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

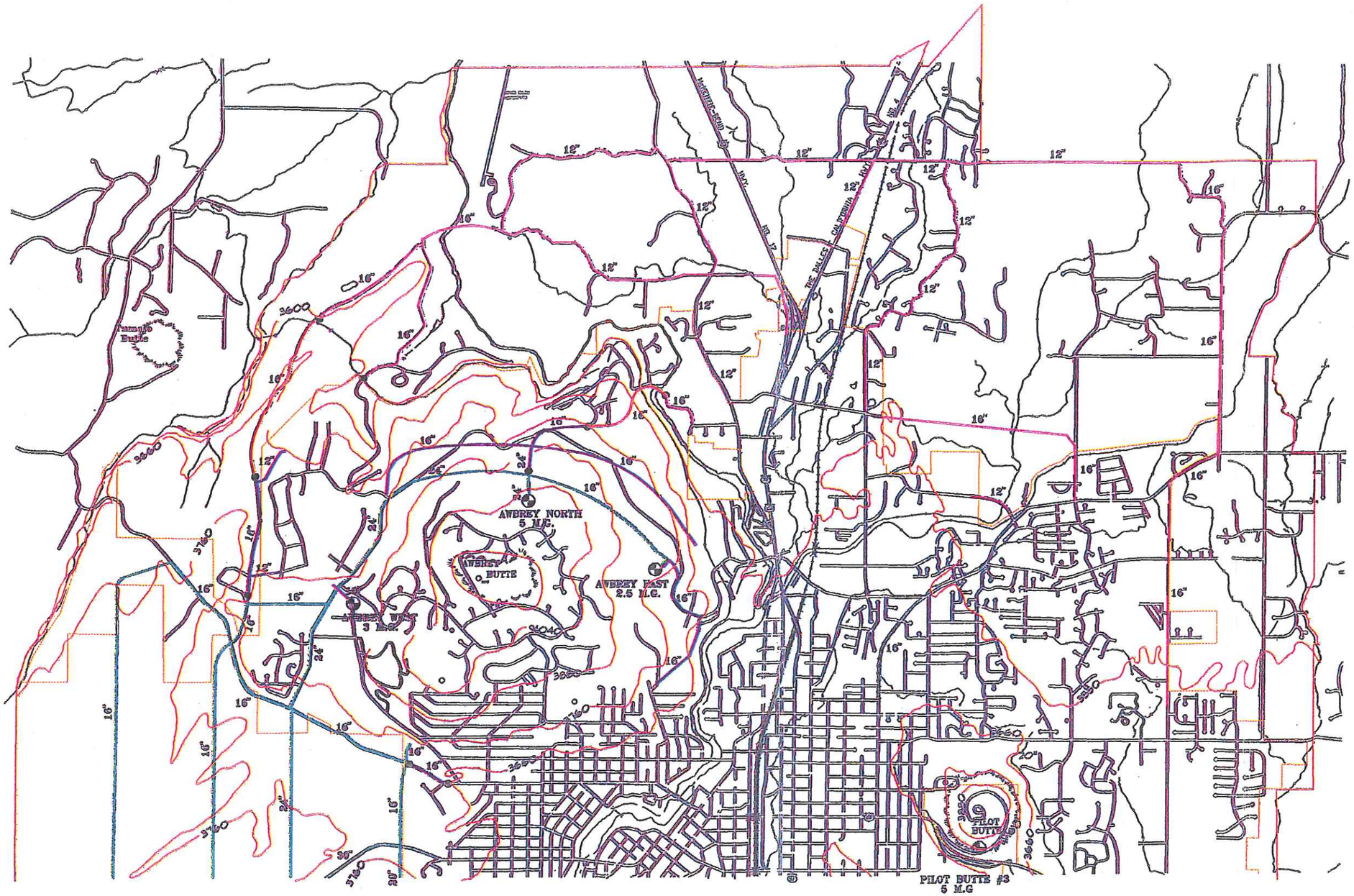
Source & Treatment =	$ 21,291,000
Reservoir Storage =	$ 19,000,000
Source, Transmission & Distribution Lines =	$ 57,191,575
GRAND TOTAL WATER IMPROVEMENTS =	**$97,482,575**

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
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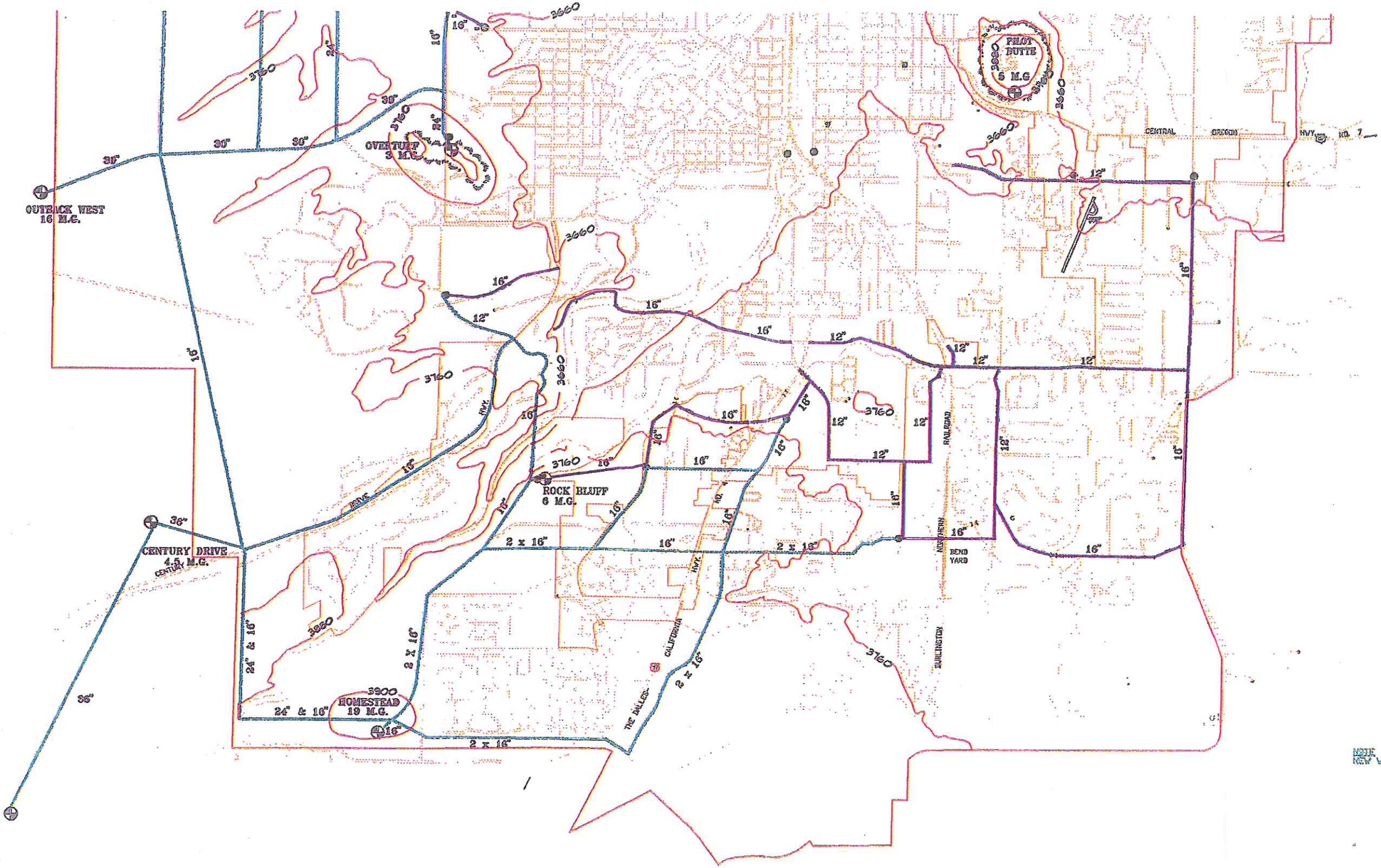
BEND NORTH AREA
NEW AND REPLACEMENT WATER LINES

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