stage II Annual Cost

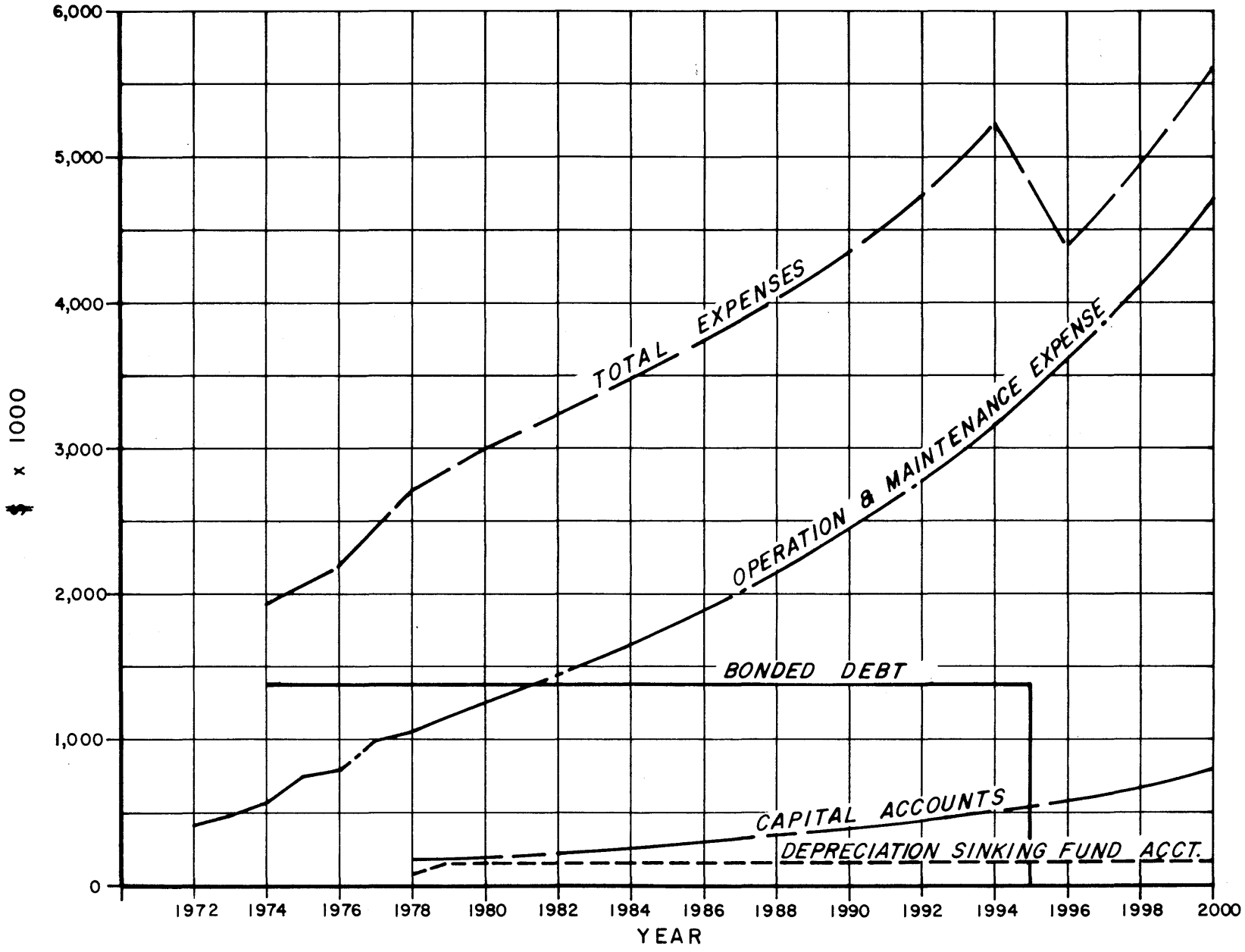
Amortization of the Stage II Project cost requires assumptions of a probable financing period and interest rate.

To provide a range of expected annual project repayment costs, three interest rates were chosen. These rates represent the highest and lowest which might be expected. The intermediate rate represents the approximate interest rate that would be expected with State financing.

TABLE III-1
Project Annual Cost
(Based on 30-Yr Repayment Period for 1981 Project Costs)

Interest Rate %	Annual Cost $	First Year's Interest $
9	7,659,913	7,082,312
6	5,717,000	4,721,540
4	4,550,779	3,147,694

FIGURE III-3
ACTUAL AND PROJECTED EXPENSES FOR THE CHEYENNE WATER WORKS



Project Repayment Alternative I

Revenues sufficient to meet the increased annual expenses of project repayment and existing expenses can be generated by increasing the cost of the water to the consumers. In this case, the consumers are the municipal and industrial users of the City of Cheyenne.

A rate study, using the projected population and respective water use, was done to determine the cost per 1000 gallons necessary to meet the projected expenses.

Projected expenses were calculated by adding Total Expense for a year shown in Figure III-3 to the Total Project Annual Cost (Table III-1).

It was assumed that both the municipal and industrial cost per 1000 gallons would be equal, that the average minimum monthly charge would remain at its present rate and that the amount allowed under this minimum charge would be reduced to 3000 gal/month.

Total 1982 expenses are:

Stage II Annual Payment	$5,717,000
Basic Annual Expenses	3,232,700
Total 1982 Expenses	$8,949,700

To meet these expenses from water sales and minimum fees, a rate of $1.78/1000 gallons would be required. Figure III-4 shows that, after the first year, revenues exceed expenses by an increasing amount. This is due to an increasing number of consumers paying for water service. Rate reductions would be necessary about every two years to keep revenues from exceeding expenses by a great amount.

Project Repayment Alternative II

Another financing method which may be used would be to defer payment of all or a portion of the debt principal for a certain length of time. This would reduce the annual payment of the project in the first years and allow the population (water consumption) to increase and thereby reduce the water cost to the individual consumer.

Figure III-5 illustrates the effects of deferred principal payments. 1982 expenses were projected to be $8,949,700 and include the principal portion of the annual payment.

Project Annual Payment	$5,717,000
Less: Interest Portion (6%)	4,721,540
	$ 995,460
1982 Expenses	$8,949,700
Less: 1982 Revenues	7,954,092
	$ 995,608

FIGURE III-4
REVENUES VS. EXPENSES

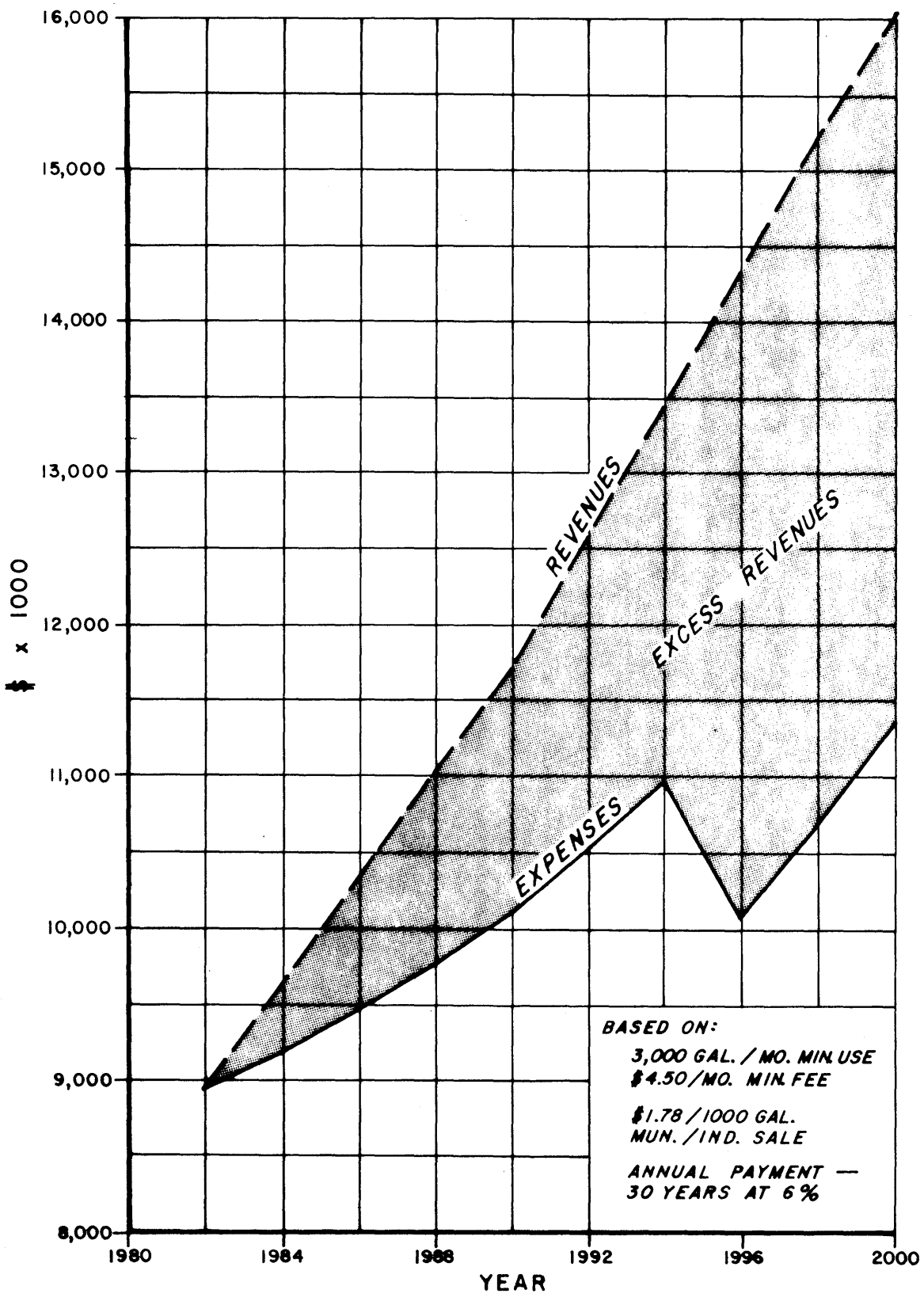
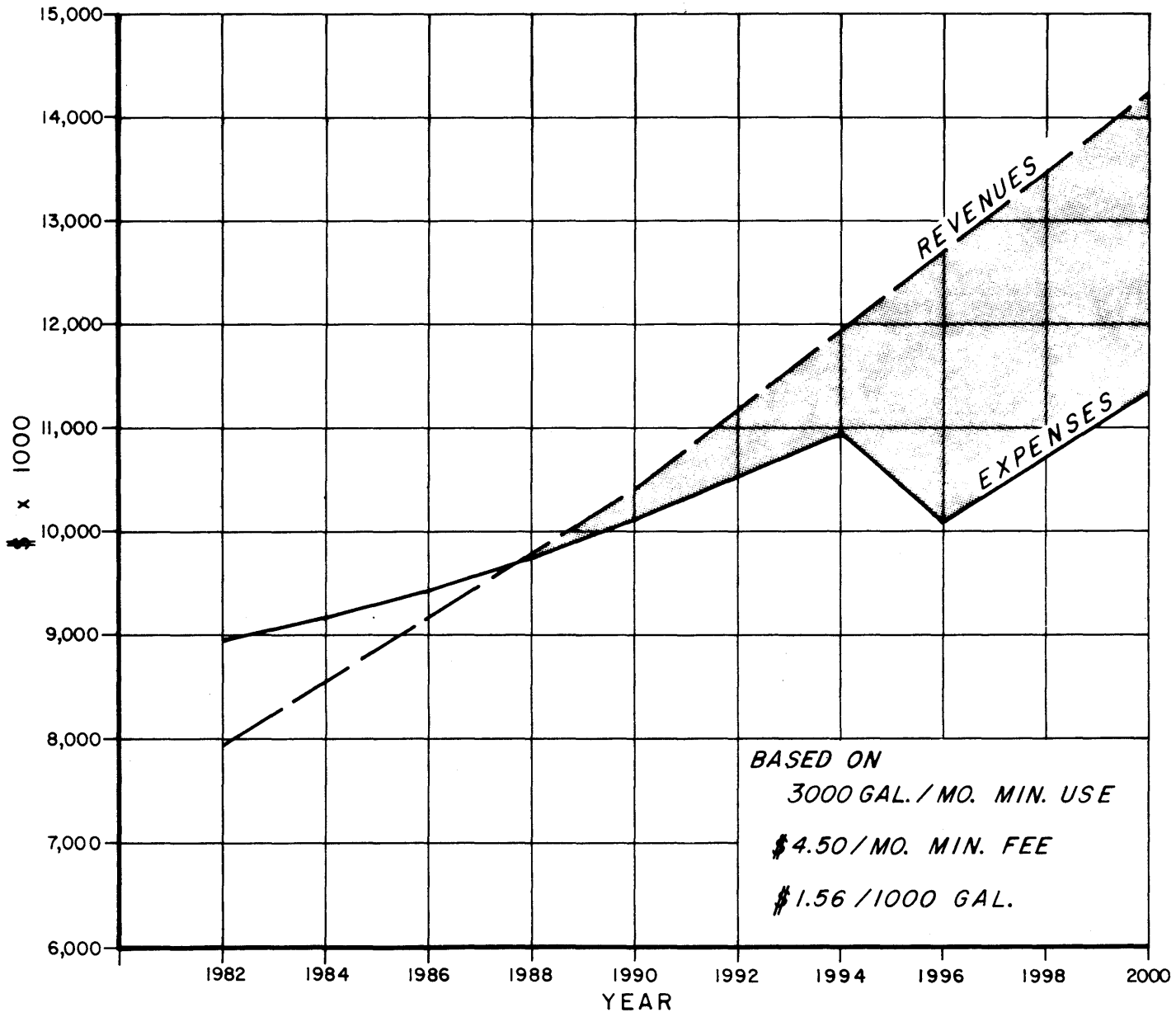


FIGURE III-5
REVENUES VS. EXPENSES WITH DEFERRED PRINCIPAL PAYMENTS



Revenues begin increasing as the population and consumption increases until 1988 where revenues equal expenses. From this point on, excess revenues would be generated and the previously deferred principal payments could be paid off.

Project Repayment Alternative III

The Stage II expansion in the Little Snake Drainage is expected to yield an average of 18,000 acre feet per year. It is also projected that Cheyenne will not need the entire amount until the year 2000. Until that time it would be possible to sell the excess water to municipal or industrial interests on the North Platte or Laramie Rivers on an interim basis to help offset the costs of water development. Figure III-6 shows the amount of excess water collected which could be marketed.

The determination of cost of this excess water requires the calculation of the incremental project cost associated with collection and storage.

Since water will be collected and stored in both the Hog Park and Douglas Creek facilities and would also be available for release from both, it would seem logical that all facilities except the pipelines should be included. Therefore, the excess water incremental cost should be calculated using the cost of the following facilities:

Hog Park Dam Enlargement	$ 9,075,000
Collection System	24,575,100
Rob Roy Dam Enlargement	17,324,780
Total	$50,974,880

Amortization of this amount over a 30-year period at various interest rates is given below.

TABLE III-2
Incremental Annual Cost of Collection/Storage Facilities
Annual Costs

Interest Rate %	Collection/Storage Facilities $	Pipeline Facilities $	Total $
9	4,961,895	2,698,018	7,659,913
6	3,703,325	2,013,675	5,717,000
4	2,947,878	1,602,901	4,550,779

Collection and Storage Cost @ 6% $\frac{\$3,703,325}{18,000\ AF} = \$206/AF$

The cost of water to Cheyenne consumers would then be based upon the annual cost of water for the entire project plus the total annual expenses referred to in Figure III-3.

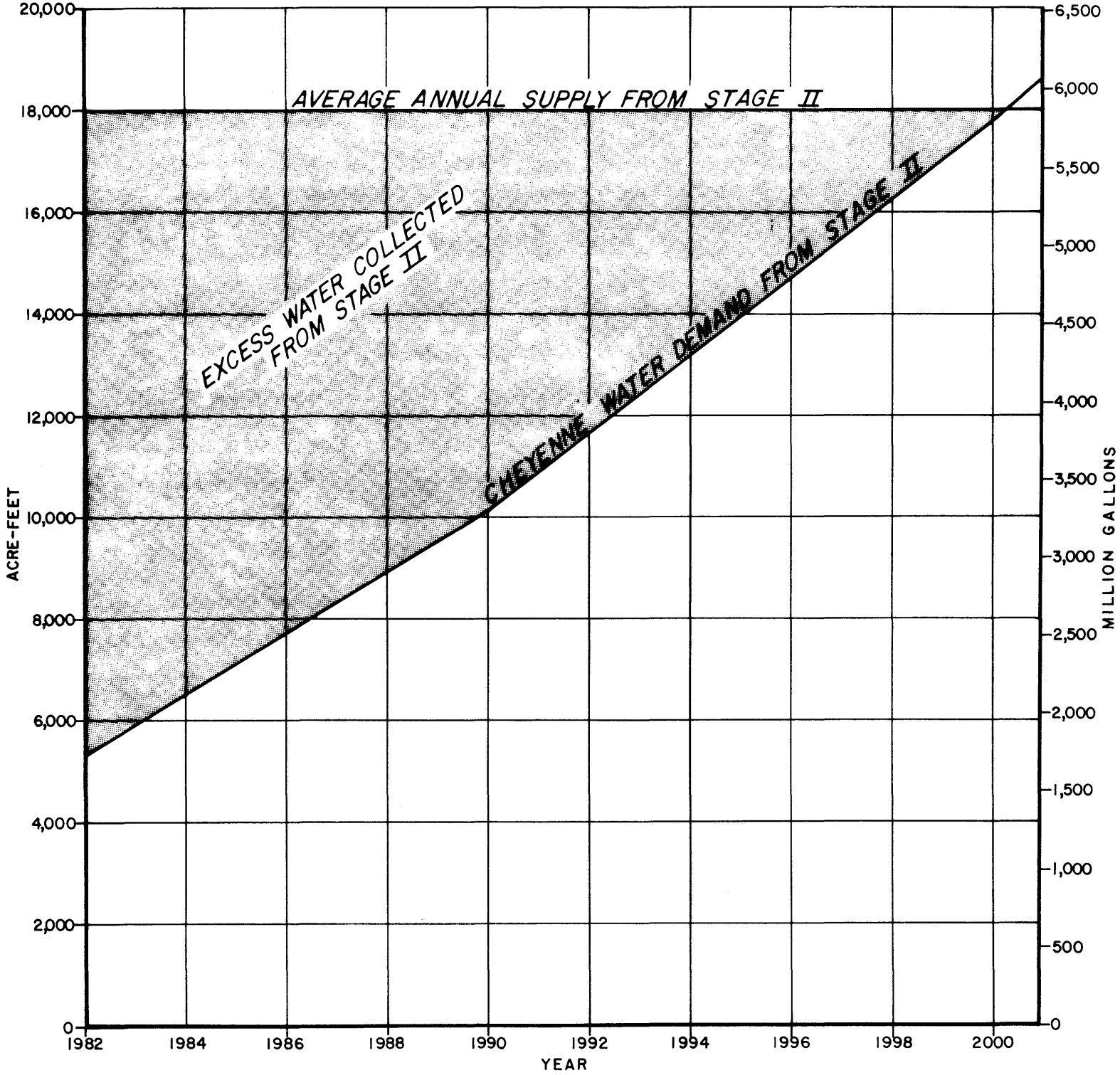


FIGURE III - 6
STAGE II EXPANSION ANNUAL SUPPLY & DEMAND

Figure III-7 shows the results of one operation study which was run to determine the water cost to Cheyenne consumers. At a 6% amortization rate, assuming a $4.50 average minimum charge and a 3000 gallon/month minimum use the rate would be $1.23 per 1000 gallons. It can be seen that in 1988, expenses have risen to equal revenues and at that time a rate increase would be required.

Discussion of Repayment Alternatives

The City of Cheyenne has indicated, that if it were to seek project financing of the conventional bonding form, a debt interest rate of around 9% per annum could be expected. At this rate, an annual payment of $7,660,000 would be required if amortized over a 30-year period. The cost of the water to the consumer under any of the three repayment alternatives at this interest rate would be extremely high. If this project is to be economically feasible, it is necessary to obtain a source of financing which can provide an annual interest rate below that which is required from conventional bonding sources. It is for this reason that the City of Cheyenne has applied for State assistance in the financing of the project.

Of the three repayment alternatives discussed previously, alternative III will provide the necessary debt servicing revenues at the lowest cost to the consumer. The cost of water shown on Figures III-4, III-5, and III-7 were calculated using the same 6% amortization rate. Figure III-8 is an illustration of what the water cost to the consumer would be under repayment alternative III at any interest rate between 0 and 10%.

This alternative is dependent upon the sale of excess water. The economic advantages diminish as the quantity of unsold excess water increases.

Project Implementation Alternatives

The three repayment alternatives are based upon the assumption that the City of Cheyenne, after obtaining project financing, will build, operate, and own the project and provide a water service for its customers in Cheyenne and the downstream North Platte. The State role would, therefore, be only to provide the money necessary to build the project at an interest rate that is affordable.

An option which might be considered would be for the State to build the project and then resell the water to Cheyenne, the priority customer, on a permanent but as needed basis. The State could then market any excess water in the system to outside customers. Operation and maintenance of the system could remain the responsibility of Cheyenne since it is the prime user for whom the project was intended.

Another option available would be for the State to provide the financing as has been assumed but also agree to buy the excess water collected by the system. This water could then be sold by the State to outside customers. The State would be assuming the role of "water broker" for any excess Cheyenne Project water and would relieve Cheyenne of this responsibility.

FIGURE III-7
REVENUES VS. EXPENSES
WITH
EXCESS WATER SALES

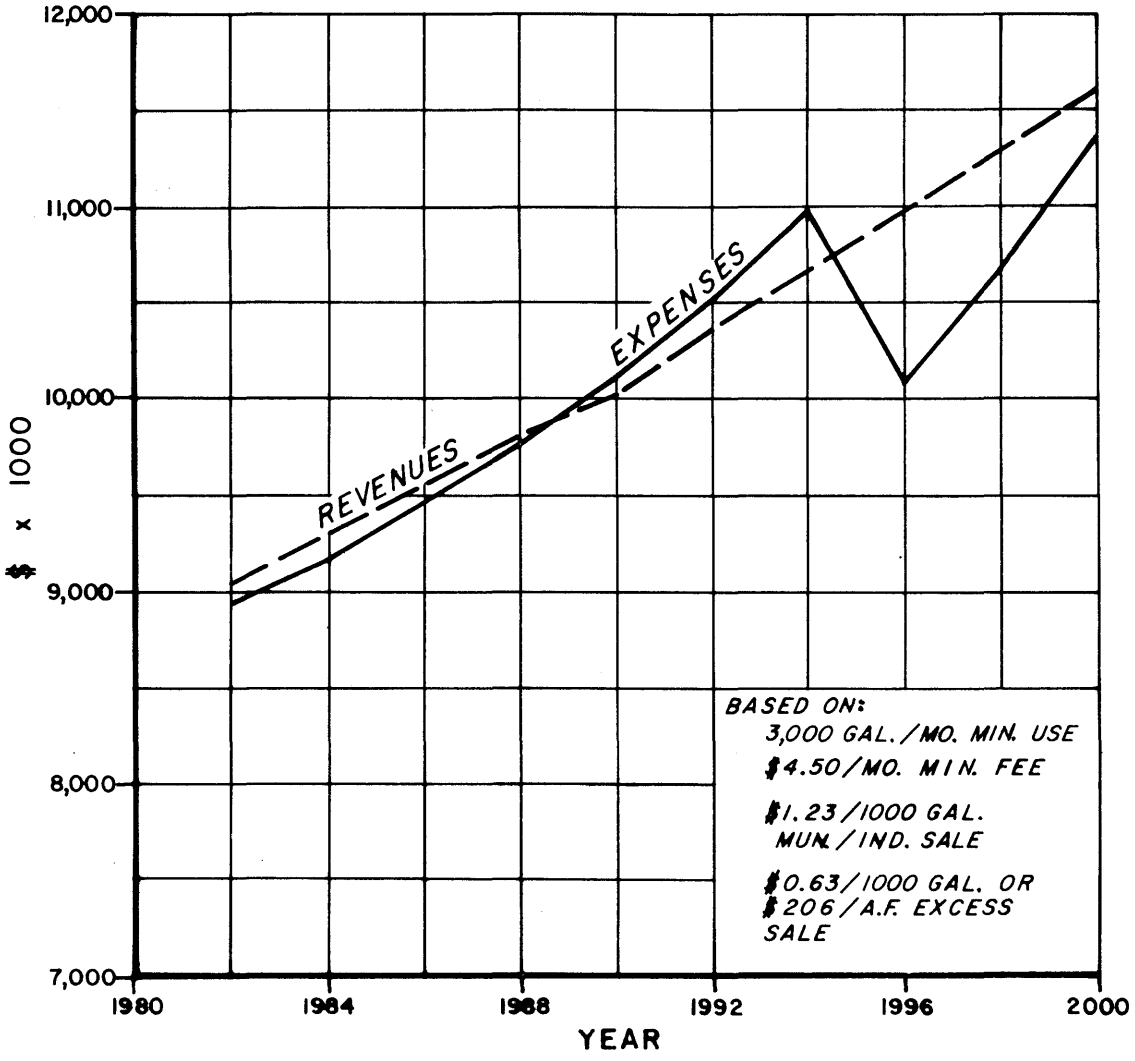
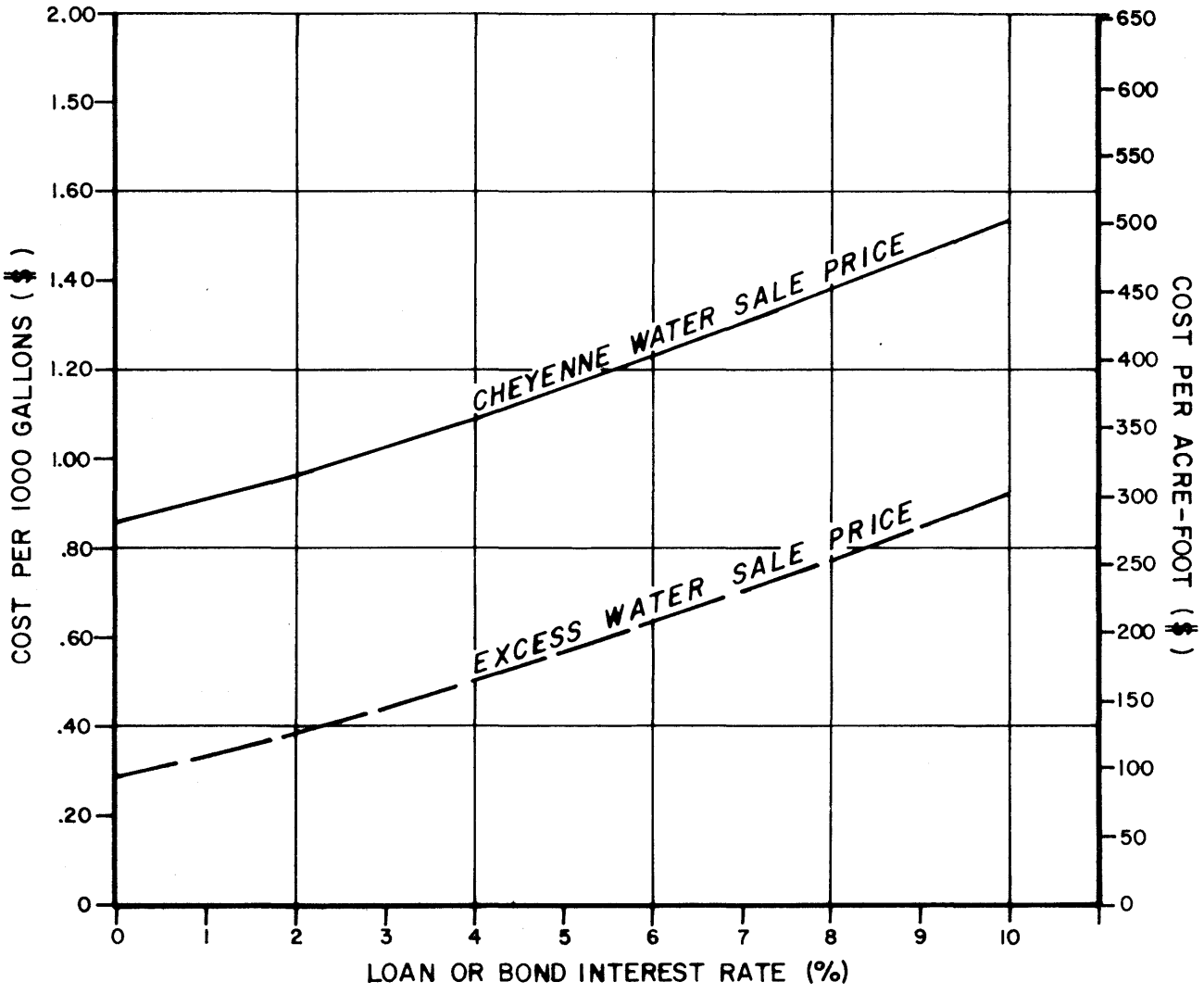


FIGURE III-8
WATER COST
VS.
INTEREST RATE

(BASED ON 1981 PROJECT COSTS AND 1982 ESTIMATED WATER DEMAND WITH EXCESS WATER SALES)



CONCLUSIONS

The City of Cheyenne's water supply system is presently operating at or near its capacity. To provide water for current and anticipated growth, supplies must be increased to meet the demand.

Stage II of the Cheyenne Water Project satisfies the requirements of meeting water demands until the year 2000. To depend upon this plan as the only source of future water would be ignoring the possibility that its construction may not be allowed. Because of this possibility, other sources of supplies need investigation and options developed.

A City issue of revenue bonds to finance the project will result in excessively high water cost to the consumer due to the high anticipated bond interest rate. Therefore, financing assistance is needed to keep this cost at a reasonable level.

REFERENCES

"Annual Financial Report of the Board of Public Utilities", City of Cheyenne, Cheyenne, Wyoming, June 30, 1978

J. T. Banner & Associates, Inc., "The Cheyenne Water Supply Plan", March 1961

J. T. Banner & Associates, Inc., "Report on Water Supplies Available from Second Stage Expansion of Cheyenne's Little Snake Diversion Facilities", October 1974

J. T. Banner & Associates, Inc., "Report on Proposed Expansion of Cheyenne's Little Snake Diversion Facilities", October 1974

J. T. Banner & Associates, Inc., "Report on Proposed Expansion of Cheyenne's Douglas Creek Facilities", July 1977

U.S.D.A. Forest Service, "Huston Park Unit, Final Environmental Statement", September 29, 1977

Wesche, Thomas A., "Fishery Resources and Instream Flow Recommendations for Streams to be Impacted by Cheyenne's Proposed Phase II Development", July 15, 1977