City of Bend

Utilities System Master Plan Update

Population, Sewerage System
& Water System

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TABLE OF CONTENTS

I. INTRODUCTION

CITY OF BEND

I. INTRODUCTION

GENERAL

The City of Bend, having worked with the 1992 Utilities System Master Plan, has determined that a periodic review and update of this plan is essential to the continued facilities management by the City. This document will be the first in a series of updates prepared by City staff and specific consultants when appropriate for the technical aspect of the plan only. This plan update will focus primarily on recent growth trends within the City and Urban Growth Boundary and those impacts on future sewer and water facilities necessary to satisfy the growth demands.

A five year capital improvement program will be included in this update. This program is the same as presented annually to the City Council. The five year program enables the City of Bend to resolve immediate growth concerns within each facility's service area. No analysis of SDC's will be included within this update. The original calculations for SDC's are contained in the June 1992 document. Updates associated with SDC's are prepared by the Finance Department.

PRIOR REPORTS

The June 8, 1992 Utilities System Master Plan.

Previous sewerage system reports include the BECON Phase II Sewer Study completed in 1979 and the Stevens, Thompson and Runyan/Tenneson Facilities Plan adopted in 1976.

The Stevens, Thompson and Runyan/Tenneson Facilities Plan recommended a sewer plan, design criteria, population patterns, estimated costs and an implementation schedule for improvements. It separated the construction into two phases: inside the City limits and outside the City limits.

The BECON (Bend Engineering Consultants) Plan updated the sewerage Facilities Plan of 1976 by redefining the design criteria for the major collection systems, and presenting plans for construction of the present Wastewater Treatment Plant located northeast of the City.

Previous water system reports include a 1980 master plan prepared jointly by Century West Engineering Corporation and Central Oregon Engineering and Surveying, and a 1970 study completed by CH2M. Other studies completed for developments within Bend (e.g. Awbrey Butte) were also consulted.

PURPOSE OF UPDATE

The purpose of this report is to identify future improvements to water and sewerage systems required to serve the urban growth areas, develop short range capital improvement projects necessary to implement the Master Plan, and accommodate the ever changing growth trends. Studies by private engineering firms and City staff have examined the existing water and sewerage utility systems and the master plan. Certain areas within the master plan have been modified to accommodate growth, topographical features and system capabilities.

The main update objectives are listed below:

Population Growth & Density Analysis

1. Re-evaluate the population information updated by the City for the Bend Area General Plan.

2. Re-develop a map defining the sewer drainage basins including sub-basins and water pressure zones, and their correlation to the Transportation Analysis Zones (TAZ's) and population.

3. Provide population information for the sewer basins and water pressure levels for ultimate buildout based on the year 1995.

Water Distribution & Facility Analysis

1. Update information relative to BUILDOUT.

2. Compile information developed for the BUILDOUT into the City's base map project.

Wastewater System & Treatment Facility Analysis

1. Update the existing and future wastewater system in the master plan computerized spreadsheet format.

2. Re-verify wastewater flows and determine system requirements for the ultimate service area.

3. Determine immediate system weaknesses and pump station abandonment, and provide capital improvements for elimination through the year 2001.

4. By utilizing outside consultant information, re-evaluate wastewater treatment process and recommended improvements to service the ultimate sewer area and the immediate needs.

5. Compile information developed for the BUILDOUT into the City's base map project.

System Development Charges

STUDY AREA

For this study, the area considered for the System Development Charge formation is the outer Urban Growth Area (UGA) as defined by the City's current Bend Area General Plan. Generally, this UGA is defined as the area bounded by Tumalo Creek and Shevlin Park to the west; Cooley Road east of Hwy. 97, and approximately one-half mile north of Cooley Road west of Hwy. 97 for the northern boundary; between 27th Avenue and Hamby Road for the east boundary; and Knott Road and the Homestead Subdivision as the south boundary.

II. POPULATION ANALYSIS

CITY OF BEND

II. POPULATION ANALYSIS

BACKGROUND

The City of Bend is updating the Bend Area General Plan which will include new population forecasts for the urban area. At the same time, the City is preparing a Transportation System Plan for the urban area. The transportation plan includes a forecast of population, households, and employment by more than 130 transportation analysis zones (TAZ's) that cover the long range planning area and even adjacent areas in the County.

For the Transportation System Plan, the City staff prepared population and housing estimates for 1995 and theoretical BUILDOUT numbers if all the residential land is developed within the Urban Growth Area. The 1995 Urban Growth Population is estimated at 38,300 and the BUILDOUT population is projected to be 94,597 persons.

Although the BUILDOUT population could not be reached until well into the next century, it is used for water and sewer planning since these systems have a much longer planning horizon than land use and transportation plans. There were several assumptions used by City staff in the development of dwelling unit counts and population estimates for the 1995 and BUILDOUT scenarios. These assumptions were:

1. The 1995 housing numbers were based on dwelling counts plus subdivision and multi-family plats expected to come 'on-line' in 1995, and reasonable growth in large master plan developments. An average of 2.3 persons per dwelling unit was used to estimate population.

2. For the BUILDOUT dwelling forecast a density of 3.5 units per acres was used for all of the single family zoning districts (RS, RL, SR 2½, UAR-10). For areas with approved master plans such as Awbrey Butte, Awbrey Glen, and Broken Top the approved density was used.

3. An average density of 15.5 units per acres were used for multi-family zoning districts (RM, RH). No changes to the existing amount of multi-family lands were included in the BUILDOUT forecasts.

4. The BUILDOUT scenario assumed full occupancy of all dwelling units.

POPULATION TRENDS AND PROJECTIONS - BEND URBAN AREA

The demographic trends and projections for the Bend Urban Area, Pressure Zones, and Drainage Basins are as follows. The demographic information for 1995 and BUILDOUT is based upon TAZ density and housing unit tables provided by the City of Bend.

Although population projections have been made, it is not feasible to attempt to pinpoint specific dates with specific population figures. Both Bend and Deschutes County have experienced widely varying growth rates. For example, Deschutes County's growth was 100 percent from 1970 to 1980, and 40 percent from 1980 to 1990 (source: County Planning Department). Therefore, BUILDOUT population of an estimated 94,597 could occur at anytime during this planning period. Even though BUILDOUT could occur by 2015, it is more likely that the population at that date would be much less.

The following table provides a general estimate of population growth as it relates to the two types of housing units:

BEND URBAN AREA

Population	SF Units	MF Units	Total
46,056	16,446	3,577	20,023
60,000	20,870	5,217	26,087
70,000	24,044	6,391	30,435
80,000	27,131	7,652	34,783
90,000	30,130	9,000	39,130
94,597	30,868	10,262	41,130

SF = Single Family
MF = Multiple Family

The TAZ demographic data was also used as a basis for distributing housing units and population by pressure zone and drainage basin. Allocation routines were used within a computerized geographic information system (GIS) to determine the distribution of single and multiple-family housing units and population by pressure zone and drainage basin. The results of these demographic distributions for water and sewer system planning for 1995 and BUILDOUT are as follows:

WATER:

POPULATION BY PRESSURE ZONES
AT 1995

PZONES	SF	MF	TOT	POP
1	60	0	60	166
2	214	0	214	628
3	3,501	523	4,024	9,255
4	5,923	1,170	7,093	16,313
5	4,869	1,746	6,615	15,214
6	1,879	138	2,017	5,197
TOTAL	16,446	3,577	20,023	46,773

POPULATION BY PRESSURE ZONES
AT BUILDOUT

PZONES	SF	MF	TOT	POP
1	333	0	333	767
2	895	0	895	2,057
3	8,303	980	9,283	21,350
4	9,872	2,767	12,639	29,070
5	4,264	5,086	9,350	21,504
6	7,201	1,429	8,630	19,849
TOTAL	30,868	10,262	41,130	94,597

SEWER:

POPULATION BY SEWER DRAINAGE BASINS
AT 1995

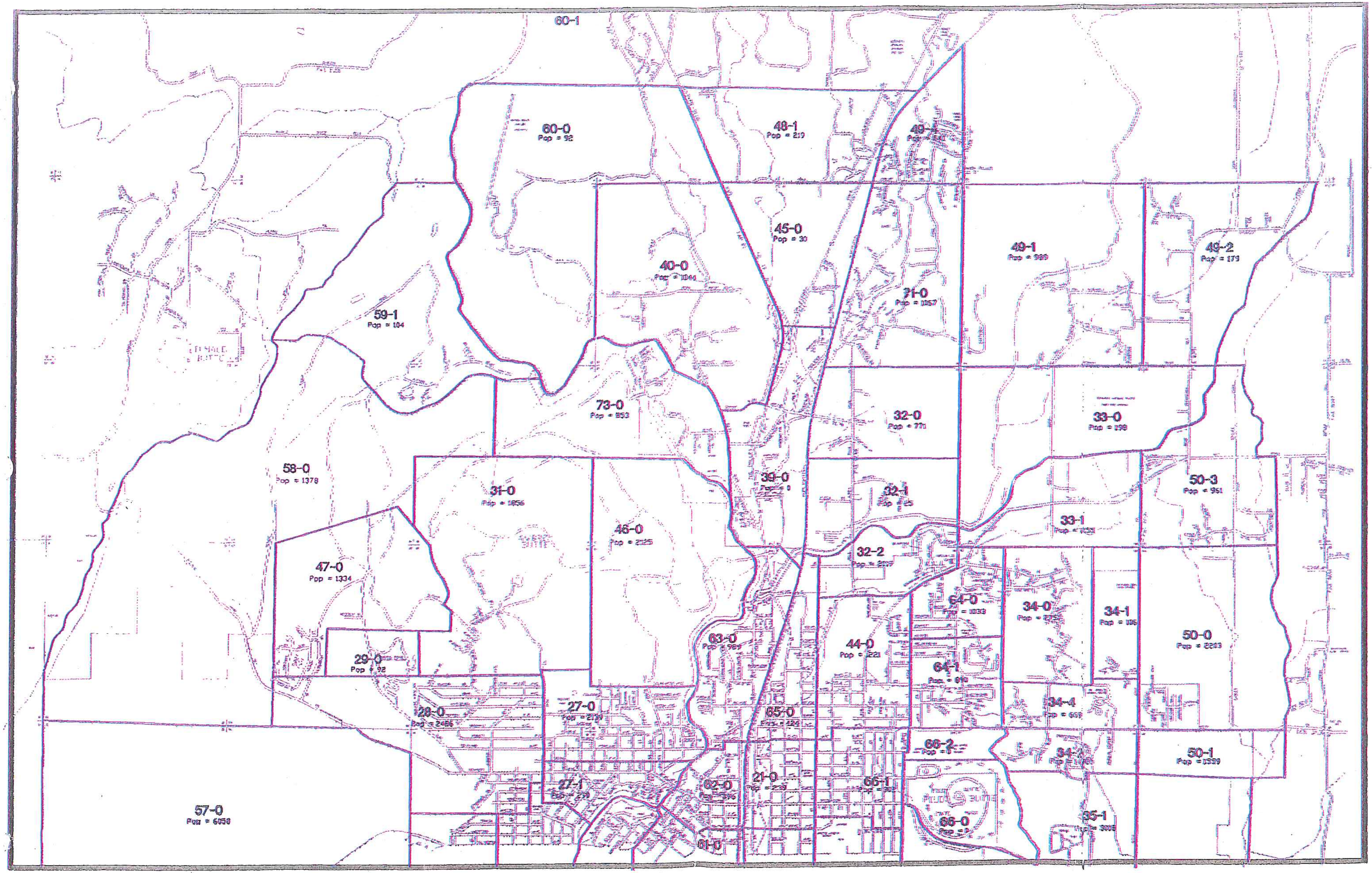
DRAIN	SF	MF	TOT	POP
1	18	0	18	41
2	29	2	31	71
3	77	3	80	184
4	294	0	294	677
5	19	0	19	43
6	51	0	51	117
7	45	0	45	104
8	71	0	71	163
9	5	0	5	12
10	10	0	10	24
11	41	0	41	95
12	70	0	70	160
13	38	94	132	303
14	10	0	10	24
15	337	68	405	932
16	3	0	3	6
17	283	37	320	736
18	128	12	140	323
19	113	28	141	325
20	231	49	280	643
21	545	20	565	1,299
22	1	0	1	2
23	117	95	222	510
24	110	66	176	405
25	160	68	228	524
26	157	33	190	437
27	21	62	83	191
28	181	11	192	441
29	400	110	510	1,172
30	176	38	214	493
31	140	254	394	907
32	769	402	1,171	2,694
33	587	56	643	1,480
34	51	29	80	177
35	0	0	0	0

36	127	41	168	387
37	120	31	151	347
38	0	44	44	102
39	44	1	45	104
40	65	0	65	150
41	412	0	412	948
42	491	218	709	1,630
43	240	10	250	576
44	98	25	123	282
45	280	52	332	764
46	13	58	71	163
47	25	0	25	57
48	162	137	299	688
49	88	0	88	203
50	294	31	325	748
51	239	308	547	1,258
52	78	50	128	295
53	76	16	92	211
54	161	0	161	370
55	278	61	339	780
56	143	0	143	330
57	850	0	850	1,954
58	336	0	336	772
59	144	1	144	332
60	42	0	42	96
61	64	19	83	191
62	49	98	147	337
63	316	0	316	726
64	56	0	56	128
65	54	0	54	125
66	53	0	53	121
67	959	0	959	2,206
68	187	0	187	430
69	14	0	14	32
70	164	12	176	404
71	73	0	73	169
72	35	0	35	81
73	90	2	90	208
74	20	40	60	139
75	1	0	1	1
76	53	0	53	123
TOTAL	16,446	3,577	20,023	46,053

POPULATION BY SEWER DRAINAGE BASINS
AT BUILDOUT

DRAIN	SF	MF	TOT	POP
1	0	0	0	0
2	62	2	64	148
3	235	2	237	546
4	699	0	699	1,608
5	88	0	88	202
6	258	0	258	594
7	180	0	180	414
8	130	0	130	299
9	11	0	11	26
10	120	0	120	276
11	177	0	177	406
12	334	0	334	767
13	380	275	655	1,507
14	91	0	91	209
15	1,535	316	1,851	4,256
16	230	0	230	528
17	820	37	857	1,971
18	204	104	308	707
19	227	223	450	1,034
20	385	53	438	1,008
21	772	20	792	1,822
22	440	0	440	1,012
23	182	119	301	693
24	246	564	810	1,863
25	1,327	208	1,535	3,531
26	361	55	416	957
27	55	85	140	321
28	171	15	186	428
29	473	122	595	1,369
30	401	249	650	1,495
31	566	1,685	2,251	5,177
32	703	402	1,105	2,542
33	575	14	589	1,354
34	342	589	931	2,142
35	74	0	74	169
36	1,175	117	1,292	2,972
37	146	47	193	444

38	0	0	0	0
39	27	1	28	65
40	45	1	46	105
41	461	2	463	1,064
42	672	237	909	2,090
43	434	10	444	1,020
44	85	47	132	304
45	378	129	507	1,167
46	22	48	70	160
47	770	0	770	1,771
48	847	229	1,076	2,475
49	347	19	366	842
50	976	22	998	2,295
51	385	515	900	2,071
52	128	155	283	652
53	71	42	113	260
54	136	38	174	400
55	333	32	365	840
56	912	0	912	2,097
57	1,864	0	1,864	4,287
58	467	0	467	1,073
59	292	1	293	675
60	63	0	63	146
61	737	17	754	1,734
62	110	105	215	495
63	1,417	0	1,417	3,260
64	226	0	226	520
65	189	0	189	435
66	970	0	970	2,230
67	3,282	0	3,282	7,549
68	249	0	249	573
69	32	0	32	74
70	286	316	602	1,385
71	187	0	187	429
72	348	0	348	801
73	703	2	705	1,622
74	92	326	418	962
75	0	0	0	0
76	814	0	814	1,872
	33,532	7,597	41,129	94,597



scale 1" = 3000' design

drawn Mary Pelton date 01/24/95

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TRAFFIC ANALYSIS ZONES AND POPULATION AT BUILDOUT

FIGURE A

scale 1" = 3000' design

drawn Mary Polston date 01/24/95

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TRAFFIC ANALYSIS ZONES AND POPULATION AT BUILDOUT

FIGURE B

III. SEWER UTILITY PLAN

CITY OF BEND

III. SEWER UTILITY PLAN

GENERAL

The sewer utility plan portion of the Master Plan Update includes examination of the existing and future wastewater collection systems to service the Urban Growth Area The population density information derived from the Traffic Analysis Zones has been transferred to coincide with the sewer drainage basins to determine the population serviced by each basin area. From this data the sewer mains have been sized and located to adequately serve the UGA. Note that the Wastewater Treatment Plant Facility will be discussed in a separate section.

EXISTING COLLECTION SYSTEM

There are four types of sewage systems currently existing within the Urban Growth Area. One, City sewer with subsequent treatment; two, septic tanks with drainfields; three, septic tanks with drill-holes and four; Juniper Utilities which is a pressure sewer system. This Master Plan Update is based on the ultimate elimination of all septic systems and connection to the City collection and treatment system.

The current sewer guidelines within the Urban Growth Boundary are adhering to the recommendations set forth in the BECON Phase II Sewer Report. The Phase II Report specified several improvements to the city sewer system which have since been constructed. They include Interceptors A, B & C which generally conveyed sewage flows from the old treatment plant on the east side to the present facility located northeast of town The proposed Riverside Pump Station and the Awbrey Butte Interceptor have not been constructed which was to serve the area from Awbrey Butte north to the D.C.M.I.D. Canal. The North Interceptor is presently constructed and will serve the areas north of the North Unit Main Canal to Yeoman Road. This will eventually service the area from Bend River Mall northward to the Mountain View Mall pump station and from O.B. Riley Road on the west to Yeoman Road on the east.

The limits of the existing system are from the Mountain View Mall and Wyndemere subdivision on the north end, to the Wagners Pinebrook Plaza and Mt. Bachelor Village at the south, from Valhalla Heights and portions of Awbrey Butte on the west, to St. Charles Hospital and Mt. View High School on the east. Of course there are many areas in between these limits that do not have city sewer or are on approved septic drainfields, pressure sewers or sand filters. This study will seek to incorporate these pockets into the City system, along with the remainder of the Urban Growth Area.

DESIGN PARAMETERS

Design Period

The design period will not be set to a specific date in time, but rather that point in which the Urban Growth Boundary will reach total buildout. This growth will coincide with the current Land Use & Zoning Code to determine the limits of development and population density according to the Traffic Analysis Zones as previously described.

General Design Equation

The following design parameters were used in this report to develop sewer trunk interceptor, pump station and pressure sewer sizing. They are generally accepted design criteria and have been verified through City flow records. Peak projected waste flows are used for sizing collection lines. The average waste and peak flows are used for determining pump station and pressure main design. Several design parameters have been revised from the Phase II Study and will be discussed later. However, the following will be the basic design equation for sizing the facilities. The peak and average waste flows are described as follows:

$$Q_t = Q_d + Q_n + Q_p + Q_i$$

Where,

Q_t = Total Design Flow
Q_d = Domestic Flow Allowance
Q_n = Non-domestic Flow Allowance
Q_p = Point Source Allowance
Q_i = Infiltration & Inflow Allowance

Note that average domestic waste flows shall have a peaking factor applied which will convert the average flows to design flows.

AVERAGE WASTEWATER FLOWS

The average wastewater flows are determined by the previous design equation. Values for domestic, non-domestic (commercial and industrial), point sources, and infiltration & inflow are input into the equation. The various design flows are summarized below:

- Domestic: 100 gallons per capita per day (gpcd)
- Non-domestic:
  General Commercial/
  Industrial: 1,300 gallons per acre per day (gpad)
  Highway Commercial: 4,200 gallons per acre per day (gpad)
- Point Sources: To be determined individually
- Infiltration & Inflow: 225 gallons per acre per day (gpad)

Several changes have been made to the average design flow values from the BECON Phase II Study of 1979. The domestic flows have been decreased from the 125 gpcd figure to 100 gpcd. The previous value was based on treatment plant records which substantiated 150 gpcd, however water meters were planned on being installed for domestic use. Metering has historically reduced sewage flows and therefore the BECON Study recommended reduced domestic flows to 100 gpcd. The daily per capita domestic waste flow figure of 100 gpcd was arrived at by exchanging infiltration & inflow allowances for domestic waste flows. The I&I rate of 500 gpad previously assigned is not reasonable for the Central Oregon climate or soil strata. A figure of 225 gpad has been used as a balance between typical design allowance and the actual low infiltration and inflow rates indicated by plant records. The reduced I&I allowance will be transferred to the domestic waste flows to match the high water consumption recorded in Bend. These allowances provide a comparable factor of safety as that produced by the Phase II design by increasing the domestic waste flow and reducing the infiltration and inflow allowance.

The non-domestic commercial and industrial waste flows have also been increased from the BECON 1979 Phase II Study. City water consumption records show that for general commercial and industrial businesses the water usage varies from 400 to 1,800 gpad, with the average being 1,100 gpad. For this study, a design value of 1,300 gallons per acre per day was used. Additionally, a study of the water demands by the commercial areas located along Highway 97 was performed. This resulted in winter flows from 3,200 to 4,200 gpad. A design value of 4,200 gallons per acre per day was used for this highway/commercial area.

DESIGN WASTEWATER FLOWS

Design wastewater flows have been determined by taking the average waste flows and applying a peaking factor to the average domestic flows. A wet weather allowance for the infiltration and inflow was then added to the average flows to determine the peak design flow. The peaking factor used for domestic flows is described below:

- Peaking Factor: (apply to domestic flows only)
  Interceptors and Treatment Facilities, P.F. = 2.0
  Average Domestic Flows below 1.0 MGD, P.F. = 3.0
  Average Domestic Flows between 1.0 & 2.5 MGD, P.F. = 2.5
  Average Domestic Flows between 2.5 & 5.0 MGD, P.F. = 2.25
  Average Domestic Flows greater than 5.0 MGD, P.F. = 2.0

DESIGN POPULATION

The design population is based on buildout of the Urban Growth Area according to information gathered from the Traffic Analysis Zones and land use zoning. The population at buildout is 94,597 people. For detailed information refer to the previous chapter on Population Analysis.

DESIGN CRITERIA

Gravity Sewers

Future gravity sewers should be designed to meet or exceed the standard requirements for scouring and cleansing velocity as determined by the Department of Environmental Quality. The peak waste flow should be used for sizing gravity sewer mains. Lines should be sized to provide capacity with minimal surcharging of manholes.

Permanent Pump Stations

Future pump station wet well structures should be designed to accommodate the ultimate service population. Pumps should be designed to the projected 5-year waste flows, but allow expansion to serve the ultimate requirement. All pump stations should be designed to provide the full projected waste flows with one pump out of operation for repair or maintenance. Pump stations should be reviewed by City staff to determine if they require standby generators for power failures, or if portable generator capability is sufficient. Criteria for this determination may be based on size of the facility, longevity of the system, environmental concerns and/or City Standards & Specifications.

Force Mains

Pressure force mains should be designed to provide adequate cleansing velocities. A minimum of 3 feet per second (fps) is recommended. Velocities greater than 5 fps should be avoided as they demand excessive pump head requirements. Generally, it is sound engineering practice to size the pump station so that force mains reach cleansing velocities a minimum of three times per day.

COLLECTION AND CONVEYANCE IMPROVEMENTS

North End Area

Flows from Awbrey Butte and the basins west of Awbrey Butte will be siphoned across the Deschutes River near the northwest corner of the Urban Growth Area (UGA) and converge with flows from the Gopher Gulch Interceptor. Possible flow at this point is 2007 gpm and would require a 21-inch pipe (minimum slope). From here the direction of flow is north to the proposed Gopher Gulch Pump Station, where it is pumped to the east until it can flow by gravity east along the northerly boundary of the UGA to the proposed Industrial Park. A 21and 24 inch pipe is an adequate size until flows from the industrial park are added making the peak flow 3441 gpm which would require a 27-inch pipe (minimum slope). This line will then extend to the northeast and connect to existing Interceptor A2 (as identified in the BECON Phase II report).

Awbrey Butte Area

The north and east sides of Awbrey Butte will flow down to the River's Edge Interceptor, which will follow the D.C.M.I.D. Canal around the base of Awbrey Butte to the west. The Riverhouse and areas along O. B. Riley Road as far north as Archie Briggs Road will be pumped to the River's Edge Interceptor from the proposed Rimrock Pump Station. The west side of Awbrey Butte will flow to a line running north near the existing alignment of College Way. This line will join the River's Edge Interceptor and create a peak flow of 1425 gpm, which will require a 21-inch line (minimum slope).

West Area

The West area will be served by several interceptors running northeasterly. The West Interceptor is planned to drain a portion of the area between Skyliners Road and Shevlin Park Road, and join an existing line on Shevlin Park Road near Mt. Washington Boulevard. Skyliners Interceptor will drain areas on both sides of Skyliners Road and join an existing line on Newport Avenue near College Way. The Overturf Interceptor will drain a large area between Skyliners Road and Century Drive (Basin 47). Mt. Bachelor Village and The Inn of the Seventh Mountain will be served by the Village Interceptor, a line running parallel and just south of Century Drive. This line will also serve a small portion of the area north of Century Drive across from Mt. Bachelor Village.

Southwest Area

The proposed Pinebrook Interceptor is planned to drain the southwestern area of the UGA, from the Deschutes River through Pinebrook subdivision to Highway 97. The peak flow at this point (691 gpm, Basin 67A). Another line will follow the Central Oregon Canal northeasterly to Blakely Road and connect to an existing 15-inch line.

South Central Area

Much of the South Central Area is served by Juniper Utilities (J.L Ward's system) and a possible peak flow for the area served is 1342 gpm; therefore a gravity line to service this area would be an 18-inch line (minimum slope). The line would flow northerly along Brosterhous Road and then to the east at American Lane, where it will require a 21-inch line, and continue east along Desert Wood Drive to a point near Central Oregon Canal.

East Area

The extreme southeast corner of the UGA (Basin 66) will pump to Ferguson Road. The proposed Southeast Interceptor will drain the area between Tekampe Road and Basin 66 and flow northerly and join with the Brosterhous Interceptor. Peak flow at this point is 3751 gpm, which would require a 30-inch line. The line will continue northeasterly to Reed Market Road, then north on 27th Street (27th Street Interceptor). It will drain the area from the East UGA to Pilot Butte, and continue north to Neff Road. Here the line will follow Neff Road east to Eagle Road, then north along Eagle Road, where it will be called the East Interceptor.

CONSTRUCTION COST ESTIMATE

The estimated construction cost for the sewage collection system is approximately $_____ million. A detailed breakdown of estimated construction cost is shown in Table B. The breakdown is by drainage basin.

SEWER FUND FIVE YEAR CAPITAL BUDGET
SEWER GROWTH RELATED

Priority	Definition
0 =	Construction contracted as of June 30, 1995
1 = Critical	Imperative for reliable sewer service
2 = Essential	Absolutely necessary for operation of system
3 = Necessary	Needed for efficient operation of system
4 = Desirable	Useful for proper operation of system
5 = Pending	Of no immediate consequence

TYPE OF PROJECT	PRIORITY	Amounts by fiscal year (in thousands) 96-97	97-98	98-99	99-20	00-01
SEWER EXPENSION PROGRAM FOR U.G.B.						
(S.E. 9TH EXTENSION)	1	200.0				
(S.E. REED MARKET EXTENSION)	3		40.0	200.0	160.0	
COMPLETE BLAKELY RD. INTERCEPTOR (18")	1	350.0				
BROSTERHOUS INTERCEPTOR (21")	1	32.0	435.0	300.0	400.0	
DRYING BED DECANT SYSTEM	1	200.0				
DEGASIFICATION BASIN EXPANSION	1	400.0				
PLANT AERATION BASIN MODIFICATIONS	1	150.0				
CHAMBERLAIN PUMP STATION WET WELL EXPANSION	1	25.0				
DRAKE PUMP STATION WET WELL EXPANSION	1	75.0				
RIVERHOUSE PUMP STATION WET WELL EXPANSION	1	50.0				
BOYD ACRES TIE-IN	1	50.0				
RIVERS EDGE INTERCEPTOR	1	410.0				
BROSTERHOUS INTERCEPTOR (27")	1	22.5	325.0			
RIMROCK PUMP STATION	1	200.0				
OLNEY REPLACEMENT	1	250.0				
PLANT WASTE ACTIVATED SLUDGE THICKNER	2	75.0	675.0			
ANAEROBIC DIGESTER	3		150.0	1350.0		
MECHANICAL DEWATERING	4			150.0	1350.0	
SUNRISE TIE-IN	5				17.2	155.8
SECONDARY CLARIFIER NO. 3	5				120.0	1080.0
TOTAL		2489.5	1625.0	2000.0	2047.2	1234.8

SEWER SYSTEM MASTER PLAN UPDATE
DRAINAGE BASIN FLOW CALCULATIONS BY LAND

TABLE "A"

					HIGHWAY COMMERCIAL		COMMERCIAL/ INDUSTRIAL		RESIDENTIAL		INFLOW & INFILTRATION			
	MANNING'S n:			0.013	LOADING (gpad):	4200	LOADING (gpad):	1300	LOADING (gpcd):	100	I/I RATE (gpad):	225	TOTAL	
	BASIN #	PIPE DIA (in)	PIPE SLOPE (ft/ft)	FLOW CAPACITY (gpm)	AREA (ac)	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	POPU-LATION	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	PEAK FLOW (gpm)	% PIPE CAP
	67				30	88	0	0	4529	944	600	94	1125	
	67A				0	0	0	0	3020	629	386	60	689	
		12	0.0014	597										116%
	65				0	0	0	0	435	91	55	9	99	
	65+67+67A=sum65				30	88	0	0	7984	1663	1041	163	1913	
		18	0.0012	1631										117%
AREA #1	62				18	53	0	0	495	103	120	19	174	
	sum65+62=sum62				48	140	0	0	8479	1766	1161	181	2088	
		18	0.0012	1631										128%
	61				0	0	0	0	1734	361	325	51	412	
		12	0.0022	748										55%
	sum62+61=sum61				48	140	0	0	10213	2128	1486	232	2500	
		18	0.0012	1631										153%
	54,59				0	0	4	4	1075	224	204	32	259	
	sum61+54,59=sum59				48	140	4	4	11288	2352	1690	264	2759	
		18	0.007	3940										70%
	70				24	70	0	0	1385	289	230	36	394	
		10	0.0028	519										76%
	60				122	356	0	0	146	30	154	24	410	
		10	0.0028	519										79%
	60+70=sum70				146	426	0	0	1531	319	384	60	805	
		12	0.0024	781										103%
	52				49	143	0	0	652	136	116	18	297	
	sum70+52=sum52				195	569	0	0	2183	455	500	78	1102	
	53				3	9	0	0	260	54	53	8	71	
	sum59+53=sum53				51	149	4	4	11548	2406	1743	272	2831	
	sum52+sum53=sum5253				246	718	4	4	13731	2861	2243	350	3932	
		24	0.0009	3045										129%
	51				42	123	31	28	2071	431	223	35	617	
		12	0.0022	748										82%
	44				18	53	67	60	304	63	169	26	203	
	sum5253+51+44=sum44				306	893	102	92	16106	3355	2635	412	4752	
		24	0.0008	2871										165%
	46				25	73	139	125	160	33	185	29	261	
	sum44+46=sum46				331	965	241	218	16266	3389	2820	441	5012	
		27	0.0006	3406										147%
	49				0	0	173	156	842	175	267	42	373	
		10	0.0028	519										72%
	32				0	0	188	170	2542	530	372	58	757	
	49+32=sum32				0	0	361	326	3384	705	639	100	1131	

SEWER SYSTEM MASTER PLAN UPDATE
DRAINAGE BASIN FLOW CALCULATIONS BY LAND

					HIGHWAY COMMERCIAL		COMMERCIAL/ INDUSTRIAL		RESIDENTIAL		INFLOW & INFILTRATION			
	MANNING'S n:			0.013	LOADING (gpad):	4200	LOADING (gpad):	1300	LOADING (gpcd):	100	I/I RATE (gpad):	225	TOTAL	
	BASIN #	PIPE DIA (in)	PIPE SLOPE (ft/ft)	FLOW CAPACITY (gpm)	AREA (ac)	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	POPU-LATION	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	PEAK FLOW (gpm)	% PIPE CAP
		15	0.0016	1158										98%
	39				0	0	0	0	65	14	23	4	17	
	sum32+39=sum39				0	0	361	326	3449	719	662	103	1148	
	to be added to sum4020													
	57				0	0	0	0	4287	893	1280	200	1093	
		15	0.0015	1121										98%
	55				4	12	0	0	840	175	401	63	249	
	57+55=sum55				4	12	0	0	5127	1068	1681	263	1342	
		18	0.0013	1698										79%
	69				0	0	0	0	74	15	37	6	21	
	68				0	0	0	0	573	119	134	21	140	
	sum55+69+68=sum68				4	12	0	0	5774	1203	1852	289	1504	
		21	0.001	2247										67%
	56				0	0	78	70	2097	437	289	45	552	
	sum68+56=sum56				4	12	78	70	7871	1640	2141	335	2056	
		21	0.001	2247										91%
	66				0	0	0	0	2230	465	339	53	518	
AREA #2	63				0	0	0	0	3260	679	626	98	777	
	66+63=sum63				0	0	0	0	5490	1144	965	151	1295	
		15	0.0015	1121										115%
	64				0	0	0	0	520	108	141	22	130	
	sum56+sum63+64=sum64				4	12	78	70	13881	2892	3247	507	3481	
		27	0.0008	3932										89%
	58				0	0	0	0	1073	224	297	46	270	
	sum64+58=sum58				4	12	78	70	14954	3115	3544	554	3751	
		30	0.0006	4512										83%
	50				0	0	0	0	2295	478	530	83	561	
	sum58+50=sum50				4	12	78	70	17249	3594	4074	637	4312	
		30	0.0006	4512										96%
	34				0	0	50	45	2142	446	471	74	565	
	sum50+34+sum34				4	12	128	116	19391	4040	4545	710	4877	
AREA #3		30	0.0006	4512										108%
	15				0	0	0	0	4256	887	1046	163	1050	
	sum34+15=sum15				4	12	128	116	23647	4926	5591	874	5927	
		36	0.0004	5994										99%
	43				0	0	36	33	1020	213	260	41	286	
	31				0	0	52	47	5177	1079	433	68	1193	
	43+31=sum31				0	0	88	79	6197	1291	693	108	1479	
		15	0.0022	1358										109%
	21				0	0	0	0	1822	380	443	69	449	

SEWER SYSTEM MASTER PLAN UPDATE
DRAINAGE BASIN FLOW CALCULATIONS BY LAND

					HIGHWAY COMMERCIAL		COMMERCIAL/ INDUSTRIAL		RESIDENTIAL		INFLOW & INFILTRATION			
	MANNING'S n:			0.013	LOADING (gpad):	4200	LOADING (gpad):	1300	LOADING (gpcd):	100	I/I RATE (gpad):	225	TOTAL	
	BASIN #	PIPE DIA (in)	PIPE SLOPE (ft/ft)	FLOW CAPACITY (gpm)	AREA (ac)	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	POPU-LATION	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	PEAK FLOW (gpm)	% PIPE CAP
	sum31+21=sum21				0	0	88	79	8019	1671	1136	178	1928	
		18	0.0138	5532										35%
	24				0	0	0	0	1863	388	170	27	415	
		12	0.0014	597										69%
	sum21+24=sum24				0	0	88	79	9882	2059	1306	204	2342	
		27	0.0017	5732										41%
	17				0	0	0	0	1971	411	206	32	443	
	sum24+17=sum17				0	0	88	79	11853	2469	1512	236	2785	
		27	0.0017	5732										49%
	48 (includes inn 7th mtn.-1150 pop.)				0	0	323	292	3625	755	922	144	1191	
		10	0.0032	555										215%
	47				0	0	3	3	1771	369	1623	254	625	
		18	0.0008	1332										47%
	48+47=sum47				0	0	326	294	5396	1124	2545	398	1816	
		21	0.0015	2753										66%
	45				0	0	3	3	1167	243	160	25	271	
		8	0.0038	333										81%
Area #8	sum47+45=sum45				0	0	329	297	6563	1367	2705	423	2087	
		21	0.0017	2930										71%
	41				0	0	15	14	1064	222	209	33	268	
		8	0.004	342										78%
	sum45+41=sum41				0	0	344	311	7627	1589	2914	455	2355	
		21	0.0011	2357										100%
	40				0	0	0	0	105	22	42	7	28	
	sum41+40=sum40				0	0	344	311	7732	1611	2956	462	2383	
	25				0	0	0	0	3531	736	807	126	862	
		10	0.0158	1232										70%
Area #10	36				0	0	0	0	2972	619	885	138	757	
		15	0.0069	2404										32%
	25+36=sum36				0	0	0	0	6503	1355	1692	264	1619	
		15	0.0129	3287										49%
	30				0	0	12	11	1495	311	199	31	353	
	20				0	0	2	2	1008	210	300	47	259	
	30+20+sum36=sum20				0	0	14	13	9006	1876	2191	342	2231	
		21	0.0026	3624										62%
	sum40+sum20=sum4020				0	0	358	323	16738	3487	5147	804	4614	
		27	0.0011	4611										100%
	sum4020+sum39=sum39a				0	0	719	649	20187	4206	5809	908	5762	

SEWER SYSTEM MASTER PLAN UPDATE
DRAINAGE BASIN FLOW CALCULATIONS BY LAND

				HIGHWAY COMMERCIAL		COMMERCIAL/ INDUSTRIAL		RESIDENTIAL		INFLOW & INFILTRATION			
	MANNING'S n:		0.013	LOADING (gpad):	4200	LOADING (gpad):	1300	LOADING (gpcd):	100	I/I RATE (gpad):	225	TOTAL	
BASIN #	PIPE DIA (in)	PIPE SLOPE (ft/ft)	FLOW CAPACITY (gpm)	AREA (ac)	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	POPU-LATION	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	PEAK FLOW (gpm)	% PIPE CAP
	36	0.0006	7341										78%
29				0	0	0	0	1369	285	166	26	311	
	10	0.0026	500										62%
sum39a+29=sum29				0	0	719	649	21556	4491	5975	934	6074	
38				0	0	0	0	0	0	16	3	3	
sum29+38=sum38				0	0	719	649	21556	4491	5991	936	6076	
26				0	0	0	0	957	199	101	16	215	
	10	0.0028	519										41%
sum38+26=sum26				0	0	719	649	22513	4690	6092	952	6291	
	18	0.0317	8385	16" pressure line from westside p.s. to 18" gravity line									75%
35				78	228	0	0	169	35	78	12	275	
	10	0.0028	519										53%
sum26+35=sum35				78	228	719	649	22682	4725	6170	964	6566	
37				77	225	0	0	444	93	118	18	336	
sum35+sum46+37=sum37				486	1418	960	867	39392	8207	9108	1423	11914	
	30	0.0017	7595										157%
42				0	0	99	89	2090	435	467	73	598	
	12	0.007	1335										45%
33				11	32	0	0	1354	282	308	48	362	
42+33=sum33				11	32	99	89	3444	718	775	121	960	
	18	0.0018	1998										48%
sum37+sum33=sum33a				497	1450	1059	956	42836	8924	9883	1544	12874	
	30	0.0051	13154										98%
28				7	20	0	0	428	89	106	17	126	
27				42	123	28	25	321	67	100	16	230	
sum33a+28+27=sum27				546	1593	1087	981	43585	9080	10089	1576	13230	
	24	0.0106	10452										127%
23				19	55	37	33	693	144	113	18	251	
sum27+23=sum23				565	1648	1124	1015	44278	9225	10202	1594	13481	
	24	0.0103	10303										131%
19				7	20	19	17	1034	215	114	18	271	
sum23+19=sum19				572	1668	1143	1032	45312	9440	10316	1612	13752	
	27	0.0081	12513										110%
18				0	0	0	0	707	147	107	17	164	
sum17+sum19+18=sum18				572	1668	1231	1111	57872	12057	11935	1865	16701	
	36	0.0035	17731										94%
72				71	207	270	244	801	167	563	88	706	
	15	0.0015	1121										63%
Area #6 74				0	0	422	381	962	200	480	75	656	
72+74=sum74				71	207	692	625	1763	367	1043	163	1362	

SEWER SYSTEM MASTER PLAN UPDATE
DRAINAGE BASIN FLOW CALCULATIONS BY LAND

					HIGHWAY COMMERCIAL		COMMERCIAL/ INDUSTRIAL		RESIDENTIAL		INFLOW & INFILTRATION			
	MANNING'S n:			0.013	LOADING (gpad):	4200	LOADING (gpad):	1300	LOADING (gpcd):	100	I/I RATE (gpad):	225	TOTAL	
	BASIN #	PIPE DIA (in)	PIPE SLOPE (ft/ft)	FLOW CAPACITY (gpm)	AREA (ac)	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	POPU-LATION	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	PEAK FLOW (gpm)	% PIPE CAP
		21	0.001	2247										61%
	14				0	0	0	0	209	44	98	15	59	
	sum18+sum74+14=sum14(yeoman @ canal)				643	1875	1923	1736	59844	12468	13076	2043	18122	
		42	0.0018	19190										94%
	sum14+sum15=sumpp				647	1887	2051	1852	83491	17394	18667	2917	24049	
		36	0.0039	18717										128%
	11				0	0	0	0	406	85	94	15	99	
	sumpp+11=sum11				647	1887	2051	1852	83897	17479	18761	2931	24149	
		42	0.0017	18650										129%
	22				0	0	0	0	1012	211	487	76	287	
	12				0	0	0	0	767	160	438	68	228	
	22+12=sum12				0	0	0	0	1779	371	925	145	515	
Area #4		10	0.0026	500										103%
	13				0	0	0	0	1507	314	537	84	398	
		10	0.003	537										74%
	sum12+13=sum13				0	0	0	0	3286	685	1462	228	913	
		15	0.0015	1121										81%
	76				0	0	0	0	1872	390	440	69	459	
		10	0.0026	500										92%
Area #5	75A				0	0	0	0	0	0	80	13	13	
	75				65	190	46	42	0	0	111	17	248	
	76+75A+75=sum75				65	190	46	42	1872	390	631	99	720	
		12	0.0022	748										96%
	73				0	0	0	0	1622	338	525	82	420	
	sum75+73=sum73				65	190	46	42	3494	728	1156	181	1140	
		15	0.0015	1121										102%
	10				0	0	0	0	276	58	219	34	92	
	sum73+10=sum10				0	0	0	0	3770	395	744	116	512	
		15	0.0015	1121										46%
	sum13+sum10=sumEE				0	0	0	0	7056	1080	2206	345	1425	
		21	0.001	2247										63%
	9				0	0	0	0	26	5	124	19	25	
	sumEE+9=sum9				0	0	0	0	7082	1085	2330	364	1449	
Area #4		21	0.001	2247										64%
	16				0	0	0	0	528	110	614	96	206	
	5				0	0	0	0	202	42	575	90	132	
	16+5=sum5				0	0	0	0	730	152	1189	186	338	
	sum9+sum5=sum95				0	0	0	0	7812	1238	3519	550	1787	

SEWER SYSTEM MASTER PLAN UPDATE
DRAINAGE BASIN FLOW CALCULATIONS BY LAND

				HIGHWAY COMMERCIAL		COMMERCIAL/ INDUSTRIAL		RESIDENTIAL		INFLOW & INFILTRATION			
	MANNING'S n:		0.013	LOADING (gpad):	4200	LOADING (gpad):	1300	LOADING (gpcd):	100	I/I RATE (gpad):	225	TOTAL	
BASIN #	PIPE DIA (in)	PIPE SLOPE (ft/ft)	FLOW CAPACITY (gpm)	AREA (ac)	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	POPU-LATION	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	PEAK FLOW (gpm)	% PIPE CAP
	30	0.0006	4512										40%

SEWER SYSTEM MASTER PLAN UPDATE
DRAINAGE BASIN FLOW CALCULATIONS BY LANC

				HIGHWAY COMMERCIAL		COMMERCIAL/ INDUSTRIAL		RESIDENTIAL		INFLOW & INFILTRATION			
	MANNING'S n:		0.013	LOADING (gpad):	4200	LOADING (gpad):	1300	LOADING (gpcd):	100	I/I RATE (gpad):	225	TOTAL	
	BASIN #	PIPE DIA (in)	PIPE SLOPE (ft/ft)	FLOW CAPACITY (gpm)	AREA (ac)	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	POPU-LATION	PEAK FLOW (gpm)	AREA (ac)	PEAK FLOW (gpm)	PEAK FLOW (gpm)	% PIPE CAP
	71				0	0	0	0	429	89	832	130	219	
		18	0.0012	1631										13%
	sum95+71=sum71				0	0	0	0	8241	1327	4351	680	2007	
		21	0.001	2247										89%
	3				0	0	0	0	546	114	615	96	210	
	sum71+3=sum3				0	0	0	0	8787	203	1447	226	2217	
		21	0.001	2247										99%
	2				0	0	129	116	148	31	314	49	196	
	4				0	0	62	56	1608	335	598	93	484	
	sum3+2+4=sum4				0	0	191	172	10543	569	2359	369	2897	
		24	0.0008	2871										101%
	513 acres of ind. park=ip				0	0	513	463	0	0	513	80	543	
	sum4+ip=sumip				0	0	704	636	10543	569	2872	449	3441	
Area #7		27	0.0007	3678										94%
	6				0	0	0	0	594	124	429	67	191	
	7				0	0	0	0	414	86	352	55	141	
	sumip+6+7=sum7				0	0	704	636	11551	779	3653	571	3773	
		27	0.0007	3678										103%
	8				0	0	0	0	299	62	536	84	146	
	sum7+8=sum8				0	0	704	636	11850	841	4189	655	3919	
		30	0.0006	4512										87%
	sum8+sum11=total				647	1887	2755	2487	95747 **	18320	22950	3586	28067	
		42	0.002	20228										139%

** includes 1,150 people @ inn of 7th mtn.

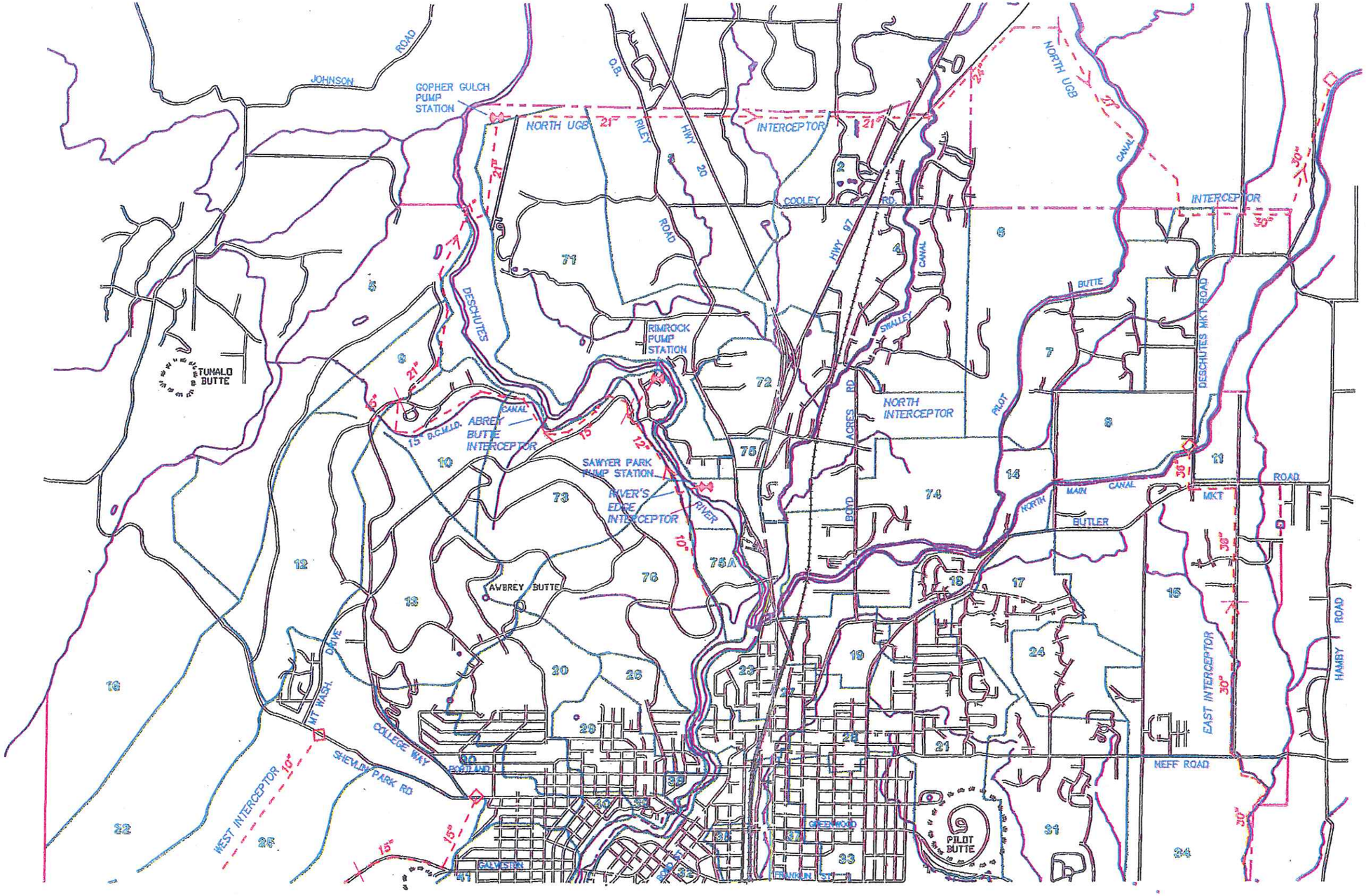
SEWER CONSTRUCTION COST ESTII

NEW SEWER LINES

BASIN #	DIA 10"	12"	15"	18"	21"	24"	27"	30"	36"	TOTAL COST
	$/FT 100.00	105.00	110.00	120.00	130.00	150.00	175.00	200.00	235.00	
2					2400					$312,000.00
3					7000					$910,000.00
4					800	1600				$344,000.00
5					2500					$325,000.00
7							1200			$210,000.00
8								6200		$1,240,000.00
9			1200		3500					$587,000.00
10			4700							$517,000.00
15								4500	6000	$2,310,000.00
61	1170	4000								$537,000.00
62				4000						$480,000.00
63	1900	1000	4000		3800					$1,229,000.00
67	1500	1800	3200							$691,000.00
71					5500					$715,000.00
73		2400	5000							$802,000.00
76	3500									$350,000.00
IND. PARK (513 AC.)						3000	7000			$1,675,000.00
TOTAL	8070	9200	18100	4000	25500	4600	8200	10700	6000	$13,234,000.00

TABLE "B"

Revised April 1, 1996

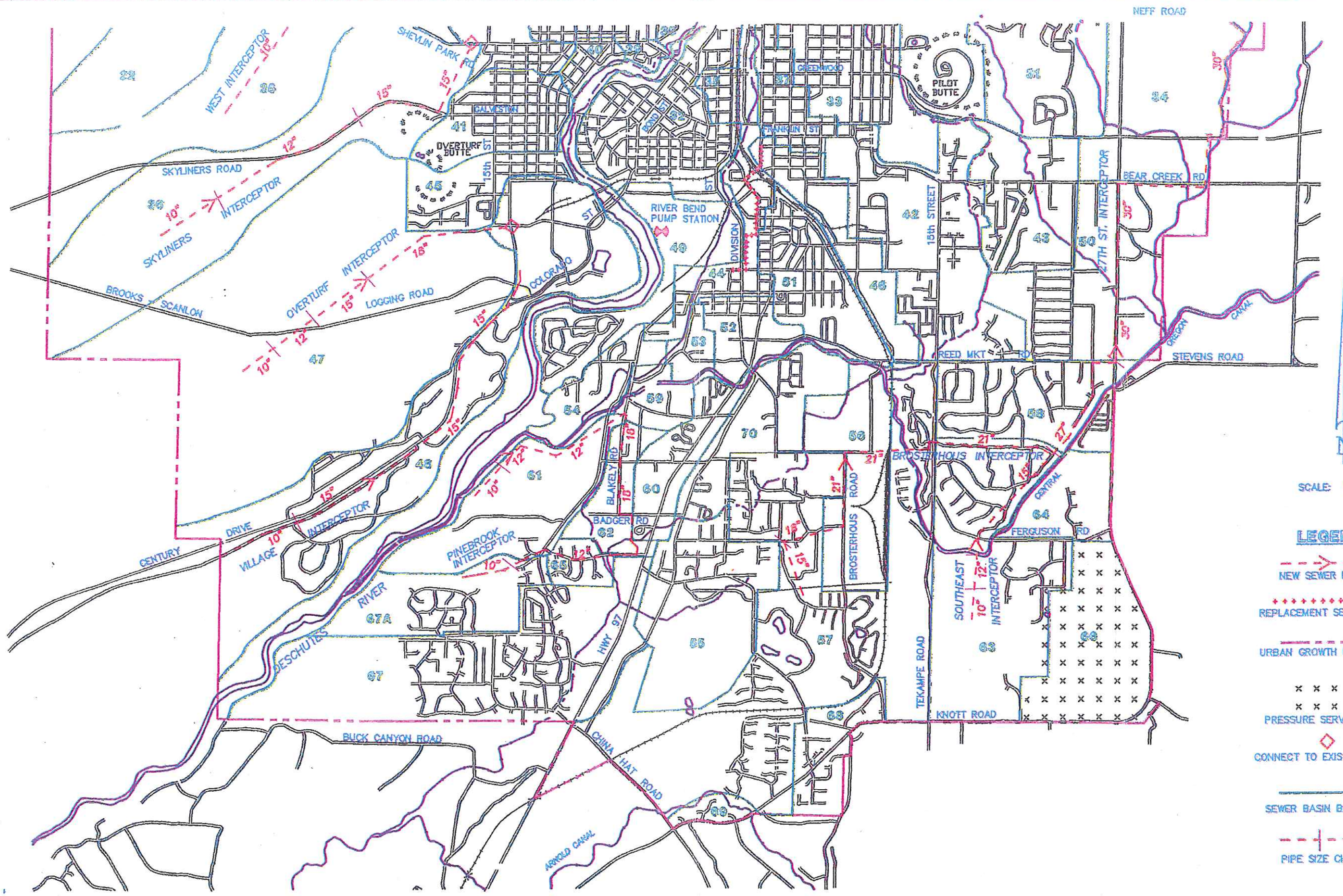


scale	1"=3000'	design	MDW
date	MARCH 3 ,1996	drawn	SLP
file	C:\PROJ\SEWSYS\CITYS.DWG		

CITY OF BEND

NEW AND REPLACEMENT SEWER LINES

FIGURE C



scale 1"=1500' design MDW
date MARCH 3 ,1998 drawn SLP
file C:\PROJ\SEWSYS\CITYS.DWG

CITY OF BEND

NEW AND REPLACEMENT SEWER LINES

FIGURE D

IV. WATER UTILITY PLAN

CITY OF BEND

IV. WATER UTILITY PLAN

GENERAL

The existing City of Bend water system derives its source from both deep groundwater wells and surface water. The surface water originates in the Bridge Creek watershed and the intake facility is located just south of Tumalo Falls, approximately 11.5 miles west of the City. The Bridge Creek source delivers 10.9 MGD through two steel transmission mains to the Outback site where the water is chlorinated. The deep groundwater wells supply an additional 12.36 MGD for a total present source delivery of 23.26 MGD.

The water utility portion of the Master Plan Update includes examination of the existing and future water system to service the Urban Growth Area. The urban population growth information derived from the Traffic Analysis Zones has been transferred to coincide with the pressure service levels to determine the future population served in each pressure level. From this data, source, transmission and storage facilities have been sized and located to adequately serve the UGA. In reviewing current and projected populations in each pressure level, it was determined that the existing pressure level zones should be retained.

EXISTING WATER RIGHTS

Bridge Creek water rights date from 1900 to 1983. The water rights, except for 6 cfs (3.876 MGD), are shared with Tumalo Irrigation District. The amount of water available to the City depends on the flow of Tumalo Creek and the time of year. The City has 21 cfs (13.645 MGD) in summer water rights during normal water years with adequate snowpack.

As the natural flows of Tumalo decline in late summer and in drought years, the priority of the water rights system limits surface water source to the City. When flows in Tumalo Creek fall below 80 CFS, the amount of water available to the City becomes restricted. For example, at 80 CFS in Tumalo Creek the City portion of the natural flow is 16.48 CFS or 10.6 MGD, which is about the capacity of the transmission lines. A summary of water rights and limitations are listed in the following pages.

The City has 15 cfs (9.69 MGD) that are only available during winter months when municipal demands are low.

Type of right	Priority date	CFS
Summer Use Rights		
Court decree	unrestricted	6.00
Certificate 31411	1900-1907	6.52
Certificate 31665	1900-1907	2.603
Transfer B-112	1909-1913	5.99
Totals		**21.113 (13.645 MGD)**
Winter Rights Only		
October 16 - April 14		
Permit 49823	1983	15.00 (9.69 MGD)
Total Water Rights Available in Winter		**36.113 (23.34 MGD)**
Total Water Rights Available in Summer		**21.113 (13.645 MGD)**

Except for the first 6 CFS of water that was established by court decree, the flows from Bridge Creek are shared with Tumalo Irrigation District. The amount of water available to the City depends on the natural flow of Tumalo Creek, of which Bridge Creek is a major tributary. The ability to utilize surface water rights is limited by the capacity of the transmission mains from the intake to the Outback site. These transmission mains, laid in the 1920's and 1950's, have a capacity of 10.9 MGD (16.86 CFS). This leaves 4.25 CFS or 2.74 MGD of surface water that cannot be utilized without additional transmission main construction or upgrading the existing mains.

The following table lists the water rights on Tumalo Creek and the percentage share between the City of Bend and Tumalo Irrigation District.

PRIORITY DATE	CFS FLOW	CITY %	TUM. IRRIG. %
Summer Rights			
Unrestricted	6.000	100	0
August 5, 1900	7.824	25.6	74.4
September 1900	52.161	14.2	85.8
April 28, 1905	4.497	4.1	95.9
June 1, 1901	15.699	9.7	90.3
October 29, 1913	135.491	2.9	97.1
Winter Rights			
December 12, 1983 April to October Only	15.0	100	0

Flows of Tumalo Creek varies greatly from year to year depending on weather patterns. When natural flows fall to less than 80 CFS, surface water capabilities become restrained. Sharing water rights with Tumalo Irrigation District on a percentage basis require the reduction of surface water use when flows of Tumalo Creek become less that 80 CFS. The chart below demonstrates the relationship between Tumalo Creek flows and the City of Bend and Tumalo Irrigation District shares.

Historical records for Tumalo Creek show the average June flow is 218 CFS, July flow is 131 CFS, August flow is 66 CFS, and September flow is 61 CFS. Drought years can reduce the flow of Tumalo Creek to 30 CFS which would limit the City to 10.30 CFS or 6.65 MGD.

Natural Flow (CFS)	City Portion	Tumalo Irrigation Portion
30	10.30 CFS	19.70 CFS
40	11.72	28.28
50	13.14	36.86
60	14.56	45.44
70	15.59	54.41
80	16.48	63.52
100	17.52	82.48

Groundwater wells supplement the surface water rights to enable the City to meet the high summer period demands. Currently, there are permitted groundwater rights for 44.26 CFS (28.6 MGD).

The City has applied for an additional 24.00 CFS (15.51 MGD) of groundwater rights for two well fields. The applications were appealed by an environmental group and the status of the applications will be decided by October 31, 1996. It is probable that this issue will be determined by July 1996.

EXISTING FACILITIES

Well Locations and Capacities

The City has eight wells in production at this time. The two largest wells are located near the Deschutes River and produce 5.5 MGD from the deep aquifer beneath the City. Three other wells located west of Powers Road at the Rock Bluff site are operating at 3.3 MGD. The Outback site well produces 1.36 MGD, while the Westwood Well, located near Cascade Middle School, pumps 1.0 MGD. The newest well for the City is Pilot Butte Well #1 producing 1.2 MGD. Total current well production is 12.36 MGD. The City also has a potential site near Lava Island with a permitted capacity of 5 MGD, however no production wells have been developed.

Permit No. Priority Date	Location	Amount (CFS/MGD)
G-4435 November 8, 1968	Lava Island	7.75/5.0
G-4946 October 13, 1971	River Wells	16.04/10.36
G-8565 December 17, 1978	Westwood	2.47/1.60
G-11942 June 20, 1989	Rock Bluff	8.00/5.17
G-12226 September 7, 1990	Outback Site	10.00/6.46
T-7009 November 28, 1995	Awbrey Glen	4.01/2.59
Totals		**44.26 CFS or 28.60 MGD**
Applications Pending		
G-13097 August 27, 1992	Public Works	12.0/7.75
G-13098 August 27, 1992	Pilot Butte	12.0/7.75
Total Pending		**24 CFS or 15.5 MGD**

Transmission and Distribution System

The existing transmission system is comprised of two steel parallel lines which run from the Bridge Creek intake, approximately 11.5 miles west of town to the Outback site. The original water main was constructed in 1925 and a second main was installed in the mid-1950's. The upper portion of the 1925 main crosses a 3.5 mile swampy area and is being replaced with 20 inch ductile iron pipe. Approximately 2,000 feet of this old pipe has been replaced. The parallel mains have a combined capacity of 10.9 MGD or 16.9 CFS and are the limiting factor in supplying the 21.113 CFS of surface water rights. During the summer months when surface water rights are limited by low flows in Tumalo Creek, the transmission main capacity is not relevant. When flows are above 80 CFS, however, the City cannot utilize 4.25 CFS or 2.74 MGD of surface water without upgrading the transmission lines.

The City distribution system is comprised of approximately 221 miles of mains, varying from 2 to 16 inches in diameter, 7,324 control valves, 2,249 hydrants, 7,543 flat rate services, and 2,901 metered services. The current replacement policy targets about 50,000 feet of old mains for replacement. In addition, the City is looking towards effectively looping many of the system lines to improve flows. This is expected to require approximately 30,000 feet of new mains as scheduled by the Management Plan.

All surface water is transmitted from Bridge Creek to the Outback site where it is chlorinated and then routed to Overturf Reservoirs, Awbrey Reservoir or directly into the Broken Top area of service. The City has constructed a 1.5 MG chlorine contact chamber at the Outback site (south of Shevlin Park) to meet the disinfection requirements of the Surface Water Treatment Rules, Safe Drinking Water Act of 1986 and to achieve and maintain exemption from the construction of a water treatment plant. The other vital part of the treatment plant exemption is maintaining raw water quality and effective watershed control.

Water Meters

As of August, 1995, with the adoption of the revised City Charter, all new residences will have water meters installed on the service. Commercial services and those services outside the City limits are currently metered. The City has initiated a program to meter all services within five years. This program was mandated by The Oregon Water Resources Department in the adoption of the Water Conservation Rules.

The first phase of the meter program was to require meter installation on all new residences built in the service area. The second phase, starting in July 1996, is to require meters upon change of ownership or change in occupancy. In addition to these required programs, a citizen may choose to meter his residence at any time. The City has established a policy of no interest loans to residents desiring the service and the work is done by approved contractors who normally install 10-20 meters per contract. The service area will be metered by the year 2001.

Reservoir Locations and Storage Capacity

There are currently 10 reservoirs with a total combined storage of 17.0 MG within the City system. They are listed below along with their respective storage:

Reservoir	Location	Storage
Awbrey	Awbrey-South flank	5 MG
College #1	Awbrey-Southwest flank	0.5 MG
College #2	Awbrey-Southwest flank	1 MG
Overturf	Overturf Butte	3 MG
Tower	Awbrey-Top of	1 MG
Pilot Butte #1	Pilot Butte	1.5 MG
Pilot Butte #2	Pilot Butte	1 MG
Rock Bluff	West of Powers Road	1.5 MG
Westwood	South of Overturf Butte	0.5 MG
Outback	Skyliners Rd. @ Outback Site	2.0 MG
	Total	**17.0 MG**

DESIGN PARAMETERS

Design Period

The design period is not based on a specific time or date, but rather that point in which the Urban Growth Area reaches a projected population of 94,597 people. This is based on the Population Analysis as discussed previously in this report. By basing this study on the BUILDOUT population for the UGA, a clear picture of the future overall City system can be modeled.

For the design area study, 64,539 people are served. The areas presently served by private water utilities such as Avion, Roats and Ward have been excluded. The distribution systems for these areas have not been modeled.

Historical Consumption

The 1980 City of Bend Water System Plan provided historical consumption data for the years 1970 through 1979. We have included the City water records for 1989, 1990 and 1994 and have tabulated a brief summary of the historical use below.

In 1995 the Water Division studied water use patterns during several days of very hot weather when use was at a summer demand high. Results of the study showed that the one hour demand immediately following the start of irrigation hours was 36 MGD. This amount of water use was determined by analysis of the source water and the reservoir level decline. The high water use was very apparent during the first hours of the morning water time slot and the afternoon time slot.

		(Millions of Gallons)						
YEAR	POPULATION	AVE. DAILY	PEAK DAILY	PEAK HOUR	AVE. MONTHLY	MAX. MONTHLY	AVE. DAILY PER CAPITA	
1970	13,500	5.7	13.49	*	174.5	329.9	422 GPD	
1973	17,480	5.4	13.20	*	163.9	348.8	309 GPD	
1976	17,720	4.8	12.95	*	145.5	321.1	271 GPD	
1979	18,650	5.3	17.27	21MGD	162.25	349.1	284 GPD	
1989	19,000	5.69	*	21MGD	173.0	342	299 GPD	
1990	19,500	6.25	18.80	20MGD	188.5	367	320 GPD	
1994	29,400	7.90	18.00	24MGD	241.2	488.6	270 GPD	**

* data not available

** based on City service count

During the winter months, the consumptive demand is approximately 1/4 of summer irrigation demands. For example, in 1994 the daily average winter flows were 3.65 MGD while the average summer demands were 14.4 MGD.

Nationally, the average consumption rates are about 150 gallons per capita per day, while Bend averages more than 250-300 gallons per person. The peak daily flow for Bend is 750 gallons per capita per day, while the peak hourly flow is approximately 1,075 gpcd.

Possible reductions in water usage may be realized through the expansion of the City's current water conservation program. As shown above, conservation measures have reduced the per capita demand by around 25% since 1970. Weather continues to play an important role in annual water demand with cool wet summers reducing irrigation demands. Further conservation programs not only protect our valuable water resources, but they also may reduce potential costs associated with capturing source water, disinfection, constructing larger transmission mains and storage facilities.

DESIGN CONSUMPTION

The City of Bend recently calculated the peak domestic summer water consumption demand based on dwelling units. They determined the peak demand to be * 0.8 GPM per dwelling unit. From the Population Analysis section earlier in this report, it was determined that at BUILDOUT, the population will be 94,597 and service population at 64,539. This correlates to 28,060 dwelling units at a density average of 2.3 people per dwelling unit. Summer flows then calculate to be 22,450 GPM or 32.27 MGD, and the average domestic summer demand is 500 gallons per capita per day (gpcd).

General commercial industrial and highway commercial water demands were also analyzed from existing water meter data consumption records. A six month winter usage shows that for general commercial and industrial areas the demands ranged from 400 to 1,800 gallons per acre per day (gpad) with the average being 1,100 gpad. For this study a value of 1,300 gpad is used. Highway commercial areas (the corridor along Highway 97) had demands ranging from 3,200 to 4,200 gpad. For this study a value of 4,200 gpad is used. Within the study area, there are approximately 2,800 acres of general commercial and industrial lands. There is also approximately 712 acres of highway commercial lands. (See the following table)

* August 19th & 20th, 1987

COMMERCIAL WATER CONSUMPTION DATA

(Figures shown represent the monthly average winter consumption over a 6 month period)

Motels

	Water Useage (FT^3)	Number of Rooms	Site Size (Acres)
Dunes	10,737	30	0.45
Hampton Inn	37,580	99	2.19
Maverick	19,920	61	1.78
Red Lion	37,547	76	1.38
Super 8	19,007	79	1.56
Woodstone Lodge	15,070	52	0.96
Average	4,662 $ft^{3/day}$		1,38 acres

Restaurants

	Water Useage (Ft^3)	Gross Floor Area (Ft^2)	Site Size (Acres)
Beef & Brew	9,198	6,000	0.63
El Benders	7,447	11,655	2.76
Denny's	12,370	2,700	0.69
Kopper Kitchen	19,225	6,478	0.53
Mexicali Rose	11,243	2,550	0.34
Sargents	8,474	2,288	0.28
Average	2,263 $ft^{3/day}$	5,278 ft^2	0.87 acres

COMMERCIAL & INDUSTRIAL WATER CONSUMPTION DATA

	Water Usage (Ft^3)	Gross Floor Area (Ft^2)	Site Size (Acres)
APT	38,512	21,675	1.43
Al's Bug Repair	195	1,500	0.40
Beaver Coaches	9,321	95,000	7.16
Bend Plating	7,036	4,600	0.48
C.O. Bldg Supply	1,404	6,980	2.56
Centro Business	729	2,900	0.55
Fuqua Homes	10,679	100,000	5.60
Ron's Auto Body	1,000	4,274	0.85
S & W Enterprises	1,350	1,500	0.40
Average	7,802 $Ft^{3/day}$	26,492 Ft^2	2.15 Acres

A summary of the design values used for the study are found below:

- Domestic Average Summer Demand — 500 gpcd
- Domestic Peak Day Demand — 750 gpcd
- Domestic Peak Hour Demand — 1075 gpcd
- General Commercial & Industrial Lands — 1,300 gpad
- Highway Commercial Lands — 4,200 gpad

The total water consumption rate based on Domestic Average Summer Demand plus the Commercial, Industrial and Highway/Commercial lands is 27,015 GPM (38.90 MGD).

DESIGN CRITERIA

Source Capacity & Supply

The source capacity and supply system to serve the future BUILDOUT population should be based on the maximum day consumption. As described in the previous section, the domestic peak day demand is based on 750 gpcd and a population of 64,539 people. This calculates out to 48.4 MGD. Add to this the commercial and industrial demands of 6.63 MGD and the total peak day demand equals 55.03 MGD. For this study, source capacity and supply pipelines will deliver a total of 55 MGD to the system.

The source for the ultimate water supply should remain flexible. This would allow for economic, environmental and governmental regulations that may develop in the future which could dictate the source supply to pursue. From this it was determined that three different source options shall be explored simultaneously to meet future demands. They are:

- Obtain additional water rights from Bridge Creek/Tumalo Creek.
- Tap groundwater supplies through additional well permits.
- Obtain water rights for a Deschutes River source.

Future source development may come from either ground or surface water sources. This study is predicated upon the principle of developing the required source from 50% groundwater and 50% surface water. The surface water source may be Bridge Creek or the Deschutes River. The choice of surface water source will be dependent on available water rights and cost of development and treatment.

Development of groundwater sources has been the selected alternative for the past several decades. Production wells can be placed near reservoirs to meet demand in a specific portion of the distribution network.

Storage

System storage is a vital component of the overall water master plan. Storage provides the additional water necessary during times of peak consumption, fire flows and emergency system situations. For this study a rather conservative approach was taken for determining the storage requirement. City policy mandated that the storage volume equal the source capacity of 55 MG. This allows flexibility for future planning. Requirements of future regulations regarding source supply and/or emergency situations such as source contamination of the Bridge Creek supply or wellhead groundwater contamination may dictate that one source be shut down for an extended period of time.

The additional storage provided by this conservative approach will safeguard the City water system from such emergencies and allow minimal disturbance to water customers.

The total storage is based on the average summer domestic flows and the commercial/industrial demand, plus the peaking storage, emergency storage and fire flow storage.

- Average Summer Day Demand = 38.90 MG
  (includes commercial/industrial areas)

- Peak Storage is based on the difference between the peak hourly flows and the source delivery capacity. A four hour peak flow of 1075 gpcd plus the commercial/industrial demand equals 12.67 MG, while the source and supply will only deliver 9.16 MG during the same time period. The peak storage required is 12.67-9.19 or 3.51 MG.

- Emergency Storage is based on unexpected situations which may arise which could reduce the supply of potable water for City use. Examples such as a fire in the Bridge Creek watershed, ruptured supply mains, power outages, disinfection plant shutdowns and wellhead groundwater contamination all could possibly lead to a reduction or interruption in the water supply. The emergency storage is a precautionary measure to provide adequate water for 24 hours during such a time. A figure of 400 gallons per dwelling unit is typically used for determining emergency storage. Including commercial and industrial demand, this would yield a storage volume of 17.85 MG.

- Fire Flow Storage is determined by applying the appropriate fire flow to the various pressure zones and different land use areas. A fire flow demand of 5,000 GPM for a duration of five hours is applicable to both the industrial areas and the highway commercial corridor along Hwy 97. A demand of 2,500 GPM for a three hour duration is used for the general business and light industrial areas. A fire flow demand of 1,500 GPM for a two hour duration is used for all residential areas. Since this study involves the entire UGA at BUILDOUT, all three fire flow demands will occur simultaneously. The total Fire Flow Storage is then 2.13 MG.

The total storage required for domestic, peaking, emergency and fire flows equals 62.39 MGD. This correlates with the City policy on matching storage volume with source capacity of 55 MGD. See the subsequent section on Water System Improvements for reservoir locations and individual storage volumes.

Pressure Levels

There are six different pressure service areas within the planning area. The elevations range from +4,200 feet at Awbrey Butte to 3,420 feet at the north UGB boundary near the proposed future Industrial Park. The previous section on Population Analysis detailed the present and projected population for each of the pressure levels. A summary of the pressure levels with their estimated populations are detailed below:

Pressure Level	Elevation Range	1995 Population	Buildout Population
1	4,200' - 4,040'	166	767
2	4,040' - 3,880'	628	2,057
3	3,880' - 3,760'	2,621	6,597
4	3,760' - 3,660'	9,944	17,653
5	3,660' - 3,550'	14,981	21,187
6	3,550' - 3,420'	4,264	16,278
7	3,490' - 3,420'		

Customer water pressure within the service pressure levels should be no more than 95 psi, or less than 35 psi with the preferred range being from 45 to 75 psi. Pressure Reducing Valves will be necessary at junction points between the different pressure levels to maintain ideal pressures. Transmission and supply lines are the exception, as high head conditions will be required for gravity fill of several reservoirs.

Water Mains

The minimum size for new transmission waterlines for this study is 12". Several pipes will carry flows that could be conveyed through 8" pipes. However, since improvements will span possibly four to five decades, a more conservative approach is recommended to ensure fire flow capability during this interim phasing period.

Distribution waterlines should generally be sized to maintain a pipe velocity of less than six feet per second. A velocity of eight to nine feet per second should be considered the upper limit when sizing these transmission mains. Distribution lines shall be sized for the peak hourly flows of .8 gpm per dwelling unit (5.21 peak factor) (60 min) or 250 gpduph.

Transmission and supply lines should be sized for the peak daily flow. Friction head loss in lines which serve reservoirs should be analyzed to ensure proper head for gravity feed where possible.

COMPUTER SIMULATION MODEL

For this study, the computer program Micro Hardy Cross developed by Cecomp was used. This computer model simulates the existing and future water system and gives resultant pressures, head loss, velocities, flow rates, pumping rates, etc.

This system was patterned after the previous system layout of pipes and reservoirs as designed by David Evans and Associates. Corrections were made to the original system layout where pipes were missing on the map but discussed in the text portion of the original master plan.

Domestic commercial and industrial flows were modeled with reservoirs one-half full and system well pumps running. Demand flows were analyzed at 750 gpcd (48.4 MGD) and 6.63 MGD for commercial and industrial for a total of 55 MGD.

WATER SYSTEM IMPROVEMENTS

Source Supply

As described earlier, the total source requirement for the future BUILDOUT condition is 55 MGD. As of this report, the present system contains a deliverable source of 10.9 MGD in surface water from Bridge Creek, 12.36 from the well fields, for a total supply of 23.26 MGD. A total of 31.74 MGD of source supply must be developed to meet the buildout demand. This source supply for planning purposes will be obtained in three ways:

1. additional Bridge Creek rights,
2. additional Deschutes River rights, and
3. additional groundwater rights and well development.

For planning purposes, surface water will account for 50%, 15.87 MGD, of the future need, either by developing Deschutes River or Bridge Creek surface waters and 50%, 15.87 MGD, from groundwater sources.

Bridge Creek:

As described earlier, there are existing surface water rights for 23.34 MGD. However, this 23.34 MGD is available only in the low demand winter period and limited by transmission main carrying capacity of 10.9 MGD. Current surface water rights and transmission main capacity are sufficient to meet winter demands during winter conditions for buildout. Summer flows are tied to the natural flow of Tumalo Creek. When the flows of Tumalo Creek drop below 80 CFS, City rights are curtailed by water rights constraints shared with Tumalo Irrigation District. Historically, the City has been limited to 9 MGD during late summer when Tumalo flows are lowest.

In obtaining and purchasing water rights, the City should concentrate on those rights with the earliest priority dates. To optimize the summer flow high demand period the water rights dated 1900 provide the best source.

If the City were to purchase irrigation rights, they could transfer them to 'municipal rights' and hold them until needed. Each year, the annual assessments must be paid on these untapped rights and an extension fee paid every five years. It should be noted that the "municipal preference" stated in ORS 537.230, allows the City to apply for any additional flows on Tumalo Creek without requiring development of those rights until needed. Of course, the priority dates mentioned earlier still would be in effect, and this filing would only be granted for those periods of the year when water was available.

Surface Water rights are purchased by acreage allotments and the price is determined by supply and demand at time of purchase. Each major irrigation district also delivers different amounts of water for each acre of right. Current costs per acre of water, depending on source, is $1,000 to $3,000. For the purposes of this report, Tumalo water will cost $3,000 per acre and deliver 7.5 GPM per acre. Deschutes River water will cost $1,000 per acre and deliver 6 GPM per acre during the irrigation season from April to October. A detailed cost accounting of surface water development is contained in subsequent sections.

Groundwater Wells:

As described earlier, there are existing well permits for 28.60 MGD located at the Deschutes River site, Rock Bluff, Westwood, Outback, Lava Island and Pilot Butte locations. In addition, there are 15.5 MGD of groundwater rights in the application process located at Pilot Butte and near the Public Works Complex. When the application process is completed, the City will have 44.1 MGD of available groundwater for development. Groundwater production currently stands as 12.36 MGD. New well sites are selected on reservoir locations, demands on the distribution system, economic feasibility and wellhead protection criteria.

As an example, if the reservoir sited on the north side of Awbrey Butte which serves the northerly portion of town is to be constructed before the Bridge Creek source and supply lines are improved and a transmission main is constructed to the north side of Awbrey, then a deep well would become economically feasible to serve this reservoir. Likewise, other scenarios will occur where the City's Five Year Budget Planning Document will be the working tool in facilitating which reservoirs and sources will be constructed, and at what time.

It is assumed for this study that all wells are constructed at a flow rate of 1 MGD. Cost estimates for the new wellfields are included in a following section.

Treatment:

The City successfully applied for and was granted at exemption from the Surface Water Treatment Rules by the Oregon State Health Division. This exemption was granted based on raw water quality, watershed control and adequate disinfection procedures. We have had four years of experience working under the rules of the exemption and have shown that raw water quality from the Bridge Creek source is excellent. For example, the rules require that 90% of raw water samples contain less than 20 colony forming units (CFU) of fecal loading. Our records show over 97.5% of the samples meet this rule and over 60% of the samples show two or less CFU per sample.

The construction of the Outback Reservoir coupled with the CT Basin give adequate time for the chlorine to disinfect surface water before first customer. The Water Division has invested in telemetry to provide real time information on chlorine pH residuals, temperature, flows, reservoir levels and turbidity. When turbidity rises due to snow melt or precipitation events, the surface water is discontinued and groundwater resources supply the City. As a general rule, turbidity situations are limited to April and May during hot weather, warm rain on snow events.

Continuation of the exemption depends on maintaining watershed control, complying with turbidity limits and raw water quality and no disease outbreaks developing from surface water use. The main threat on the exemption is the threat of wildfire in the Bridge Creek watershed. Based on experience with the Bridge Creek Fire the raw water quality would degrade in terms of turbidity to the point where the exemption would most likely be lost. Rising water temperatures could also increase microorganism growth that would impact that exemption criteria. If the watershed were to experience a major wildfire the decision would have to be made to install filtration on Bridge Creek, develop a major plant on the Deschutes or expand groundwater production to the point where summer irrigation demands could be met.

Storage

A total of 55 MG of storage volume is required for the water system. The existing reservoirs total 17.0 MG, therefore 38.0 MG of new storage must be constructed. The existing reservoir locations were listed previously, along with their individual storage volumes. The new and existing reservoir locations, volumes and demand rates are listed below. See the accompanying maps for reservoir sites.

Reservoir	(MG) Storage Vol. Ex.	New	Tot.	(GPM) Average Summer Day Demand	(GPM) Peak Day Demand
(Existing)					
Tower	1	-	1	313	469
College #1	0.5	-	0.5	324	473
College #2	1	-	1	374	531
Outback	2	7	9	2,723	3,870
Westwood	0.5	-	0.5	681	970
Overturf	3	2	5	2,307	3,277
Pilot Butte #2	1	-	1	457	648
Rock Bluff	1.5	4.5	6	2,468	3,507
Pilot Butte #1	1.5	5	6.5	2,098	2,801
Awbrey South	5	-	5	4,845	6,884
(Proposed)					
Awbrey North	-	5	5	2,282	3,243
Century Drive	-	6	6	4,668	6,662
Homestead	-	3	3	1,130	1,606
Awbrey West	-	3	3	1,417	1,988
Awbrey East	-	2.5	2.5	907	1,289
TOTALS	17.0	38	55	27,014	38,218

The exact reservoir locations are somewhat flexible, but the elevation and storage volumes should be maintained for each pressure service area. If a proposed reservoir site proves to be difficult to obtain, a test case with the new siting should be run on the City Micro Hardy/Cross model to check for any possible constraints on the new site to the overall performance of the system. If possible, the overflow elevations of reservoirs located within the same pressure levels should be set to the same elevation.

Proposed overflow elevations are detailed below:

Reservoir	Overflow Elevation	
Awbrey	3,795 FT	
College #1	4,105 FT	
College #2	4,105 FT	
Overturf	3,871 FT	
Pilot Butte #1	3,782 FT	
Pilot Butte #2	3,880 FT	
Rock Bluff #1	3,880 FT	
Tower	4,236 FT	
Outback		
Westwood	3,870 FT	
Awbrey West	3,880 FT	(PL#4)
Awbrey North	4,010 FT	(PL#3)
Awbrey East	3,880 FT	(PL#4)
Century Drive	4,010 FT	(PL#3)
Homestead	4,010 FT	(PL#3)
Outback West	4,010 FT	
Overturf #2	3,871 FT	(PL#4)
Pilot Butte #3	3,782 FT	(PL#5)
Rock Bluff #2	3,880 FT	(PL#4)

For estimating purposes, the reservoirs were assumed to be 1.5 MG steel tanks. A complete cost estimate follows in a subsequent section.

TRANSMISSION & SUPPLY LINES

Supply lines will be defined as those pipelines transporting water from the Source intake locations to the various reservoirs. Transmission lines are pipelines which carry the water from the reservoirs to the distribution system. In the future water system, most of the transmission lines will also function as part of the distribution system. This will result from the transmission mains serving several pressure levels and will provide the distribution system with limited connection points. As many of the transmission lines could be at high head condition while passing through the service areas, Pressure Reducing Valves (PRV's) may be required for the selected connection points.

A summary of the supply lines are shown below. The transmission mains are too numerous to list here and as such are shown only on the proposed water system maps. A complete cost estimate with line lengths, sizes and unit costs will follow in the next section.

Supply Lines:

A) Bridge Creek to Outback Reservoir - Existing Bridge Creek supply lines will not accommodate any additional flow from new water rights. Any increased source from Bridge Creek will require the construction of a new 30 inch line or a combination of the two existing lines and a new third line. Head pressures are critical in the design of a new line from Bridge Creek to the Outback site due to the existing Overflow structure and the disinfection process. Potential source from Bridge Creek could be 29.51 MGD. The distance for a new supply line would be approximately 47.500 feet.

B) Outback West Reservoir to Overturf #2 Reservoir - This main is required to feed the proposed additional reservoir at Overturf. The existing steel transmission lines from the overflow site to Overturf #1 are assumed to continue to feed the present existing system at their present capacity. The new supply main will carry approximately 16.4 MGD in a 30-inch diameter pipe near Outback and reduce down to 24" pipe near Overturf with a supply of 8.3 MGD.

C) Skyliners Road to Awbrey North Reservoir - This supply line will provide for Awbrey North and will carry approximately 9 MGD. Pipeline will be a 24-inch diameter main.

D) Awbrey North to Awbrey East Reservoir - This line is a 16-inch main.

E) Lava Island River Source to Century Drive Reservoir - This pipeline will convey the full 14 MGD plus any additional water from the wellfields at Lava Island into town. Pipe size will be a 36-inch main. This supply line will most likely require a pumping station of low head lifting capacity to feed the reservoir.

F) Homestead Reservoir to Century Drive Reservoir - This supply line is a 24-inch main.

G) Homestead Reservoir to Rock Bluff Reservoirs - This supply main will supplement the wellfields at Rock Bluff to not only provide source water to the Rock Bluff Reservoirs, but also farther north to the Pilot Butte Reservoirs. The main will be two 16-inch pipes.

Again, these supply line sizes and even possible routing schemes may be considered as somewhat flexible during the interim construction phases. All revisions to the aforementioned schedule should be modeled and studied for overall conformance to the source delivery breakdown with respect to wellhead locations, the final reservoir locations and overflow elevations, and ultimate supply to serve the interim construction phasing.

CONSTRUCTION COST ESTIMATE

The construction cost estimate for the water system improvements is located at the appendix of this report. Total cost for the system including source, treatment, reservoirs, transmission and distribution mains is estimated to be almost 102 million dollars.

WATER SYSTEM COST ESTIMATE

TABLE A

Source and Treatment - 50% Surface and 50% Groundwater

Item	Quantity	Unit Cost	Total
Source			
Bridge Creek Rights	1,469 Acres (15.87 MGD)	$ 3,000	$ 4,408,000
Deschutes River Rights	1,836 Acres (15.87 MGD)	$ 1,600	$ 2,938,000
Wells (1 MGD each)	15.87 MGD	$ 300,000	$ 4,761,000
Treatment			
Bridge Creek or Deschutes River Treatment **	15.87 MGD	$ 578,700	$9,184,000

* Note: each 0.06 GPM requires approximately 1 square foot of surface treatment area for sand filtration. 1 MGD then requires 11,575 sq.ft. of filter area at a cost of $50.00 per sq.ft. of $578,700 per 1 MGD.

** Assumes existing Bridge Creek water remains unfiltered.

TABLE B

Reservoir Storage

Item	Quantity	Unit Cost	Total
1.5 MG Steel Reservoir	25 EA	$ 750,000	$ 19,000,000

TABLE C

WATER SYSTEM (1995 DOLLARS)

The cost estimate is divided into two sections: pipe which will be constructed in unimproved areas (not in existing roadways), and pipe which will be constructed in existing roadways (improved areas).

Item	Quantity	Unit Cost	Total
Unimproved Areas			
A. 12" water main	29,705 LF	$ 70.00	$ 2,079,350
B. 16" water main	157,095 LF	$ 100.00	$ 15,709,500
C. 24" water main	17,990 LF	$ 150.00	$ 2,698,500
D. 30" water main	47,500 LF	$ 200.00	$ 9,500,000
D. 36" water main	13,500 LF	$ 250.00	$ 3,375,000
			$ 33,362,350
Improved Areas			
A. 12" water main	27,910 LF	$ 85.00	$ 2,372,350
B. 16" water main	131,505 LF	$125.00	$ 16,438,125
C. 24" water main	9,650 LF	$ 175.00	$ 1,688,750
D. 30" water main	14,800 LF	$ 225.00	$ 3,330,000
			$ 23,829,225
		Sum Total All Pipelines =	$ 57,191,575

Total Cost Estimate

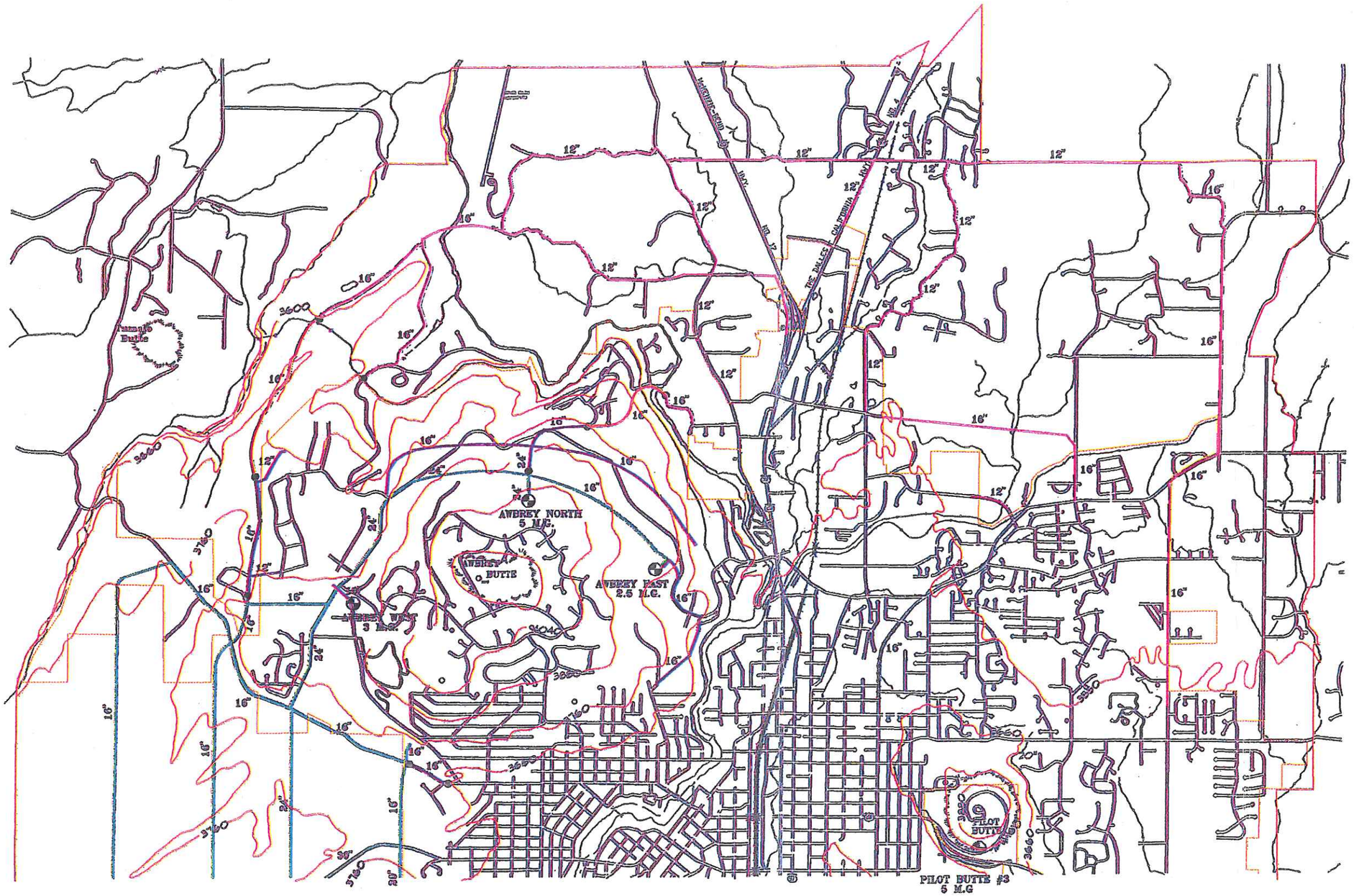
Source & Treatment =	$ 21,291,000
Reservoir Storage =	$ 19,000,000
Source, Transmission & Distribution Lines =	$ 57,191,575
GRAND TOTAL WATER IMPROVEMENTS =	**$97,482,575**

Note: Prices reflect 1995 construction dollars. Figures should be adjusted annually to meet current costs and installation.

WATER FUND FIVE YEAR CAPITAL BUDGET
GROWTH RELATED

Priority	Definition
0 =	Construction contracted as of June 30, 1995
1 = Critical	Imperative for reliable water service
2 = Essential	Absolutely necessary for operation of system
3 = Necessary	Needed for efficient operation of system
4 = Desirable	Useful for proper operation of system
5 = Pending	Of no immediate consequence

TYPE OF PROJECT	PRIORITY	Amounts by fiscal year (in thousands) 96-97	97-98	98-99	99-20	00-01
ARTHUR EXTENSION	1	185.0				
EAST MT. WASHINGTON NORTH TRANSMISSION	1	340.0	250.0	237.5		
WISHING WELL EXTENSION	1	205.0				
AWBREY PUMP STATION, 2ND PUMP	1	40.0				
ROCK BLUFF BOOSTER PUMP	1	50.0				
PILOT BUTTE #3 RESERVOIR (PL5)	1	600.0	1900.0			
CITY PORTION OF GROUNDWATER SURVEY	1	25.0				
OUTBACK WELL NO. 2	1	375.0				
SHEVLIN ROAD TRANSMISSION MAIN	2		27.0	243.0		
PILOT BUTTE #3 TRANSMISSION	2	15.0	150.0			
AWBREY #2 RESERVOIR (PL3)	2	75.0	1200.0			
PILOT BUTTE WELL NO. 3	2		375.0			
27TH STREET TRANSMISSION	3		25.0	250.0		
POWERS ROAD TRANSMISSION	3		65.0	585.0		
OUTBACK RESERVOIR NO. 2	3			87.5	337.5	450.0
BEAR CREEK WELL NO. 1	3		45.0	405.0		
AWBREY BUTTE WELL NO. 1	4			45.0	405.0	
SURFACE SOURCE ACQUISITION	4				400.0	400.0
WYNDEMERE TRANSMISSION	4			66.3	596.2	
BOYD ACRES ROAD EXTENSION	5				20.0	180.0
PILOT BUTTE WELL NO. 4	5				55.0	495.0
TOTAL		1910.0	4037.0	1919.3	1813.7	1525.0



N

SCALE: 1" = 3000'

LEGEND

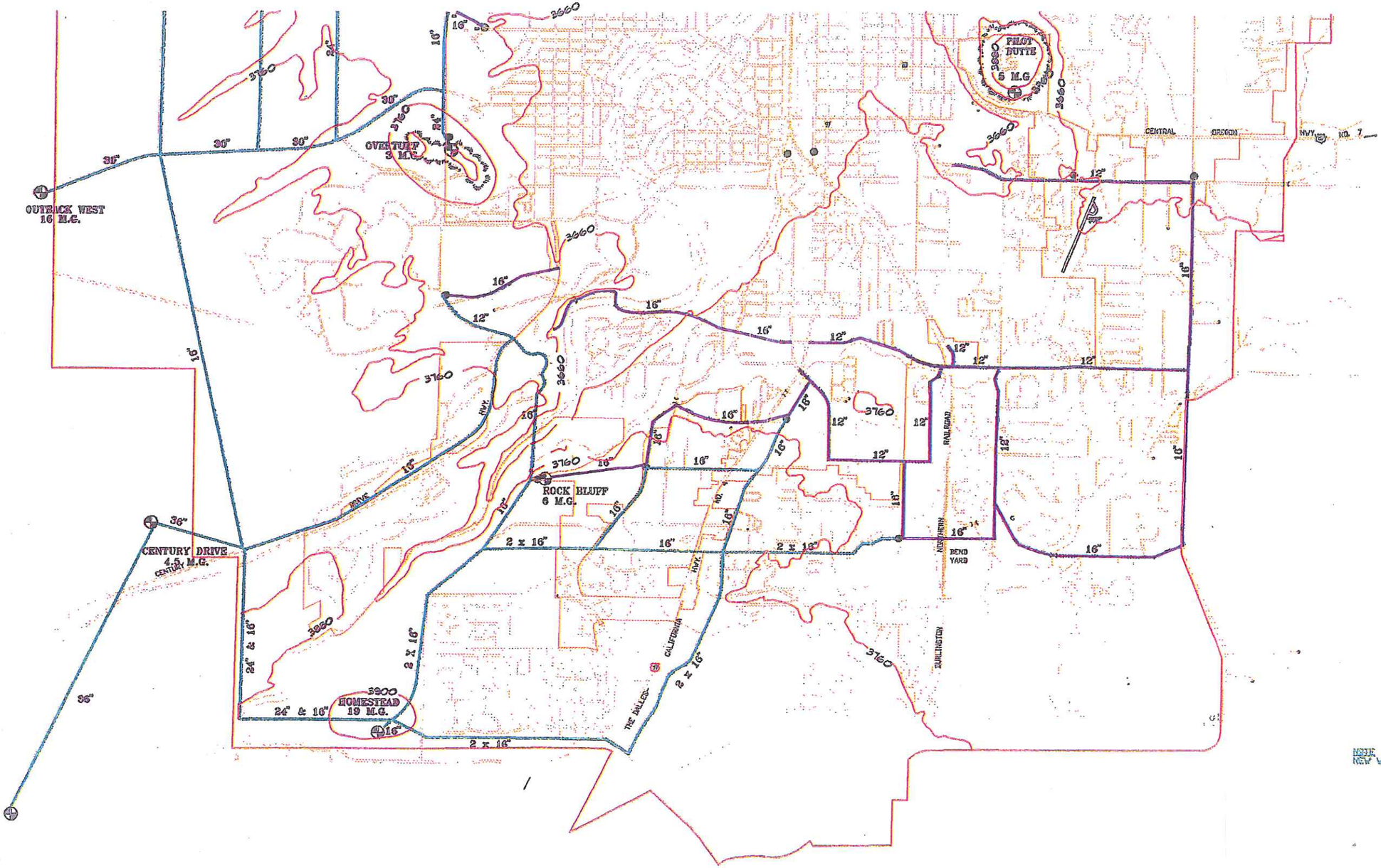
- PRESSURE ZONE BOUNDARY
- PRESSURE LEVEL 3 LINE
- PRESSURE LEVEL 4 LINE
- PRESSURE LEVEL 5 LINE
- PRESSURE LEVEL 6 LINE
- REPLACEMENT AREA
- NEW RESERVOIR LOCATION
- PRESSURE REDUCING VALVE

NOTE:
NEW WATER MAIN LOCATIONS ARE APPROXIMATE ONLY.

SCALE: 1" = 3000'
DATE: MARCH 1996
FILE: C:\ACAD\WIM\PROJ\WATERMST\NORTHMRT.DWG

BEND NORTH AREA
NEW AND REPLACEMENT WATER LINES

FIGURE E



SCALE: 1" = 3000'

LEGEND

- PRESSURE ZONE BOUNDARY
- PRESSURE LEVEL 3 LINE
- PRESSURE LEVEL 4 LINE
- PRESSURE LEVEL 5 LINE
- PRESSURE LEVEL 6 LINE
- NEW RESERVOIR LOCATION
- PRESSURE REDUCING VALVE

NOTE
NEW WATER MAIN LOCATIONS ARE APPROXIMATE ONLY.

SCALE: 1" = 3000'
DATE: MARCH 1996
FILE: C:\ACADWIN\PROJ\WATRMAST\SOUTHWST.DWG

BEND SOUTH AREA
NEW AND REPLACEMENT WATER LINES

Figure F