DRAFT OF THE

WATER SYSTEM MASTER PLAN FOR THE CITY OF PENDLETON, OREGON

WALLULIS AND ASSOCIATES, INCORPORATED

ENVIRONMENTAL & MUNICIPAL ENGINEERING

7725 S.W. VILLAGE GREENS CIRCLE WILSONVILLE, OREGON

PHONE: 503 - 694 - 1309

MAY 1995

CITY COUNCIL'S INITIAL ADOPTION OF DRAFT PLAN DATE:_______________

CITY COUNCIL'S POST HEARINGS ADOPTION OF DRAFT PLAN DATE:_______________

DRAFT PLAN No. 50

WATER SYSTEM MASTER PLAN FOR THE CITY OF PENDLETON, OREGON

ELECTED OFFICIALS

Mayor

Robert Ramig

City Council

Carolyn Anderson
John Brenne
Jim Eardley
Robert Ehmann

Phillip Houk
Craig McNaught
Allan Pinkerton
Steve Taylor

CITY STAFF

Larry Lehman
City Manager

Gerald L. Odman
Public Works Director

Ralph Baumgartner
Water Foreman

Peter H. Wells
City Attorney

David G. Lorenzen
City Engineer

Date: 5/11/95
Expires: 6/30/96

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MAY 1995

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GLOSSARY OF SELECTED TERMS AND ABBREVIATIONS

Some of the conventional alphabetical letters used in geology have been changed in the interest of continuity with letters historically associated with the flow of water (other fluids not included). The formulae are for moderate flow velocities that result in a laminar (molecules flowing in parallel) and not for turbulent or shooting flow velocities.

A

Cross sectional area of a liquid transmitting via a conduit, channel, stream bed, and/or aquifer, e.g. square feet (sq.ft.), square miles (sq.mi.)

Ac.ft. or A.F.

One foot of water over one acre of land, which is equal to 325,829 gallons of water. One acre = 43,560 square feet.

Aeolian deposit(s)

Materials that are transported and deposited by wind, e.g. sand, silt, loess, etc.

Alluvium

Deposits typical of products of disintegration and/or wearing away (erosion and/or movement by wind, water, glacial ice flows) in loose or consolidated forms, e.g. sand silt, gravel, loess or clay laid down and deposited in river beds, flood plains, lakes, and fans at the foot of mountain slopes.

Anticline

A convex upturning (fold) of the basalt strata with the sides of the fold dipping away in opposite directions from the top of the fold (ridge). Normally, in cases of a substantial folding, there is an impediment to water flows across the once contiguous aquifer(s).

Aquiclude

A geologic formation containing saturated water that is incapable of yielding significant quantities of water utilizing normal equipment and processes.

Aquifer

A formation of permeable material(s) that can accept, store, and transmit sufficient quantities of water to wells and/or springs to be a practical source of water.

Significant aquifers in lava flows, are generally in the horizontal scoriaceous zones (honeycombed) between successive lava flows which may also include alluvium deposits. Aquifers can also receive water from the vertical jointing that occurs during the cooling and contraction of the molten lava.

Aquitard

Materials resistant to the transmission of flows, e.g. the existence of clay, shale, boulders in a gravelly aquifer.

ARR

Artificial Recharge and Recovery (ARR). For unconfined and shallow water bearing aquifers, the normal practice is to apply available surface water sources on top of the ground and up gradient from the shallow aquifers to be recharged and recovered at a later time.

For confined and deep wells in the Columbia River Basalt aquifers in Oregon, the source of the recharge water may be from shallow wells or from surface sources provided that the source water:

1. Does not result in degradation of the native ground water in the underlying aquifers, and

2. Currently must meet the requirements of the U.S. Environmental Protection Agency (EPA) Safe Drinking Water Standards and such additional conditions as may be imposed by the Oregon Department of Environmental Quality (DEQ).

Artesian

An artesian condition exists when a well penetrates an aquifer and the groundwater rises above the level at which it is encountered. An artesian well may or may not be a flowing well above the surface.

Borehole

Circular hole (normally vertically downward) made by drilling or boring.

Cascading water

Ground water that enters in from the sides of the borehole and freely falls down to a lower water level.

CFS/cfs

Cubic feet per second (one cfs = 448.8 gpm).

Confined ground water

Ground water that is under pressure significantly greater than atmospheric. In a well that taps a confined ground water body, the static water level is above the top of the aquifer.

Drawdown

The lowering of ground water level caused by pumping. It is the difference, generally, in feet or meters, between the static water level and the pumping water level in a well.

Evapotranspiration

Water withdrawn from a land area by evaporation from water surfaces and moist soil and by plant transpiration.

Fanglomerate

Cemented mixture of alluvium e.g. hardpan, cliche.

Fault

A fracture(s) of the earths crust that results in shifting of one side against the other, and in this rubbing at the interface, often grinds up material at the surfaces creating an impediment to flow across the fault.

GPM/gpm

Gallons per minute (gpm).

H

Head is, the potential energy available from the elevation that a liquid occupies such as in a dam above the lands below, or the difference in elevation between two points along a conduit, stream, e.g. H_1-H_2 expressed as pressure in feet or pounds/square inch.

h_f

Hydraulic friction, the declining amount of head available between two points, because of the friction losses suffered as a result of the transmission of the liquid (internal friction of molecules within the liquid and at the interface of the liquid with other surfaces) expressed in terms of:

$$H_1\text{-}H_2/L_1\text{-}L_2$$

head loss in feet/ foot of length (or per: 100 ft.;1,000 ft.; mi.; etc.), a dimension less number.

i - Hydraulic gradient

Hydraulic gradient (slope) between two points as a result of the h_f and other losses (contractions, bends, etc.), e.g.

$$H_1\text{-}H_2/L_1\text{-}L_2 \text{ (same as } h_f\text{).}$$

vertical drop in feet/foot of length, a dimension less number

In aquifers the direction generally is understood to be that of the maximum rate of decrease in head.

Intermittent (or seasonal) Stream

A stream that flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow in mountainous areas.

k Coefficient of Permeability

Permeability "k" is a function only of the medium (porosity).

$$k = Q/iA$$

Q = Quantity of flow
i = Hydraulic gradient
A = Area

Permeability's coefficient (k) is the quantity of ground water with a temperature of 60° F capable of being transmitted through a unit cross sectional area (square foot), per unit of time (day) under a hydraulic gradient of 1.00 (1 foot head/1 foot of length) at a viscosity of 1.00, e.g. with a hydraulic gradient of 1.0 (100%) the capacity in gallons per day/sq.ft. Also known as the Meinzer unit.

L
Distance between two points along a conduit, stream, etc. and normally in units of: feet (ft.), miles (mi.).

***L* Liter**

Metric unit of volume.

Lithology
The physical constituents, grain size, composition and arrangement (packing) , etc. of the material.

MCL
Minimum contaminant level.

MGD/mgd
Million gallons per day (one MGD = 694.44 gpm or 1.55 cfs).

Monocline
The axis of the intersection of a geologic fold, at an oblique angle (inclined slope) to another slope at a different incline. The change in slope is normally a moderate change in slope from a bending of the underlying lava, which is conforming to a lower strata.

MSL/msl
Mean sea level datum

Q

Quantity of flow of a fluid transmitted from a source or between two points over a unit of time, e.g. gallons per minute (gpm or GPM), gallons per day (gpd or GPD), million gallons per day (mgd or MGD), cubic feet per second (cfs or CFS).

For water normally transmitted by a conduit, temperature and viscosity corrections are not normally required. The basic formula for Q is:

$$Q = vA, \text{ where:}$$

v = velocity
A = Area

Hydrology formulae may include the affect of additional parameters, e.g. capillarity, temperature, viscosity, molecular attraction, etc.

Perched ground water

Unconfined ground water separated from an under-lying body of ground water by an unsaturated zone (dense impermeable material).

Perennial stream

A stream that flows continuously.

Permeability

The ability of the soil(s), rock, etc. in a water bearing formation to transmit water, in a similar function as a pipeline or other conduit, when there is a difference in hydraulic heads between two points. The permeability is dependent upon the size, shape, extent, and continuity of pores throughout a particular water bearing formation.

For computing the flow through each foot of width of an aquifer the following formula is used:

$$Q = kDi \text{ where:}$$

k = overall average permeability coefficient of the aquifer from the top to bottom.
D = is the depth (top to bottom) of the aquifer.
i = is the hydraulic gradient.
Q = flow in gallons/day per foot of width.

ppm

Part(s) per million; an equivalent expression is mg/*L* (milligrams per liter). In this report the small letter "L" has been italicized to" *L*" distinguish it from L for length.

Porosity *n*

Porosity (n) is the percentage (or expressed as a fraction) of the pores, voids, interstices in the soil(s) or rock to it's total volume. While porosity represents the amount of water that can be stored in the aquifer, it does not indicate what the yield from the aquifer will be.

n = volume of voids/total volume

Specific yield is the amount of water that can be withdrawn from the aquifer.

Specific retention is the amount of water retained (by molecular attraction, pore size and continuity, grain size and distribution, and capillarity).

The sum of specific yield and specific retention is equal to the porosity.

Porous

Soil(s) or rock containing voids, interstices, pores, and/or other openings that may exist and may or may not interconnect.

Potentiometric surface or, head

The water elevation above mean sea level (msl) of an unconfined water body, or in a confined water body the water level to which the water will rise from when originally encountered in wells with tight vertical formations, casings and surface seals. The water level measurements are taken at, or nearly static conditions when the aquifer is in the least stressed hydrological state.

Runoff

That part of the precipitation that appears in surface streams or flows across the surface.

Saturated zone

That portion of the soil profile that generally all of the pores, voids, etc. are filled with water under a pressure greater than atmospheric.

Specific capacity

The rate of discharge of water in a well (usually in gpm) divided by the drawdown of water level (usually in feet) within the well. It is an approximate index of the capability of an aquifer to transmit water.

Specific Capacity = flow in gpm/drawdown in feet, or gpm/ft

Static water level

The elevation of the water table (in relation to the msl) during a stable or reasonably stable level is observed. This is normally determined when the aquifer(s) are not stressed by pumping of the well and other wells in the area that impact the underlying water table. The obtaining of a true static water level is unlikely because of: natural recharge, leakage from/to streams, long term stabilization of and between compartmentalized geohydrologic units (created by faults, anticlines, monoclines, synclines, etc.).

Storage coefficient

The volume of water an aquifer will release or accumulate into storage in response to a difference in the hydraulic head e.g. lowering by pumping or rising impressed by recharge sources respectively. Expressed as a volume of water through a unit of cross sectional area for a unit change in the hydraulic gradient. The formula expressed as,

$$V = ScAi$$ where:

V = volume of flow in gallons.
Sc = the storage coefficient (gal./sq.ft.)
A = the cross sectional area at right angles to the direction of flow.
i = the hydraulic gradient

Stratigraphy

Age and geometrical relationships between layers (lenses) and deposits of sedimentary origin.

Syncline

An down turning fold (like a gentle "v") of the basalt strata with the sides of the fold dipping inward from the opposite directions to the bottom of the trough formed by the folding.

Transmissivity

Transmissivity (transmissibility) is the rate at which water (at a specific viscosity) is transmittable through the full depth of an aquifer at a unit width of 1 foot when the aquifer has a unit hydraulic gradient 1.0 (100%). Expressed as:

gallons/day/per foot of width for a specified depth of the aquifer, or

gallons/sq. ft./day

Transmissivity is equal to the hydraulic conductivity multiplied by the saturated thickness of an aquifer.

Turbidity

Turbidity is an empirical measurement of light refracted from suspended or dissolved matter in water. Color also affects turbidity. The murkier the water the higher the turbidity reading.

Unconfined ground water

Water that has a water table or restated: water in an aquifer that is free to rise and fall in response to changes in storage in the aquifer e.g. pumping, inflow/outflow to streams, etc.

v

Velocity a rate of speed = distance between to points divided by the interval of time required to reach from point #1 to point #2, e.g. feet per second (fps), feet per minute (fpm), feet per day (fpd), miles per hour (mph).

V
Volume in gallons, cubic feet, acre feet, etc.

Water level
The measured distance from the surface of the ground to the surface of an unconfined water bearing aquifer at atmospheric pressure and represents the upper surface of the zone of saturation or to the top of the water surface of a confined water bearing aquifer.

Water table
The measured distance from the surface of the ground to the surface of an unconfined water bearing aquifer at atmospheric pressure and represents the upper surface of the zone of saturation.

Unsaturated zone
The zone above the water table and below the land surface that is dry or contains water liquid under less than atmospheric pressure and water vapor, air or other gasses generally at atmospheric pressure.

CHAPTER I - INTRODUCTION

A. STUDY AUTHORIZATION AND SCOPE

The City of Pendleton authorized the firm of Wallulis and Associates, Incorporated to prepare an updated Water Master Plan on September 1, 1993. The purpose of the updated Plan is to analyze the existing water system's principal elements of sources, transmission and storage for present deficiencies and future growth. Alternative solutions were studied and cost estimates prepared for each principal element.

B. COMMUNITY DESCRIPTION

The City of Pendleton is the County Seat for Umatilla County, Oregon, and is situated along the banks of the Umatilla River at the junction of U.S. Highway 395 and Interstate 84. The economy of the County and the City is based primarily on agriculture, agri-industry, livestock, timber, several State and federal regional offices, tourism, and wood related industries. Pendleton, as the largest city in Eastern Oregon, serves as a regional retail trade center, maintains a Class V "continental" airport, home of Blue Mountain Community College, a hub for transportation and distribution of goods, Pendleton Woolen Mills, Pendleton Flour Mills, Prowler Industries, Golden West Mobile Homes, Eastern Oregon Correctional Institution, and the Hill Meat Company.

C. GRAVITY WATER SYSTEM SUPPLY

In the early 1900's, the City's population was slightly below 5,000 persons and the area served by the City water system was concentrated in the valley floor. After 1910, the City began to feel the impact of additional growth, which was impetus to seek a better quality and larger quantity of water for the community.

Construction of the present gravity supply system was initiated in 1913 and in a few years 16.37 miles were constructed. In subsequent years, the line has been extended to the uppermost springs for a total of some 22 miles in length. In 1917, the North and South Hill reservoirs were constructed and replaced a single open reservoir that was located approximately two blocks below the present South Hill Reservoir.

The existing gravity water transmission supply line was constructed with circular and rectangular shapes and made from on-site formed reinforced concrete in 1913. Prior reports and City data of record indicates that the 16.4 mile long transmission line from the City South Hill Reservoir to the springs (**Gate House and Weir**) consists of pipe sizes varying from 18", 20", 22", 23", 24", 26" to 30" in diameter and 25" X 25" square.

The 30" size pipe sections were constructed when the gravity line was relocated to accommodate the construction of Interstate Highway No. 84 (I-84). The 30" size was selected to provide the City with the option of delivering additional quantities of water from a deep well field to be developed east of the City and/or additional capacity from the springs.

The gravity transmission line and spring sources are shown on the following maps:

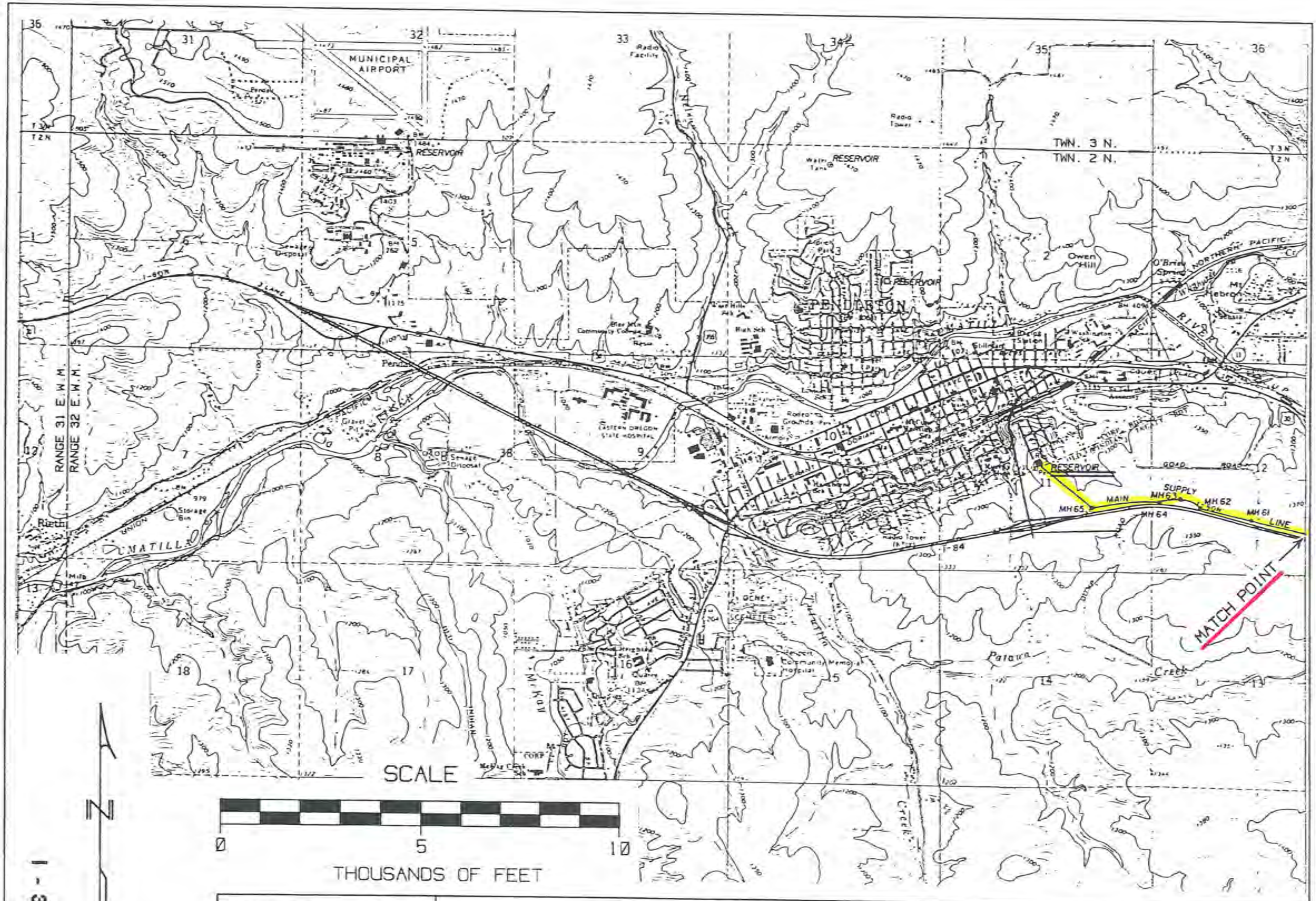
Sheet 1 of 5 (page I-3) : This drawing shows the location of the inflow line from the springs into the South Hill Reservoir. The incoming gravity water line's upstream routing heads southeasterly from the South Hill Reservoir to the easterly access entrance to the City Center Interchange, and then along the north side of I-84 to the east edge of the drawing. Match points are provided on the next 3 sheets for points of continuity for the gravity transmission pipeline as it heads progressively upriver to the springs.

Sheet 2 of 5 (page I-4): The gravity transmission line on this sheet shows that the pipe line crosses I-84 to the south side for approximately 2 miles and then returns to the north side of I-84. From this point the line continues approximately three miles to the east where it intersects old U.S. Highway No. 30 where City Well #7 and the chlorination station are located. From the chlorination station the transmission line follows the topography of the ground to the easterly edge of the drawing.

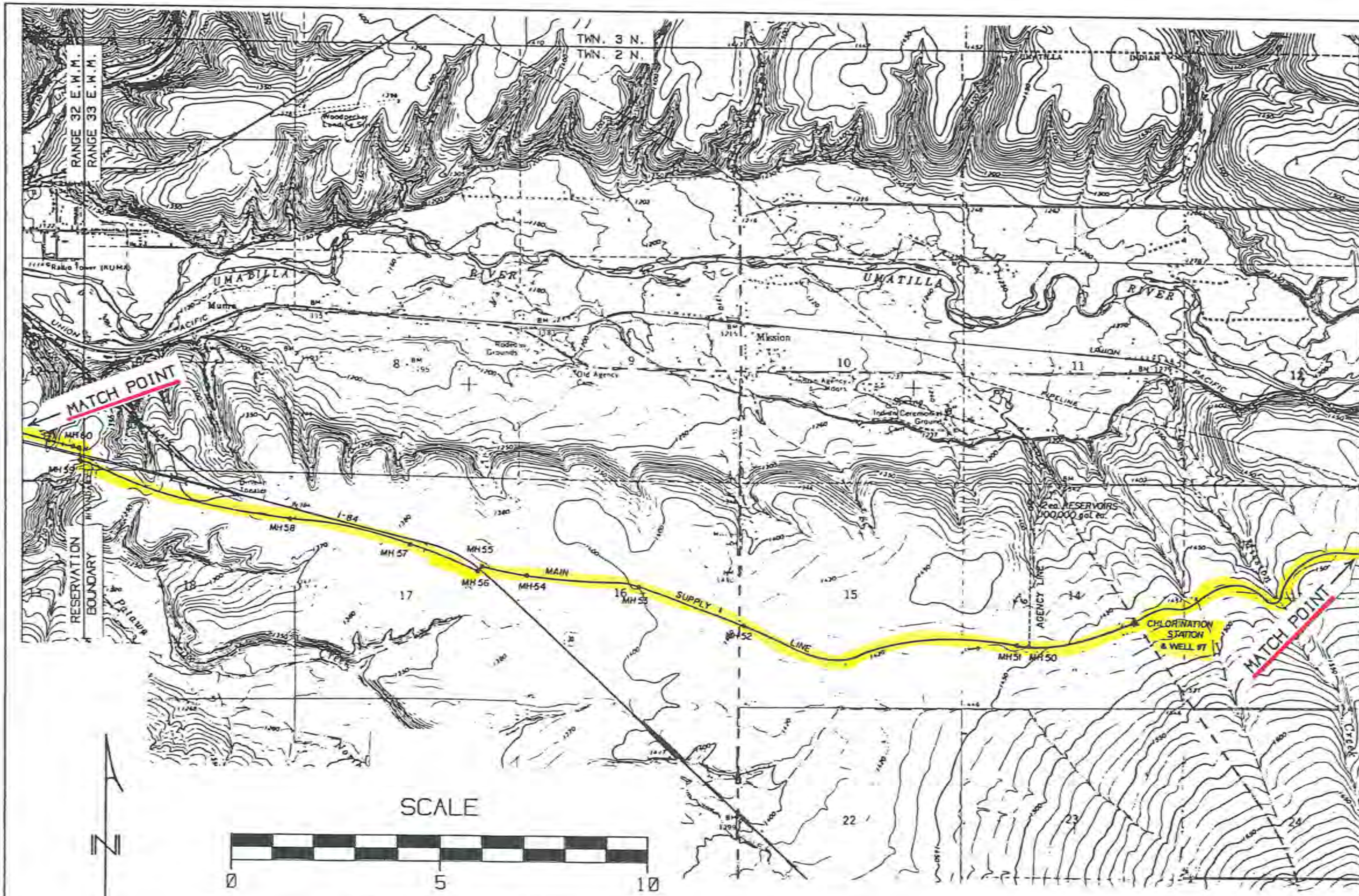
The location of the water line servicing the Umatilla Indian Agency is shown approximately 0.5 mile westerly of the chlorination station.

Sheet 3 of 5 (page I-5): The transmission pipe line on this drawing follows a northeasterly course as the pipeline gradually starts to head towards the Umatilla River valley. The irregularity of the terrain caused some abrupt changes in direction of the pipeline and the construction of siphons (inverted type-not true siphons) across stream drainages.

Sheet 4 of 5 (page I-6): Approximately 1 mile easterly from the westerly edge of this drawing is the **Gate House and Weir**. Upstream from the Gate House and Weir for approximately 5 miles in an easterly and northeasterly are the City's springs successively as follows: Wenix, Simon, Shaplish, and Longhair. Wenix, Simon and Shaplish Springs have multiple points and means of collecting spring water. The lines shown on this Sheet are representative only, and do not include all the piping and appurtenances at each spring.

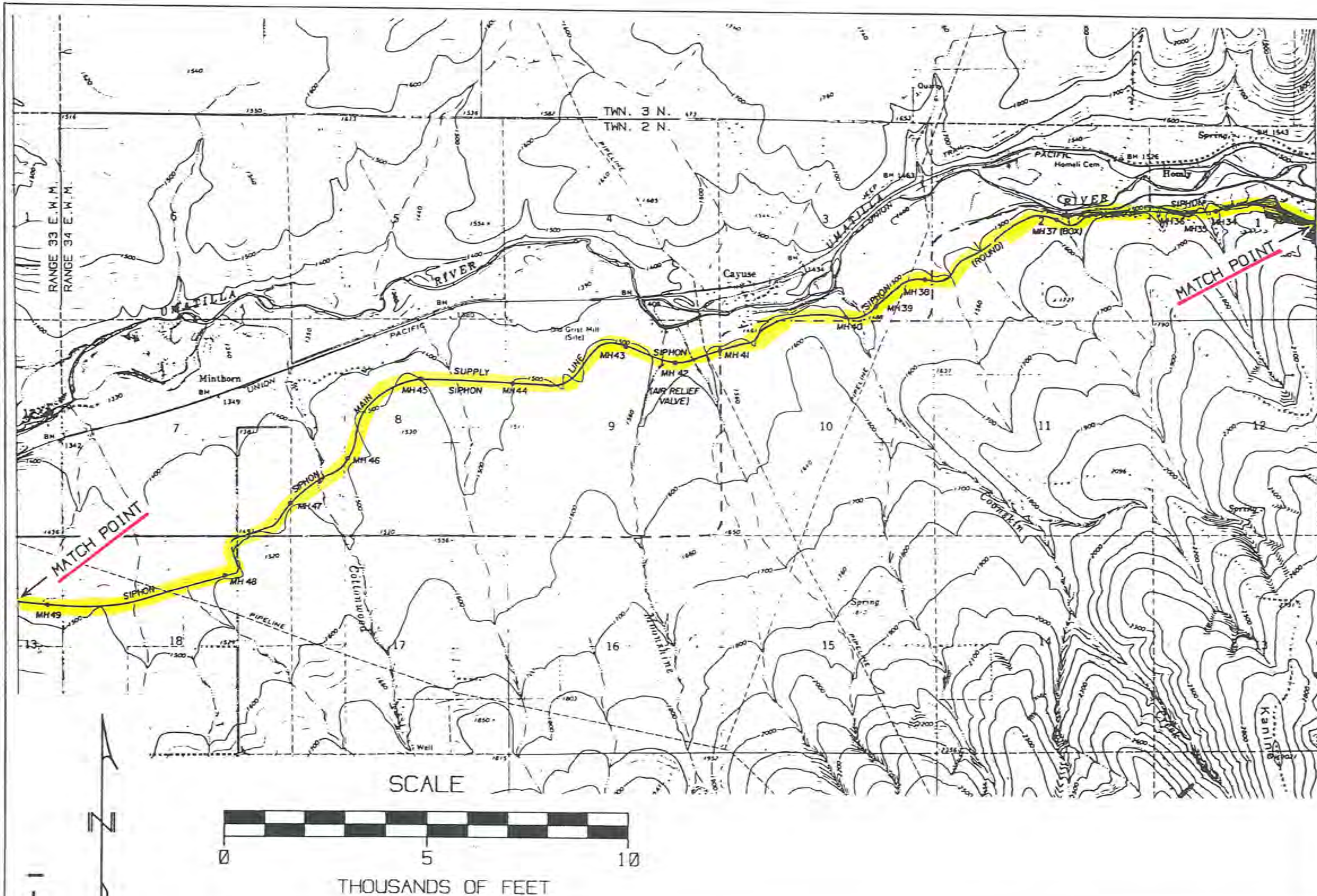


SHEET 1 OF 5 | PENDLETON GRAVITY WATER LINE FROM THE SPRINGS

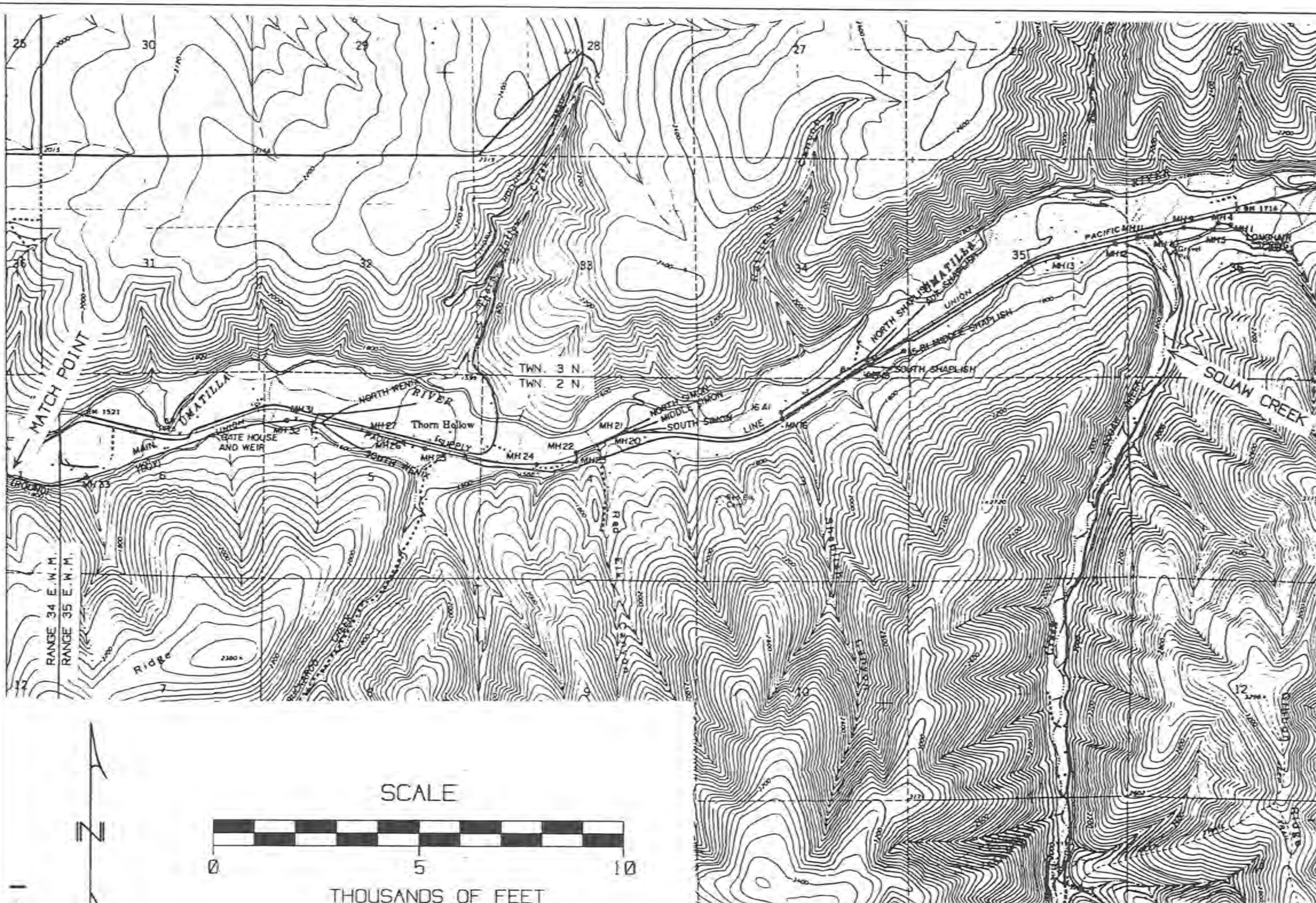


SHEET 2 OF 5

PENDLETON GRAVITY WATER LINE FROM THE SPRINGS



SHEET 3 OF 5 | PENDLETON GRAVITY WATER LINE FROM THE SPRINGS



SHEET 4 OF 5 | PENDLETON GRAVITY WATER LINE. PLUS THE SPRING SOURCES

The piping used to collect and transmit the spring water consists of closed, open joint, concrete half pipe (gravel bottom), and "A" concrete frame (gravel bottom) types. The variety includes:

12", 16" 18", 20" & 24" steel (including corrugated dipped & paved),

12" and 18" vitrified tile pipe, 6" and 12" terracotta pipe,

10", 12", 14", 15", 16" and 18" concrete pipe,

18" and 24" concrete half pipe, 20" high "A" frame collector, and

12' x 12' crib well plus a building block collector tunnel.

There is also a considerable variety of manhole types at the springs. They include cones, box and circular types. Some have open bottoms to permit the entrance of subsurface water, and others have concrete bottoms to seal out sub-surface water.

From the 1979 Water Study[1], the above springs during the years of 1953 to 1978, supplied the City with the following quantities of water in millions of gallons:

TABLE I-1

YEAR	QUANTITY	YEAR	QUANTITY	YEAR	QUANTITY
1953	994.7	1961	1,164.3	1969	1,089.8
1954	1,018.6	1962	1,089.8	1970	1,162.7
1955	1,053.6	1963	1,052.4	1971	937.7
1956	1,136.2	1964	1,110.0	1972	1,032.4
1957	1,095.4	1965	992.5	1973	1,031.2
1958	1,119.9	1966	973.4	1974	1,086.5
1959	1,222.3	1967	1,049.0	1975	885.6
1960	1,246.0	1968	1,025.8	1976	854.4
				1977	948.3
				1978	1,019.1

High Year = 1,246,000,000 gallons (1960)
Low Year = 854,400,000 gallons (1976)
Ave. Year = 1,052,400,000 gallons

[1] Page 32, Water Study for the City of Pendleton, Wallulis & Associates, September 1979

During the 1953 -1978 time period, the City's population grew from 12,500 to 14,325 and the use of the springs as a source of total supply diminished from a high of 87.47% in 1953 to a low of 57.87% in 1975. From 1971 to 1978, the springs sources supplied 64.45% of the City's water demands. Federal and State regulatory mandates promulgated the lowering of the turbidity (murkiness) limits and reduced the production from the spring sources.

Since 1982, State and Federal mandates have further lowered the turbidity limits. Until the spring sources are treated to remover the turbidity to acceptable limits, they will continue to be a minor source of supply in meeting the City's water demands. The annual quantities of water supplied from the spring sources in millions of gallons since 1982 are as follows:

TABLE I-2

YEAR	QUANTITY	YEAR	QUANTITY	YEAR	QUANTITY
1982	872.211	1985	519.460	1989	730.009
1983	671.267	1986	858.960	1990	873.674
1984	632.788	1987	593.380	1991	884.322
		1988	830.514	1992	553.078

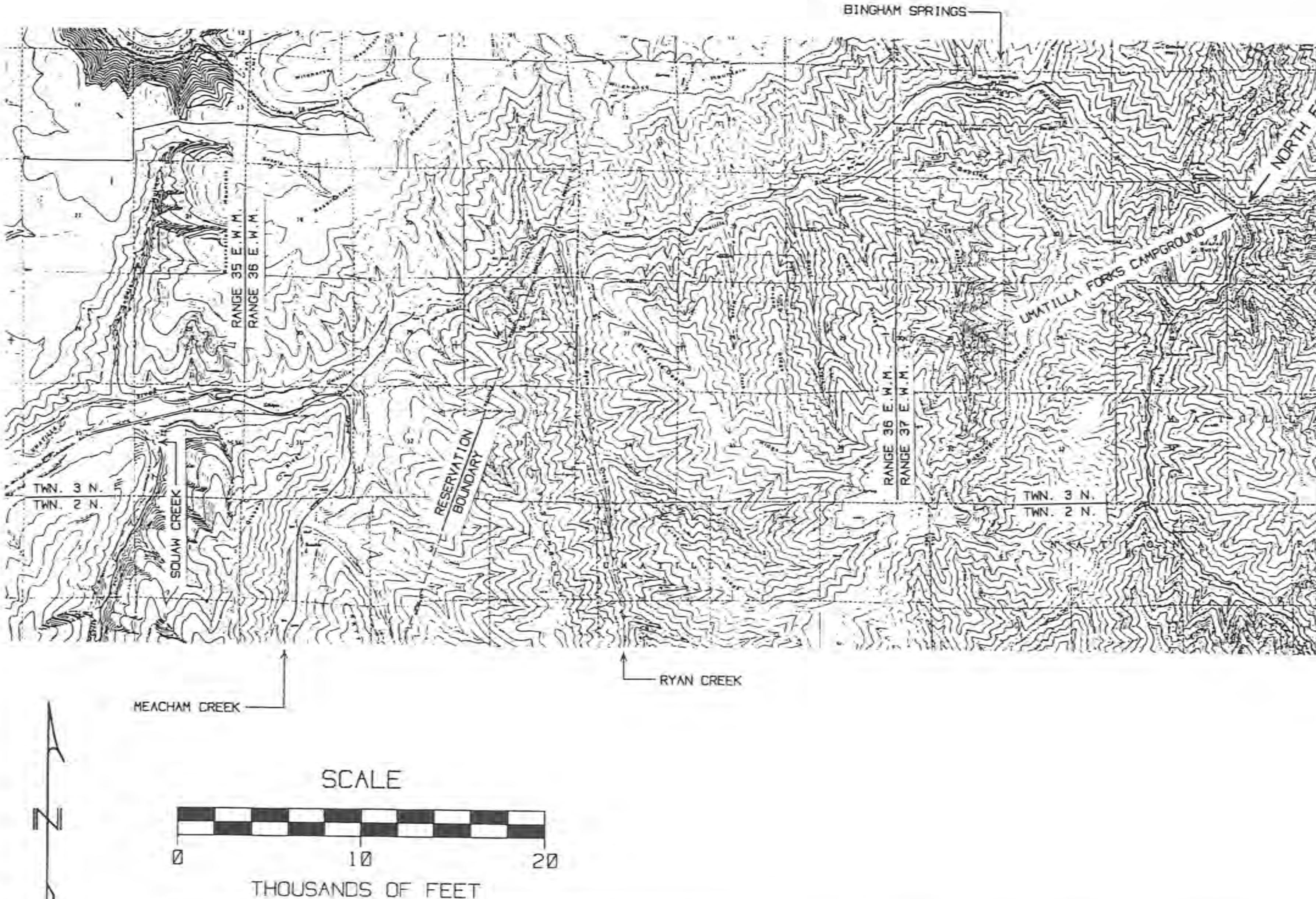
High Year = 884,322,000 gallons (1991)
Low Year = 519,460,000 gallons (1985)
Ave. Year = 729,060,000 gallons

As the Federal Government's mandates on water quality became stricter, federal and state agencies advised water suppliers of potable water with low quality water sources to abandon such sources and replace them with high quality water sources if at all possible. Low quality water that has to undergo significant treatment involves a sophisticated process. Treatment processes that require chemicals and/or oxidants often create carcinogenic compounds in the treated water. These compounds in the treated water and delivered to the customer are referred to as post Disinfection By-Products (DBP).

The Oregon Water Resources Commission (OWRC) recently placed a moratorium on the issuance of surface water permits for all drainages into the Columbia River above the Bonneville Dam until a study determines what remedial steps are needed to restore the streams fishery. In the interim, this action precludes access to these multiple stream sources, and the threat of permanent closure of several streams.

The continuing of pumping of deep wells, lowering of the water table and the further depletion of the water stored in the basalt aquifers underlying the Pendleton area, is not a long term viable option. Therefor, the City's springs water rights, unused surface water rights, and permits on the Umatilla River take on an increased value and importance to the City's future.

The purpose of showing Squaw Creek prominently near the east edge of the map on Sheet 4 of 5 (page I-6) is for identifying Squaw Creek as a reference point for the map on Sheet 5 of 5 (page I-9).



SHEET 5 OF 5 | MAP FROM SPRINGS TO THE NORTH FORK OF THE UMATILLA RIVER

On Sheet 5 of 5 Squaw Creek is identified approximately 1.5 miles easterly of its westerly edge. Note that the scale of the map had to be substantially changed to fit the full length of the approximately 12 river miles upstream from the City's upper most spring (Longhair).

The City has an undeveloped 1941 water right and 1910 permit for water from the Umatilla River. Their points of diversion are in the general vicinity of the North Fork of the Umatilla River.

D. CITY'S WELL SUPPLY SYSTEM

The springs provided all of the City's water needs until 1948 when deep Well No. 1 (S. E. Byers Avenue) and Well No. 2 (Round-up Park) were drilled to augment the gravity supply. Since 1948 an additional five deep well sources were added to the present supply system: in 1952, Well No.3 (S. W. last Street); in 1955 Well No.4 (State Hospital); in 1960 Well No.5 (Stillman Park), in 1968 Well No.7 (Mission Well) and Well No. 8 (Prison Well) obtained from the State of Oregon by a transfer in 1984.

The location of the City's wells with the exception of No.7 (Mission Well) are shown on the city map, Plate No.1 (page I-11). Well No.7 is at the same location shown for the Chlorination Station near the southeasterly section of the map on sheet 2 of 5 (page I-4). This City map does not show some of the undeveloped dedicated city streets; e.g. Reservation Addition, etc. The map does show the full extent of the City's service area, with the exception of the contract with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). The City's wells can be divided into the following 3 categories.

D.1 ACTIVE WELLS

Wells #1 through #8 (except #6) fall into this category. Some of the wells in *all 3 categories* have been renumbered from their original permit numbers as a matter of operational convenience. The changes from the original well permit numbering is documented in Chapter IV.

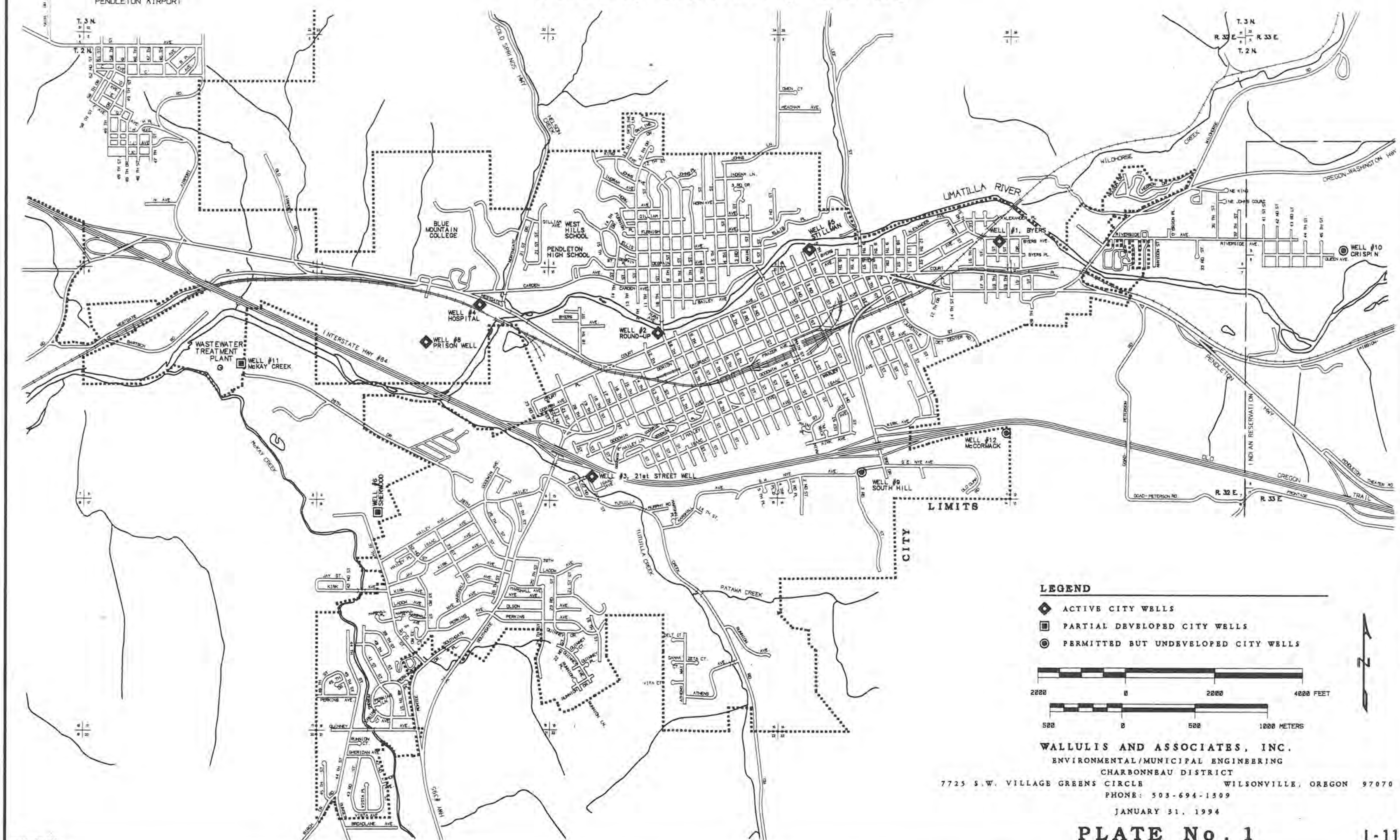
D.2 PARTIALLY DEVELOPED WELLS

Well #6 and Well #11 were permitted in 1962 and 1966 respectively and fall into this category. Well #6 is 1,501 feet deep and is currently utilized to monitor the water table in the underlying basalt aquifers. There is some conflicting information on Well #11 as to depth (334' or 339'), amount of casing installed (200' or 334') and yield (bailed dry vs. high yield). Well #11 is currently being used by the City's wastewater treatment plant. The City could make improvements to either one or both of these wells as they remain in a permit status.

D.3 UNDEVELOPED WELLS

Wells #9, and #10 fall into this category. The City has had permits for these wells since 1962 and they are still valid.

CITY OF PENDLETON, OREGON
WATER MASTER PLAN



WALLULIS AND ASSOCIATES, INC.
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CHARBONNEAU DISTRICT
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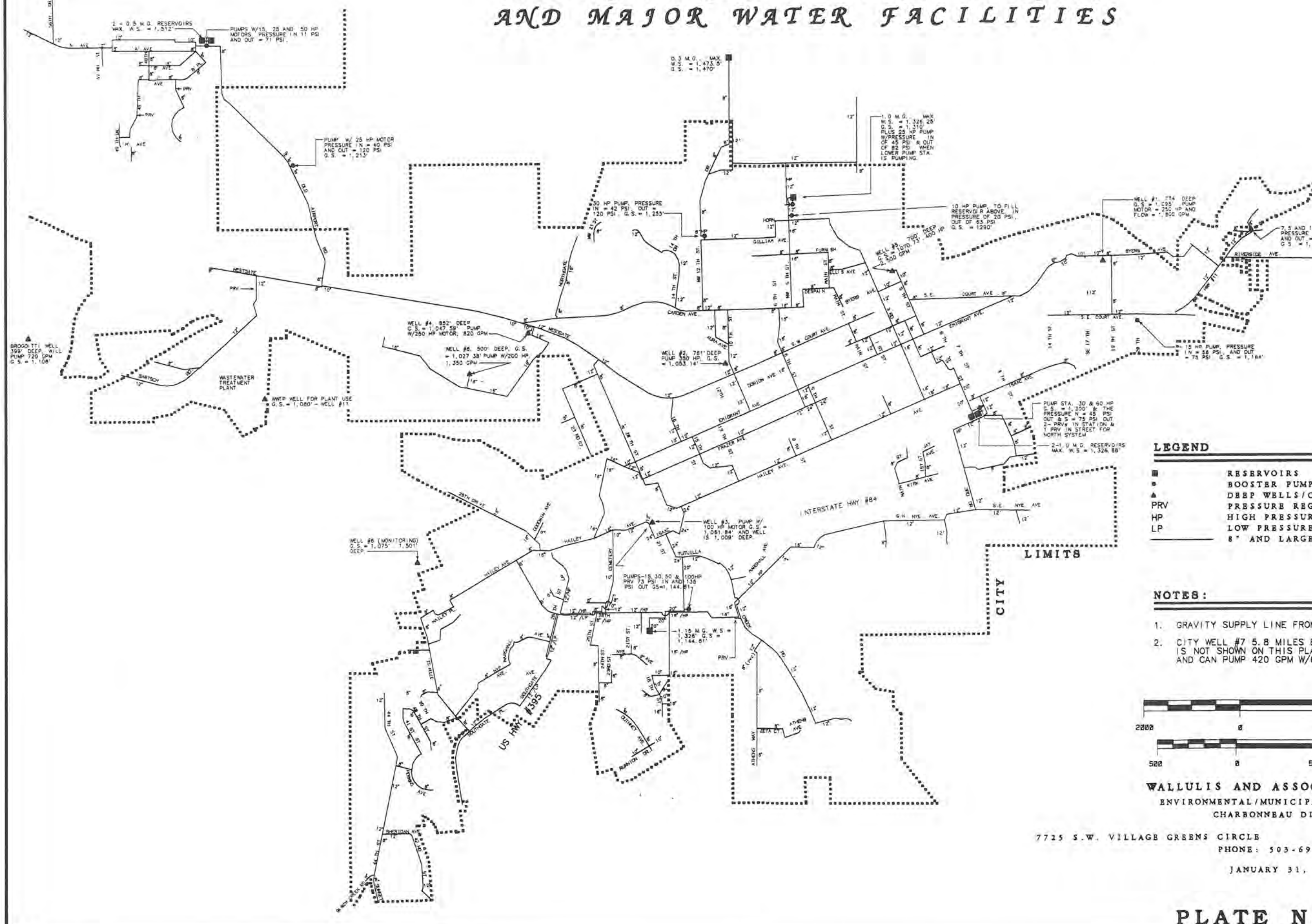
PHONE: 503-694-1509

JANUARY 31, 1994

PLATE No. 1

CITY OF PENDLETON, OREGON
WATER LINES 8" AND LARGER AND MAJOR WATER FACILITIES



LEGEND

■	RESERVOIRS
●	BOOSTER PUMPING STATIONS
▲	DEEP WELLS/CITY & PRIVATE
PRV	PRESSURE REGULATING DEVICES
HP	HIGH PRESSURE LINES
LP	LOW PRESSURE LINES
——	8" AND LARGER WATER LINES

NOTES:

1. GRAVITY SUPPLY LINE FROM SPRINGS NOT SHOWN ON THIS PLATE.
2. CITY WELL #7 5.8 MILES EAST AND 1.7 MILES SOUTH OF WELL #1 IS NOT SHOWN ON THIS PLATE. WELL IS 800' DEEP, G.S. = 1,463' AND CAN PUMP 420 GPM W/60 HP MOTOR.

2000 0 2000 4000 FEET

500 0 500 1000 METERS

N

WALLULIS AND ASSOCIATES, INC.
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PHONE: 503-694-1309

JANUARY 31, 1994

PLATE No. 2

PENLBH20.GCD

E. WATER DISTRIBUTION SYSTEM

The water systems distribution and transmission lines of 8" size and larger are of sufficient size in maintaining the systems pressure and to transmit substantial quantities of water to other areas experiencing a demand. These lines, the City's wells, reservoirs, and booster pumping stations are shown on Plate No. 2 (page I-12). Records of the physical facilities (lines 4" and larger) were examined, and conflicts reviewed and resolved by the City's Engineering Department.

The above map on Plate No.2 does appear to leave some floating islands in the distribution systems piping seemingly unattached to anything. Smaller 6" lines and even smaller 4" lines in the valley floors where the pressures are in the 100 to 130 psi range can contribute to fire flows at the fire hydrants. Plate No. 3 (page I-14) adds the 4" and 6" lines for the additional limited contribution they can make, plus to show how they provide interconnections to some of the larger distribution and transmission lines.

E.1 WATER SERVICE TO THE AIRPORT

In the late 1930's (approximately 1938-1939), a new transmission line was laid from the City's base level water system to provide service to the airport. This line was completed in the early 1940's along with a booster pump station and two wooden reservoirs. The wood reservoirs have been subsequently replaced with two 0.5 million gallon steel reservoirs.

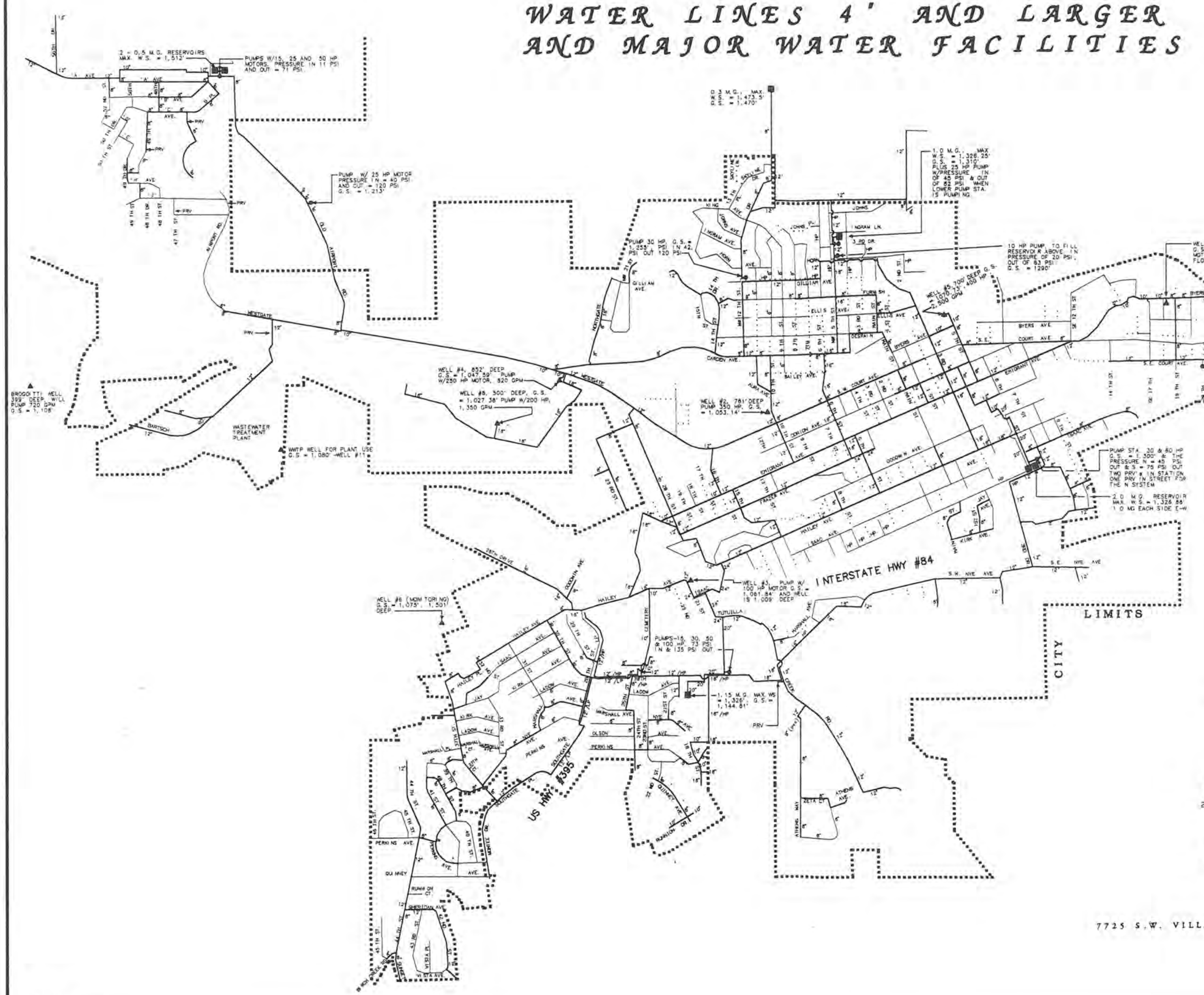
E.2 UPPER NORTH HILL SERVICE AREA

In the late 1940's, continued growth of the community resulted in residential developments at higher elevations on the North Hill. This required the construction of a 0.3 million gallon reservoir in a wheat field north of the developed city to service the upper level and the installation of a booster pump station at N. W. I2th Street and N. W. Gilliam Avenue. Later, an additional booster pump was installed at the southwest corner of the North Hill 1.0 million gallon reservoir.

E.3 MT. HEBRON - RIVERSIDE AREA

In 1951, the water system was expanded to include the Riverside and Mt. Hebron areas. The Mt. Hebron development required the installation of a small booster station, which was installed by the developer and maintained by the residents for several years. In 1973, Mt. Hebron and a small portion of the Riverside area was annexed. In 1974, the old booster station servicing Mt. Hebron was replaced with a new pumping station at the southern base of Mt. Hebron just west of U.S. Highway No. 11 to Walla Walla, Washington.

CITY OF PENDLETON, OREGON
WATER LINES 4" AND LARGER AND MAJOR WATER FACILITIES



LEGEND

■	RESERVOIRS
●	BOOSTER PUMPING STATIONS
▲	DEEP WELLS/CITY & PRIVATE
PRV	PRESSURE REGULATING DEVICES
HP	HIGH PRESSURE LINES
LP	LOW PRESSURE LINES
———	8" AND LARGER WATER LINES
———	6" DIAMETER WATER LINES
....	4" DIAMETER WATER LINES

NOTES:

1. GRAVITY SUPPLY LINE FROM SPRINGS NOT SHOWN ON THIS PLATE.
2. CITY WELL #7 5.8 MILES EAST AND 1.7 MILES SOUTH OF WELL #1 IS NOT SHOWN ON THIS PLATE. WELL IS 800' DEEP, G.S. = 1,464.10' AND CAN PUMP 420 GPM W/60 HP MOTOR.

2000 0 2000 4000 FEET

500 0 500 1000 METERS

N

WALLULIS AND ASSOCIATES, INC.
ENVIRONMENTAL/MUNICIPAL ENGINEERING
CHARBONNEAU DISTRICT
7725 S.W. VILLAGE GREENS CIRCLE WILSONVILLE, OREGON 97070
PHONE: 503-694-1309

JANUARY 31, 1994

PLATE No. 3

E.4 UPPER SOUTH HILL SERVICE AREAS

In the early 1950's (1953-1954), growth on the South Hill required the installation of a booster pump station at S. W. 8th Street and Isaac Avenue. In 1959, an additional booster pumping station was installed at S. E. 6th Street and S. E. Isaac Avenue. In 1962, these two areas were connected with a 6" line. Because of increased growth around the S.E. 3rd Street freeway interchange (I-84), these stations were subsequently replaced with a larger booster pumping station in 1968 at S. E. 7th Street and S. E. Isaac Avenue.

The booster pumping station constructed in 1993, adjacent to the southeast corner of the City's cemetery, now serves as the primary booster pumping station for the entire area. The booster pumping station at S.E. 7th Street and S.E. Isaac , now serves as a backup to the new station and for supplemental source during periods of high demands which may occur during major fires at one or more of the commercial businesses at the S.E. 3rd Street freeway interchange.

E.5 S. E. UPPER LEVEL SERVICE AREA

In the mid-1950's, a small booster pumping station was installed in the vicinity of S. E. 20th Street and S.E. Court Avenue. This booster station services a few homes and tourist commercial facilities situated at the junction of Highway No. 11 and the Old Oregon Trail Highway to Mission.

E.6 S. W. UPPER LEVEL SERVICE AREA

Residential development in the late 1950's and the early 1960's, in the Southwest area of Pendleton (Young's 1st and 2nd Additions) and the construction of the Community Hospital, required the installation of an additional booster pumping station at S. W. 25th Street and S. W. Ladow Avenue in 1961. This booster pumping station has now been replaced by the new booster pumping station constructed in 1993 cited in E.4 above.

E.7 CONFEDERATED TRIBES UMATILLA INDIAN RESERVATION, (CTUIR) AREA

In addition to the City system discussed above, the City's springs via the gravity water line services the CTUIR. Well No. 7 (Mission Well), was strategically selected to provide the CTUIR water customers with good quality water when the spring sources become too turbid (murky) for domestic use. This well, during periods when the spring sources are over 5.0 Nephelometric Turbidity Units (NTU), is utilized as a source for blending with the spring sources to reduce the turbidity to 5.0 NTU or considerably less.

E.8 SUMMARY

The present water system consists of:

- The base system servicing the Umatilla River, McKay Creek valley floors and partially up the side hills, plus being the source of water for the upper level areas,
- The North high level system,
- The airport high level system,
- The South-Southwest high level system,
- The Southeast high level system, and
- The Mt. Hebron high level system.

All of the major distribution line improvements, storage facilities and pumping facilities listed in the prior 1979 Water Master Plan have been completed and are discussed in more detail in Chapter II.

F. ACKNOWLEDGMENTS

F.1 PROFESSIONAL SUPPORT STAFF

- William E. Lawson, Consulting Engineer, Wilsonville, Oregon. Provided general technical and professional support in all areas.
- Robert Meyer, Engineers Consultants, Incorporated, Beaverton,Oregon. Provided professional support on water treatment alternatives.
- Richard Gullixson, Certified Engineering Geologist, Milton-Freewater, Oregon. Provided research, map preparation and text for the geology Chapter V.

F.2 CITY OF PENDLETON STAFF

Historical, technical data, records, and general assistance were provided by Jerry Odman, City Public Works Director; David Lorenzen, City Engineer; City Planner, Mike Hyde; and Water Superintendent, Ralph Baumgartner. Their assistance and those of their staff were invaluable in the preparation of this report. Ongoing cooperation and conferences on the various alternatives considered resulted in the early elimination of several alternatives and permitted this Study to focus on the viable alternatives.

CHAPTER II -- WATER SYSTEM REQUIREMENTS

A. POPULATION

Population trends are shown on the graph on page II-2. Records from 1890 to 1990 documents periods of: no growth, growth, losses and subsequent rebounds to a higher population levels. During the past decades, there was one static growth period (1900-10) and two decades of population losses (1920-30) - (1960-70). After each of these periods, there was a recovery or significant rebounding to new high levels. The average increase in population over the 100 year history has been 126 persons per year. The longest fast growth rate period was between 1930 and 1960 when the average yearly uniform increase in population was 264 persons per year.

Because of the erratic population growth patterns, a population band growth was selected for growth projections to the year 2,020. The projected growth rate is 142 persons per year with a population band width of 3,700 persons. This results in the following population projections:

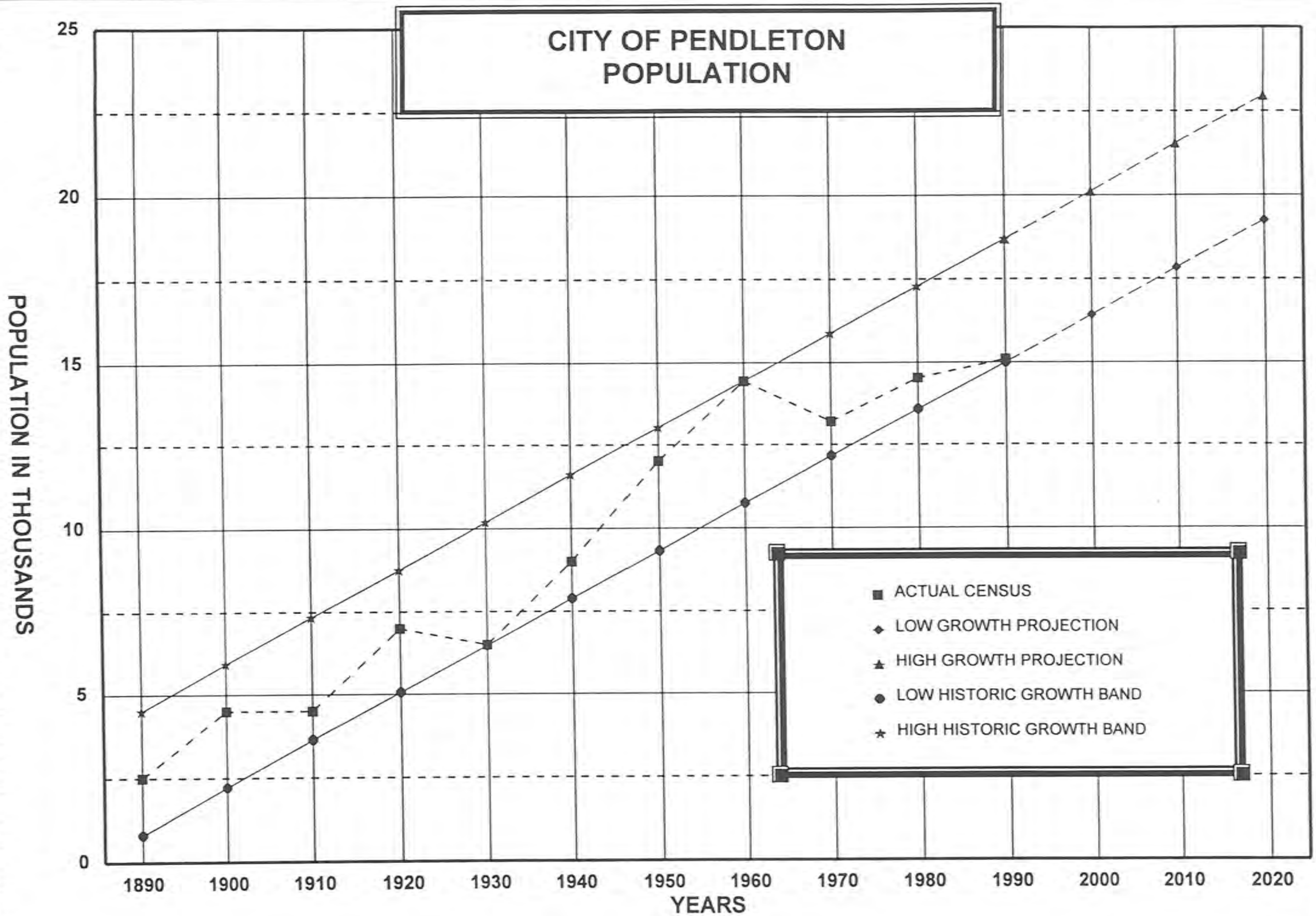
TABLE II-1

YEAR	LOW POPULATION PROJECTION	MEDIUM POPULATION PROJECTION	HIGH POPULATION PROJECTION
2,000	16,420	18,270	20,120
2,010	17,840	19,690	21,540
2,020	19,260	21,110	22,960

The prior trend of a reduction in the number of persons occupying the typical residential unit is probably at or near a point of stabilization. After a long period of degradation of the social fabric, society is recognizing the importance of the re-establishment of the former traditional family values. The return to the traditional family values, may reverse the trend of fewer occupants per residential unit. Massive job reductions in middle management and more single women as the only parent, has resulted in some young adults returning to their parents, increasing the family unit size.

The population for the year 1978 in the 1979 Water Master Plan was estimated to be 15,000 persons. The population estimate in the 1979 Water Master Plan was obtained from Ed Rhodes, former City Planner. According to actual population records from Mike Hyde, City Planner, the correct population was 13,975. The error in the population estimate of 1,025 persons (7.33 %) is of significance during periods of peak water demands and projecting future demands.

According to the City's records, Pendleton's population was 15,395 in 1992. The City water department was hard pressed to meet the water demands during the long hot summer in 1992, and again in 1994 during a normal summer. The City in both years had to request voluntary reductions in water by customers with large irrigation demands. Larger users were requested to cease all irrigation i.e. Blue Mountain College, City Parks Department, Eastern Oregon Correctional Institution, public schools, etc.



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B. FUTURE GROWTH AREAS

There presently is a lack of inventory of available rentals (now normally around zero) and residential homes for sale. This indicates that the City is about to experience another growth cycle.

The projected growth areas are shown on page II-4 and projected populations for these principal sections in ascending growth rates are as follows:

TABLE II-2

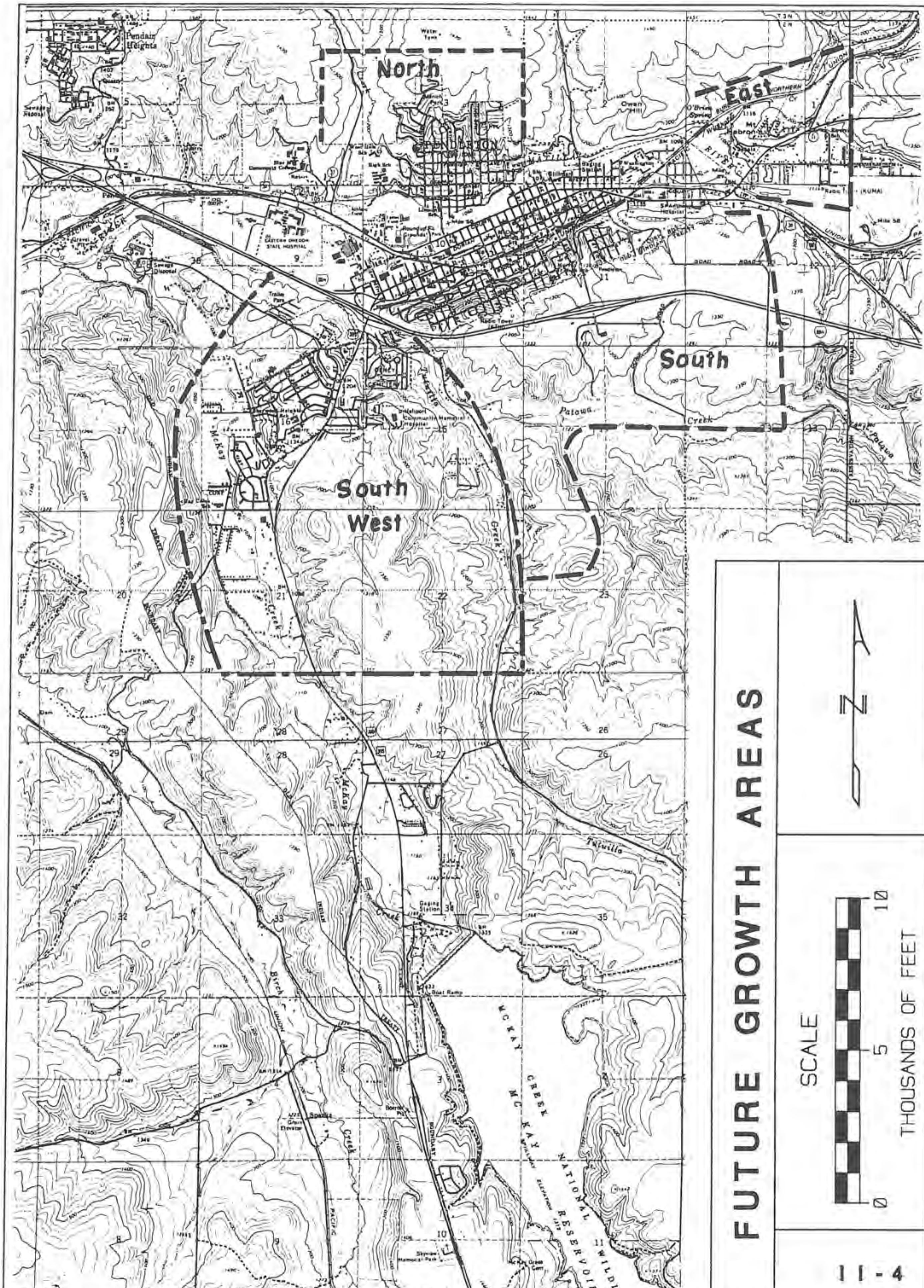
AREA	LOW GROWTH ESTIMATE	HIGH GROWTH ESTIMATE
East	190	380
North	560	I,110
South	750	1,490
Southwest	2,240	4,460
TOTALS	3,740	7,440

East: The western boundary of the Umatilla Indian Reservation boundary, east of the City, restricts the amount of growth that can be incorporated into the City's corporate limits. Land in the flood plain is another growth restraint. The continued growth in this area is anticipated to be primarily residential with minimal additional growth in the commercial sector.

North: The lands to the north of the City have been zoned productive farm land, with the exception of a small amount of land on the steeper side slopes which are available for additional growth. The shallow soil on the steeper slopes overlays basalt rock, which results in high development costs, and is an impediment to development.

South: The lands to the south of the City, lying northwesterly of the central interchange, is substantially developed except for a few lots in the Reservation Addition. The land lying northeasterly of the central interchange has had some infrastructure improvements, but slight growth, and little is expected except for some commercial development. The lands lying southeasterly of the central interchange has and will probably continue to be primarily developed as commercial. The land lying southwesterly of the central interchange is expected to have continued commercial growth on the upper plateau and residential growth in the valley floor and side hills.

Southwest: Infrastructure improvements, based on high growth projections, are recommended when an area is to be serviced by a single transmission line or distribution extension. When growth areas are to be served by more than one line, the low population projection is recommended.



FUTURE GROWTH AREAS

The extension of multiple lines (looping) has many desirable attributes, circulation of water keeping it fresh, maintaining service to an area when one of the lines servicing the area is removed in the event of an emergency or for planned maintenance.

The geographical center of the City was estimated to be in the vicinity of S.W. 20th Street and S. W. Emigrant Avenue in the 1979 Water Study[1]. This location is probably still valid as there has been little change in the City's growth.

C. LARGE DEMAND' USERS

Present large system demand users are the Eastern Oregon Correctional Institute, Pendleton Round-Up Grounds, Hill Meat Company, City Cemetery, City Parks, schools, large food stores, hospitals, and large motel complexes.

The irrigation for maintenance of landscaping during the late spring, summer months and early fall, places the largest demand on the water system. The irrigation demand super imposed on other peaking demands during ***summers with normal temperatures*** has not placed a stress on the water sources to meet those demands. During periods of ***long hot summers***, such as experienced in 1986, water demands approached the capacity of the water systems sources. In the summers of 1992 and 1994, the water demands exceeded the capacity of the City's water sources.

D. WATER CONSUMPTION HISTORY -- 1973 to 1992

Three years of water production and consumption records (1979-81 incl.) were lost during the transition of Gene Harover's retirement. The records available for the purpose of this study are monthly consumption totals.

The annual consumption records, population records and the average per capita consumption per day for each year are shown on Table II-3, on page II-6. This same information is shown in graphical form on page II-7.

The graph on page II-8 shows the source water (springs/wells) utilized to satisfy these annual water demands. To comply with the Federal EPA mandated lower amount of turbidity (1 NTU), the City has had to forego a substantial amount of water from the spring sources. The springs previously supplied 64.45% of the water from 1971-78, and supplied only 29.4% in 1992.

In Chapter IV, there is a relationship established between an observation well (1990 to 1992 inclusive) owned by the Indian Agency and the available yield from the springs. The availability of water from the springs stated in this chapter is based on that relationship.

[1] Water Study for the City of Pendleton, Oregon. Wallulis and Associates, Inc. September 1979

TABLE II-3

CITY OF PENDLETON'S WATER PRODUCTION RECORDS 1973 TO 1992

VERSUS POPULATION AVERAGE PRODUCTION PER CAPITA

YEAR	M.G./YEAR	POPULATION	GALLONS PER CAP/DAY
1973	1,588.300	13,750	316.47
1974	1,540.600	14,010	301.27
1975	1,478.400	14,080	287.67
1976	1,459.900	14,300	279.70
1977	1,456.800	14,650	272.44
1978	1,558.300	14,325	298.03
1979		14,400	
1980		14,521	
1981		14,600	
1982	1,643.521	14,550	309.47
1983	1,545.590	14,270	296.74
1984	1,524.411	14,150	295.16
1985	1,631.802	14,400	310.46
1986	1,817.550	14,445	344.73
1987	1,708.163	14,610	320.32
1988	1,703.939	14,660	318.44
1989	1,732.208	14,765	321.42
1990	1,720.381	15,090	312.35
1991	1,737.509	15,440	308.31
1992	1,879.684	15,395	334.51
MAXIMUM YEAR.	1,879.684	15,440.000	344.728
MINIMUM YEAR.	1,456.800	13,750.000	272.439
AVERAGE YEAR.	1,631.003	14,520.550	307.500

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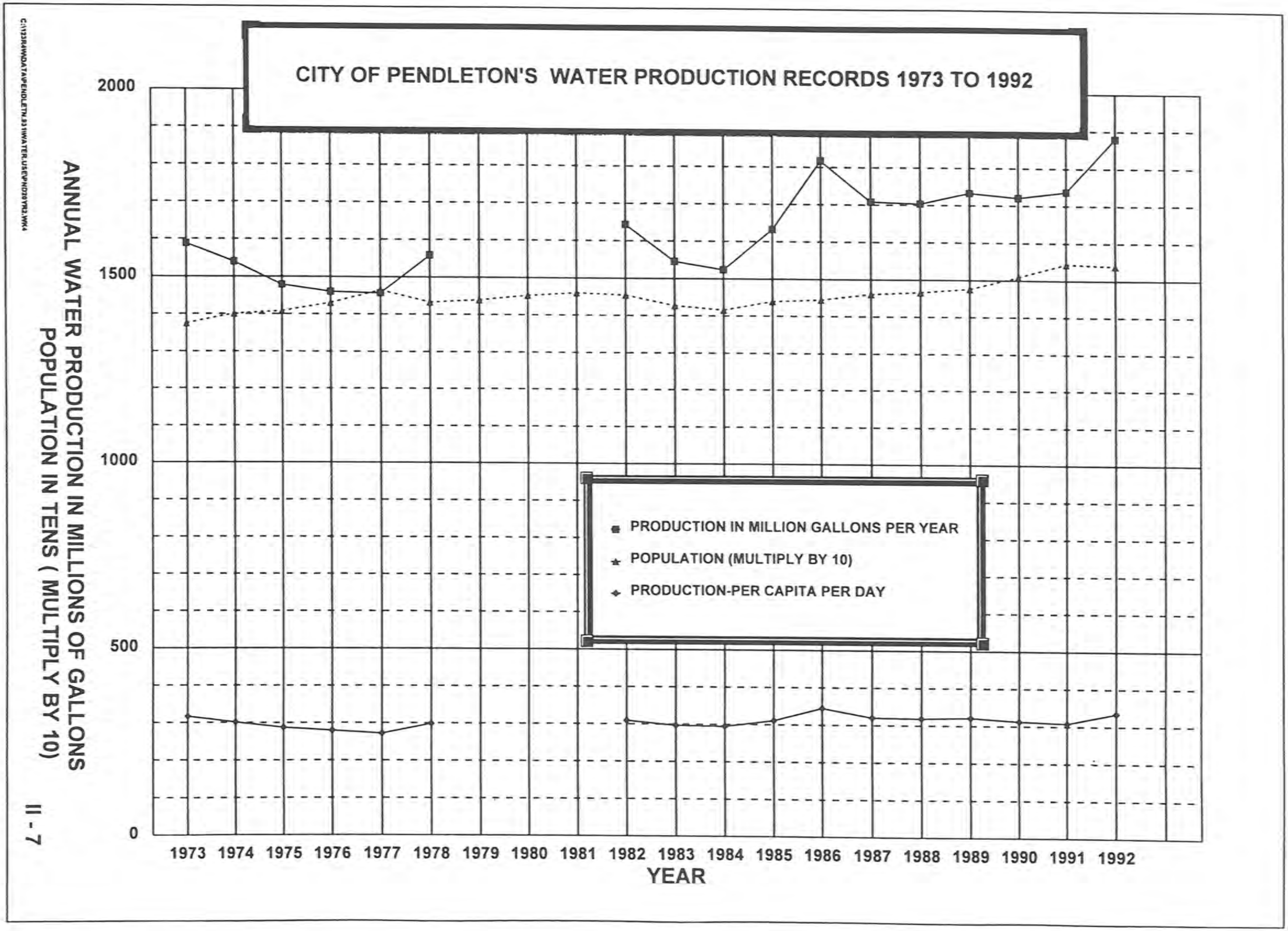

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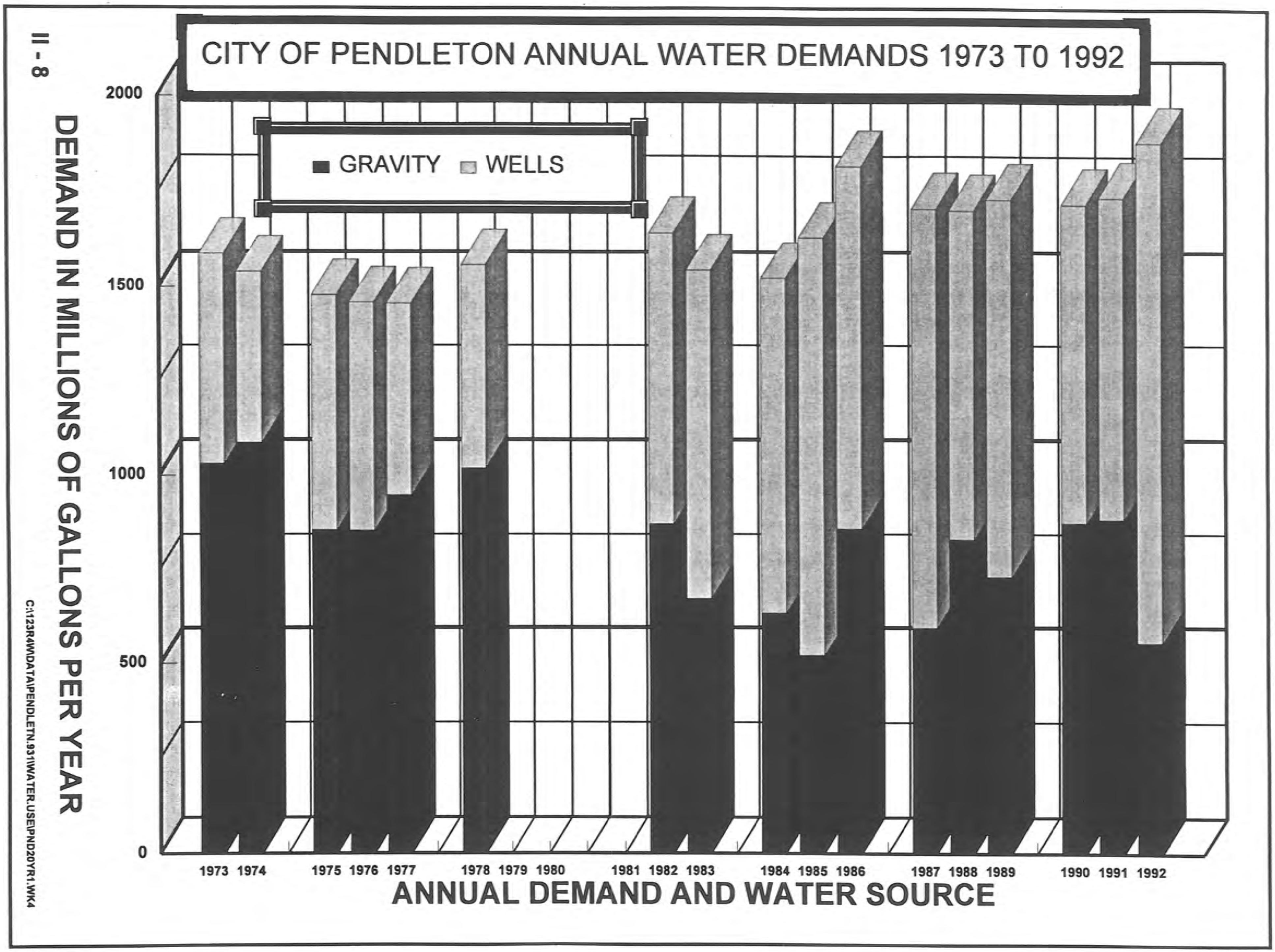
CITY OF PENDLETON'S WATER PRODUCTION RECORDS 1973 TO 1992
ANNUAL WATER PRODUCTION IN MILLIONS OF GALLONS
POPULATION IN TENS (MULTIPLY BY 10)
2000
1500
1000
500
0
PRODUCTION IN MILLION GALLONS PER YEAR
POPULATION (MULTIPLY BY 10)
PRODUCTION-PER CAPITA PER DAY
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
YEAR


CITY OF PENDLETON ANNUAL WATER DEMANDS 1973 T0 1992
GRAVITY
WELLS
DEMAND IN MILLIONS OF GALLONS PER YEAR
2000
1500
1000
500
0
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
ANNUAL DEMAND AND WATER SOURCE
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The water demands for the year 1992, the sources utilized, are shown in Table II-5 on page II-10 and graphically on the chart on page II-11. The springs should have been capable of supplying all of the City's water demands the first three months of the year, and 150 million gallons/month during the next three months. During these months, however, from January to June the City's wells supplied 43%, 92%, 79%, 81%, 73% and 69% respectively.

This heavy reliance on the deep wells places a heavy stress on the water stored in the deep aquifers and their natural rate of recharge. During the unusually hot summer months in 1992, the available supply from the springs dropped and resulted in the wells providing 84% and 74% of the water demand in the months of July and August respectively. This places a significant stress on the water stored in the deep aquifers. Also note that the wells were in use 12 months of the year, which prevents the underlying water table of the deep wells to achieve water level stability equivalent to the earlier years.

The charts developed for the year 1982-92 inclusive show the monthly demands, the water source utilized in meeting those demands, and the limited use of the water available from the springs because of turbidity. The monthly bypassing of the springs and deep well pumping are summarized in the Table II-4 below.

TABLE II-4

YEAR	MONTHS OF SURPLUS SPRING WATER NOT USED AND DEEP WELLS SOURCES REQ'D.	MONTHS WHEN ALL THE SPRING WATER BYPASSED TO THE RIVER	MONTHS OF THE YEAR THE DEEP WELLS ARE USED
1992	Jan.-Mar.	0	All
1991	Jan.-May & Dec.	0	All
1990	Jan.-April	0	All
1989	incomplete data	1 - March	All
1988	incomplete data	0	All
1987	incomplete data	2 - Feb. & March	All
1986	incomplete data	1 - March	All
1985	incomplete data	0	All
1984	incomplete data	2 - Feb. & Dec.	All
1983	incomplete data	3 - Jan. - March	All
1982	incomplete data	0	All

TABLE II-5

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1992

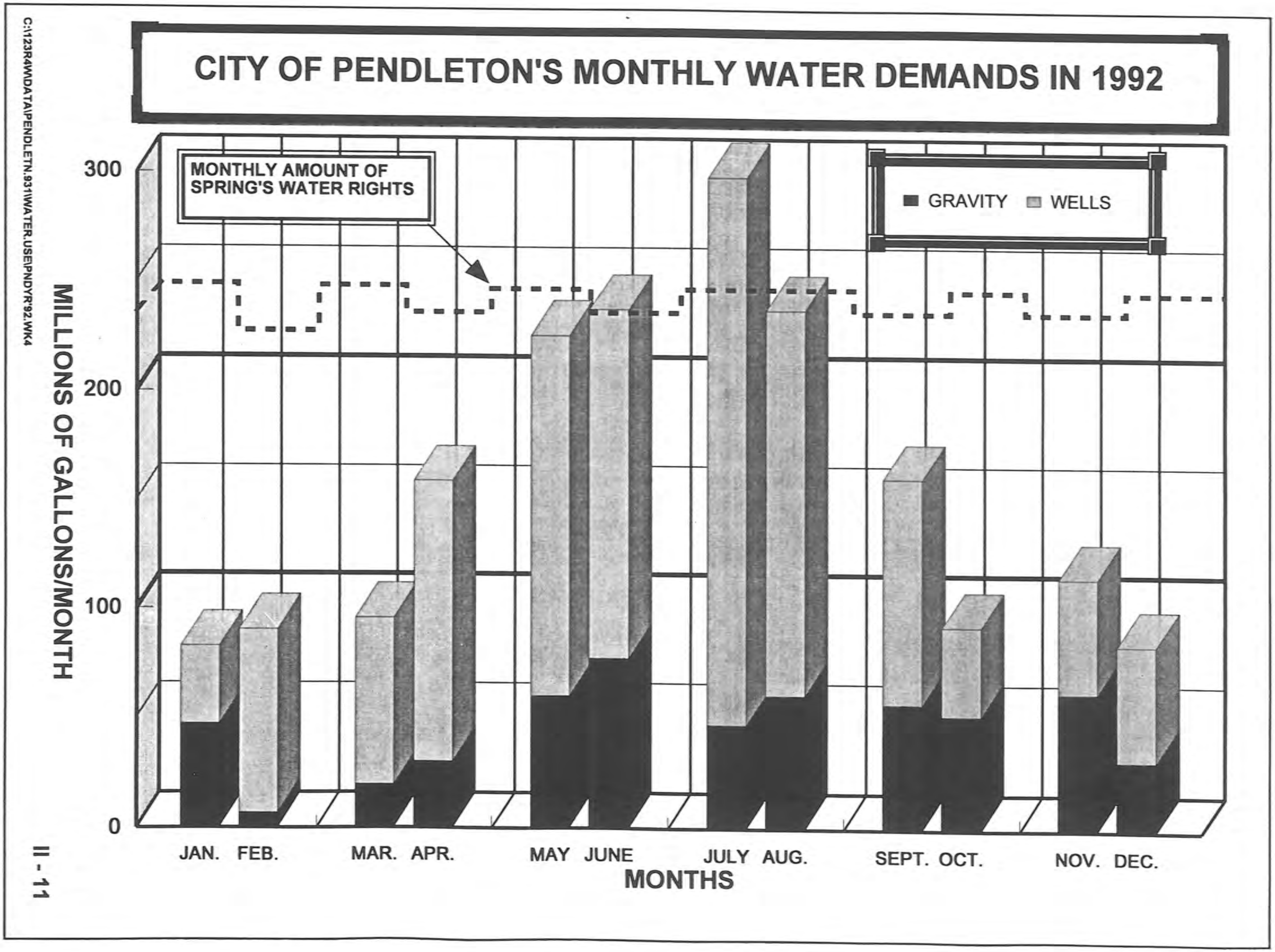
IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL	% SPRINGS	% WELLS
JAN.	47.264	35.468	82.732	57.13	42.87
FEB.	6.820	83.548	90.368	7.55	92.45
MAR.	19.695	76.195	95.890	20.54	79.46
APR.	30.235	128.981	159.216	18.99	81.01
MAY	60.270	165.394	225.664	26.71	73.29
JUNE	77.511	160.135	237.646	32.62	67.38
JULY	47.238	251.333	298.571	15.82	84.18
AUG.	60.828	176.601	237.429	25.62	74.38
SEPT.	57.100	103.372	160.472	35.58	64.42
OCT.	52.000	40.537	92.537	56.19	43.81
NOV.	62.500	52.357	114.857	54.42	45.58
DEC.	31.617	52.685	84.302	37.50	62.50
YR. TOTAL	553.078	1,326.606	1,879.684	29.42	70.58
MAX. MO.	77.511	251.333	298.571		
MIN. MO.	6.820	35.468	82.732		

SUPPLY WATER	FROM	ABOVE SOURCES
MAX. MO.	57.13	92.45
MIN. MO.	7.55	42.87

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max. month	2.584	8.108	9.631	COMBINATION OF SPRINGS & WELLS
Min. month	0.244	1.144	2.669	COMBINATION OF SPRINGS & WELLS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CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1992
MONTHLY AMOUNT OF SPRING'S WATER RIGHTS
GRAVITY
WELLS
MILLIONS OF GALLONS/MONTH
300
200
100
0
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
MONTHS

The water demands for the year 1991, the sources utilized, are shown in Table II-6 on page II-13 and graphically on the chart on page II-14. The springs should have been able to supply all of the City's water demands the first six months of the year and all of the month of December. During the months of January to June, the City's wells supplied 35%, 49%, 33%, 32%, 38% and 30% respectively, plus 30% in December.

The water demands for the year 1990, the sources utilized, are shown in Table II-7 on page II-15 and graphically on the chart on page II-16. The springs should have been able to supply all of the City's water demands the first four months of year, most of May and all of the month of December. During the months of January to May, the City's wells supplied 40%, 37%, 86%, 14%, and 16% respectively, plus 17% in December.

The water demands for the year 1989, the sources utilized, are shown in Table II-8 on page II-17 and graphically on the chart on page II-18. The springs should have been able to supply all of the City's water demands the first five months of year, most of November and all of the month of December. During the months of January to May, the City's wells supplied 77%, 74%, 100%, 17%, and 14% respectively, plus 22% in November and 60% in December.

The water demands for the year 1988, the sources utilized, are shown in Table II-9 on page II-19 and graphically on the chart on page II-20. The springs should have been able to supply all of the City's water demands the first four months of year. The turbidity at the springs during the months of January to April, required the City's wells to supply 21%, 25%, 78%, and 11% of the City's water demand, respectively.

The water demands for the year 1987 the sources utilized, are shown in Table II-10, on page II-21 and graphically on the chart on page II-22. The springs should have been able to supply all of the City's water demands the first four months of year. During the months of January to April, the City's wells supplied 73%, 100%, 100%, and 69% respectively.

The water demands for the year 1986 the sources utilized, are shown in Table II-11, on page II-23 and graphically on the chart on page II-24. The springs should have been able to supply all of the City's water demands the first four months of year. During the months of January to April, the City's wells supplied 35%, 78%, 100%, and 45% respectively.

In Chapter IV, pages IV 18 -21, a correlation was developed between an existing shallow Indian Agency well near the City's Gate House and Weir and the yield from the City's springs. The available records covered a period from March 1989 to September 1993. This correlation indicated that there are times when the yield from the springs can exceed the spring's collective water right of 7.56 MGD. The gravity line from the springs however, is only capable of transmitting a maximum of 5.25 MGD.

TABLE II-6

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1991

IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	59.179	31.503	90.682		65.26	34.74
FEB.	41.491	39.290	80.781		51.36	48.64
MAR.	75.600	37.966	113.566		66.57	33.43
APR.	67.628	32.039	99.667		67.85	32.15
MAY	76.831	46.369	123.200		62.36	37.64
JUNE	101.409	42.584	143.993		70.43	29.57
JULY	95.000	156.242	251.242		37.81	62.19
AUG.	76.161	190.214	266.375		28.59	71.41
SEPT.	67.202	122.051	189.253		35.51	64.49
OCT.	65.410	66.217	131.627		49.69	50.31
NOV.	90.800	59.435	150.235		60.44	39.56
DEC.	67.611	29.277	96.888		69.78	30.22
YR. TOTAL	884.322	853.187	1,737.509	**YR. AVERAGE**	50.90	49.10
MAX. MO.	101.409	190.214	266.375	**MAX. MO.**	70.43	71.41
MIN. MO.	41.491	29.277	80.781	**MIN. MO.**	28.59	29.57

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max. month	3.380	6.136	8.593	COMBINATION OF SPRINGS & WELLS
Min. month	1.482	0.944	2.606	COMBINATION OF SPRINGS & WELLS

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1991

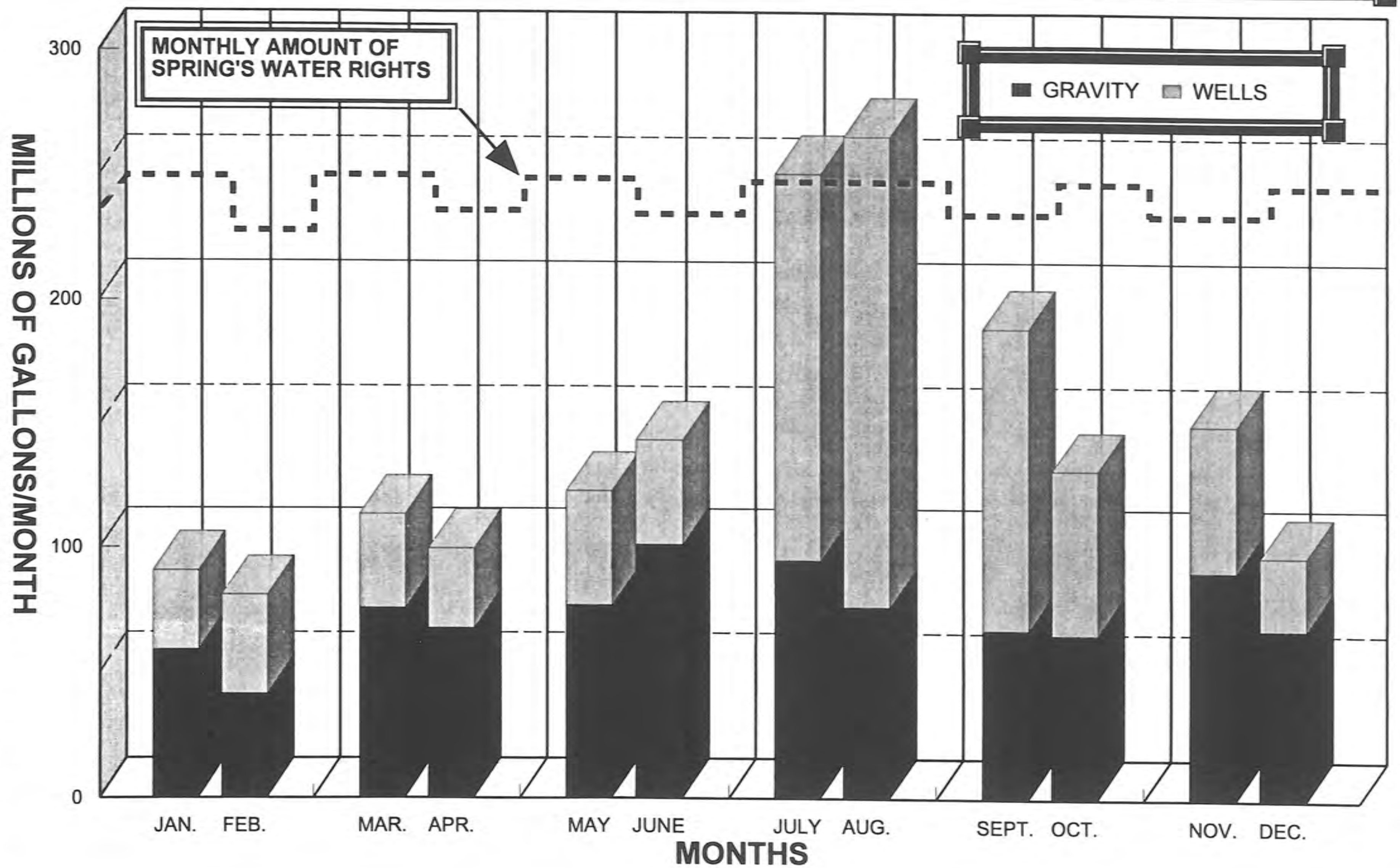

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TABLE II-7

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1990

IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	54.138	35.795	89.933		60.20	39.80
FEB.	48.885	28.478	77.363		63.19	36.81
MAR.	14.363	85.534	99.897		14.38	85.62
APR.	109.420	18.532	127.952		85.52	14.48
MAY	126.400	24.824	151.224		83.58	16.42
JUNE	113.115	97.787	210.902		53.63	46.37
JULY	60.610	168.107	228.717		26.50	73.50
AUG.	66.143	154.397	220.540		29.99	70.01
SEPT.	51.200	144.006	195.206		26.23	73.77
OCT.	55.800	60.505	116.305		47.98	52.02
NOV.	94.800	12.466	107.266		88.38	11.62
DEC.	78.800	16.276	95.076		82.88	17.12
YR. TOTAL	873.674	846.707	1,720.381	**YR. AVERAGE**	50.78	49.22
MAX. MO.	126.400	168.107	228.717	**MAX. MO.**	88.38	85.62
MIN. MO.	14.363	12.466	77.363	**MIN. MO.**	14.38	11.62

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max. month	4.213	5.423	7.378	COMBINATION OF SPRINGS & WELLS
Min. month	0.513	0.402	2.496	COMBINATION OF SPRINGS & WELLS

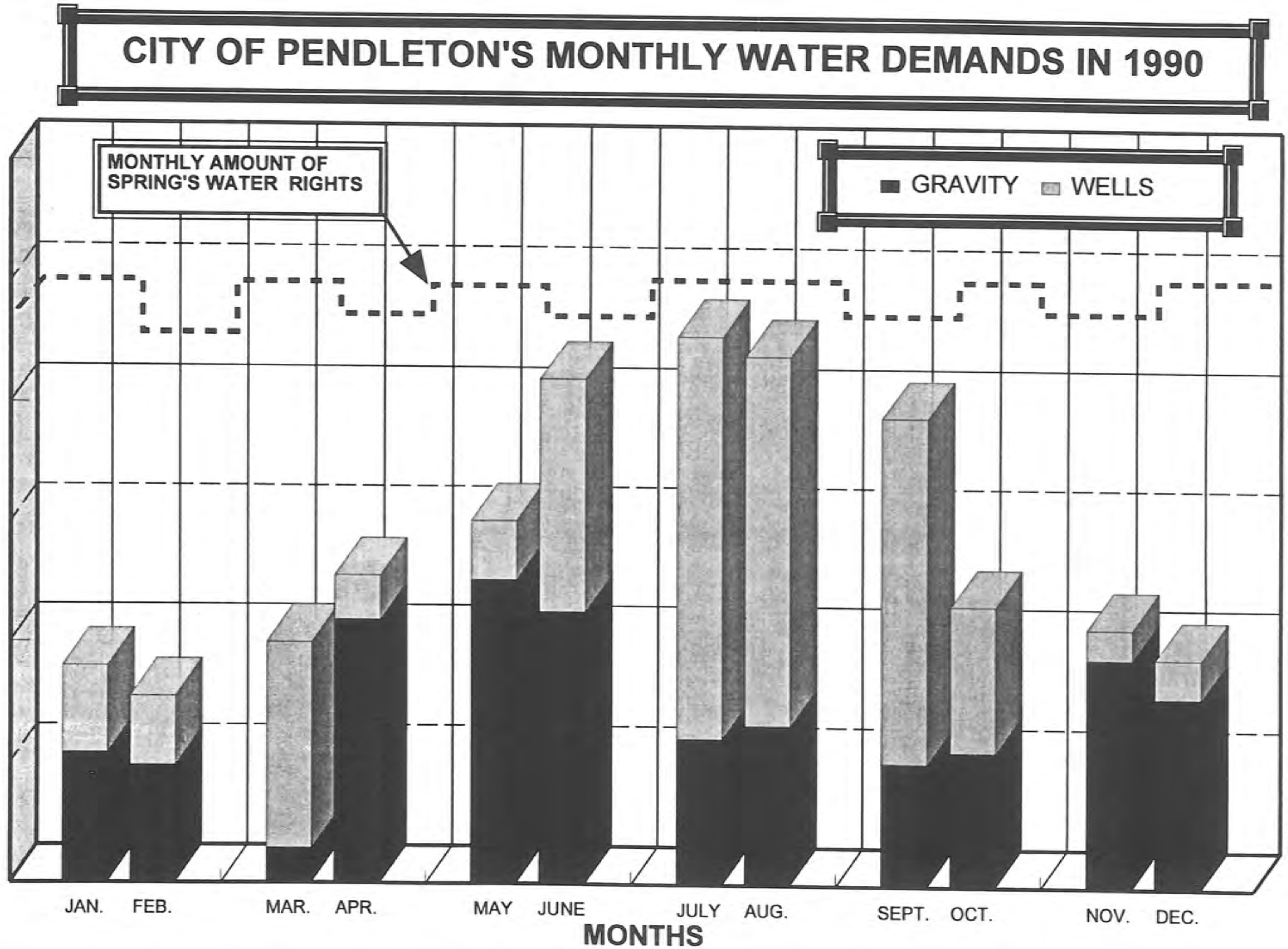

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TABLE II-8

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1989

IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	20.000	66.594	86.594		23.10	76.90
FEB.	22.312	64.381	86.693		25.74	74.26
MAR.	0.000	90.765	90.765		0.00	100.00
APR.	88.400	17.916	106.316		83.15	16.85
MAY	117.400	19.355	136.755		85.85	14.15
JUNE	97.100	152.432	249.532		38.91	61.09
JULY	81.990	175.960	257.950		31.79	68.21
AUG.	66.600	163.055	229.655		29.00	71.00
SEPT.	63.207	120.021	183.228		34.50	65.50
OCT.	65.800	57.180	122.980		53.50	46.50
NOV.	71.900	20.821	92.721		77.54	22.46
DEC.	35.300	53.719	89.019		39.65	60.35
YR. TOTAL	730.009	1,002.199	1,732.208	**YR. AVERAGE**	42.14	57.86
MAX. MO.	117.400	175.960	257.950	**MAX. MO.**	85.85	100.00
MIN. MO.	0.000	17.916	86.594	**MIN. MO.**	0.00	14.15

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max. month	3.913	5.676	8.321	COMBINATION OF SPRINGS & WELLS
Min. month	0.000	0.578	2.793	COMBINATION OF SPRINGS & WELLS

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1989

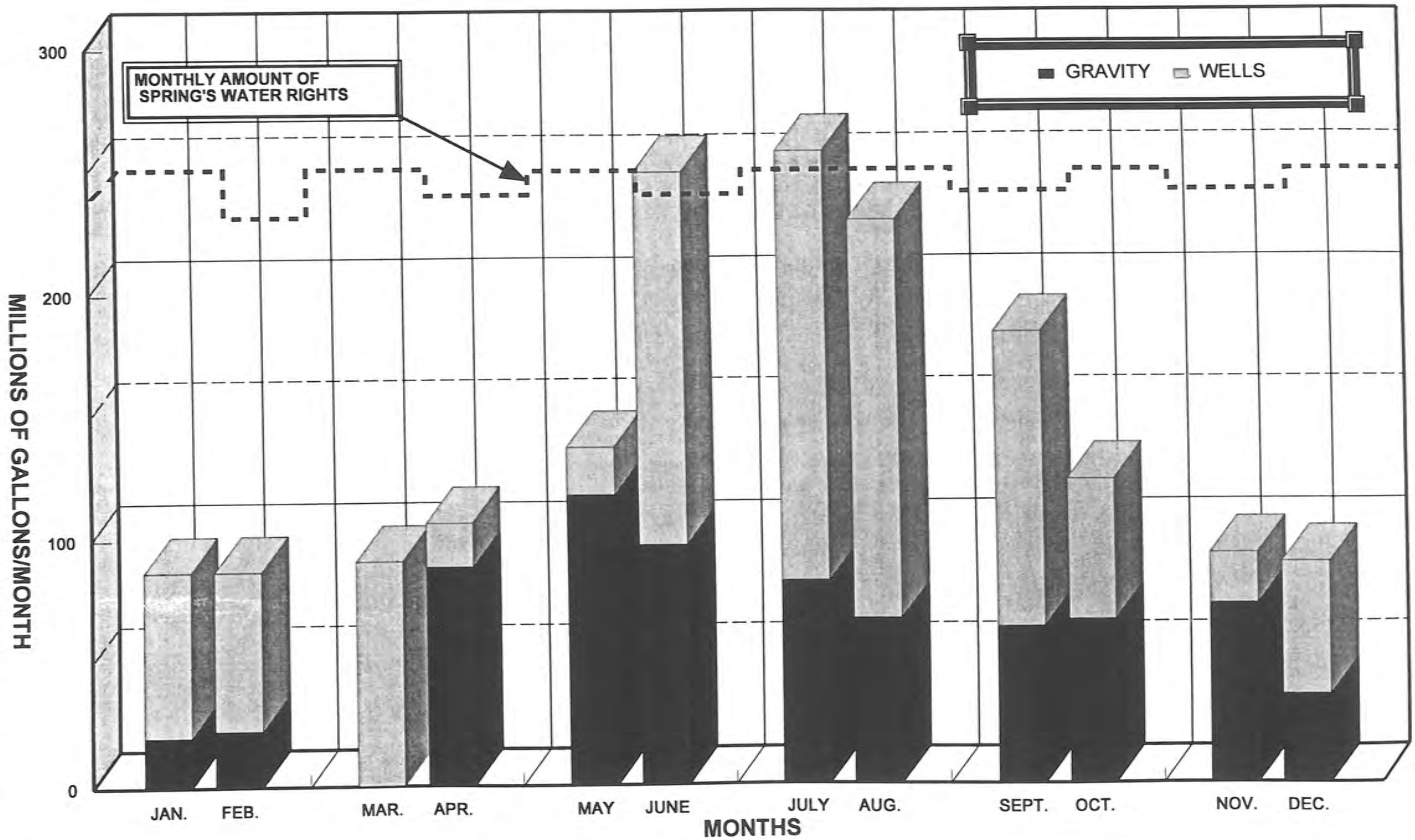

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TABLE II-9

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1988

IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	65.451	17.559	83.010		78.85	21.15
FEB.	48.820	16.586	65.406		74.64	25.36
MAR.	18.294	65.549	83.843		21.82	78.18
APR.	97.700	12.360	110.060		88.77	11.23
MAY	110.700	43.814	154.514		71.64	28.36
JUNE	108.700	88.557	197.257		55.11	44.89
JULY	62.200	181.401	243.601		25.53	74.47
AUG.	52.000	207.614	259.614		20.03	79.97
SEPT.	47.900	147.735	195.635		24.48	75.52
OCT.	52.400	69.610	122.010		42.95	57.05
NOV.	88.949	12.422	101.371		87.75	12.25
DEC.	77.400	10.218	87.618		88.34	11.66
YR. TOTAL	830.514	873.425	1,703.939	**YR. AVERAGE**	48.74	51.26
MAX. MO.	110.700	207.614	259.614	**MAX. MO.**	88.77	79.97
MIN. MO.	18.294	10.218	65.406	**MIN. MO.**	20.03	11.23

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max. month	3.690	6.697	8.375	COMBINATION OF SPRINGS & WELLS
Min. month	0.653	0.330	2.110	COMBINATION OF SPRINGS & WELLS

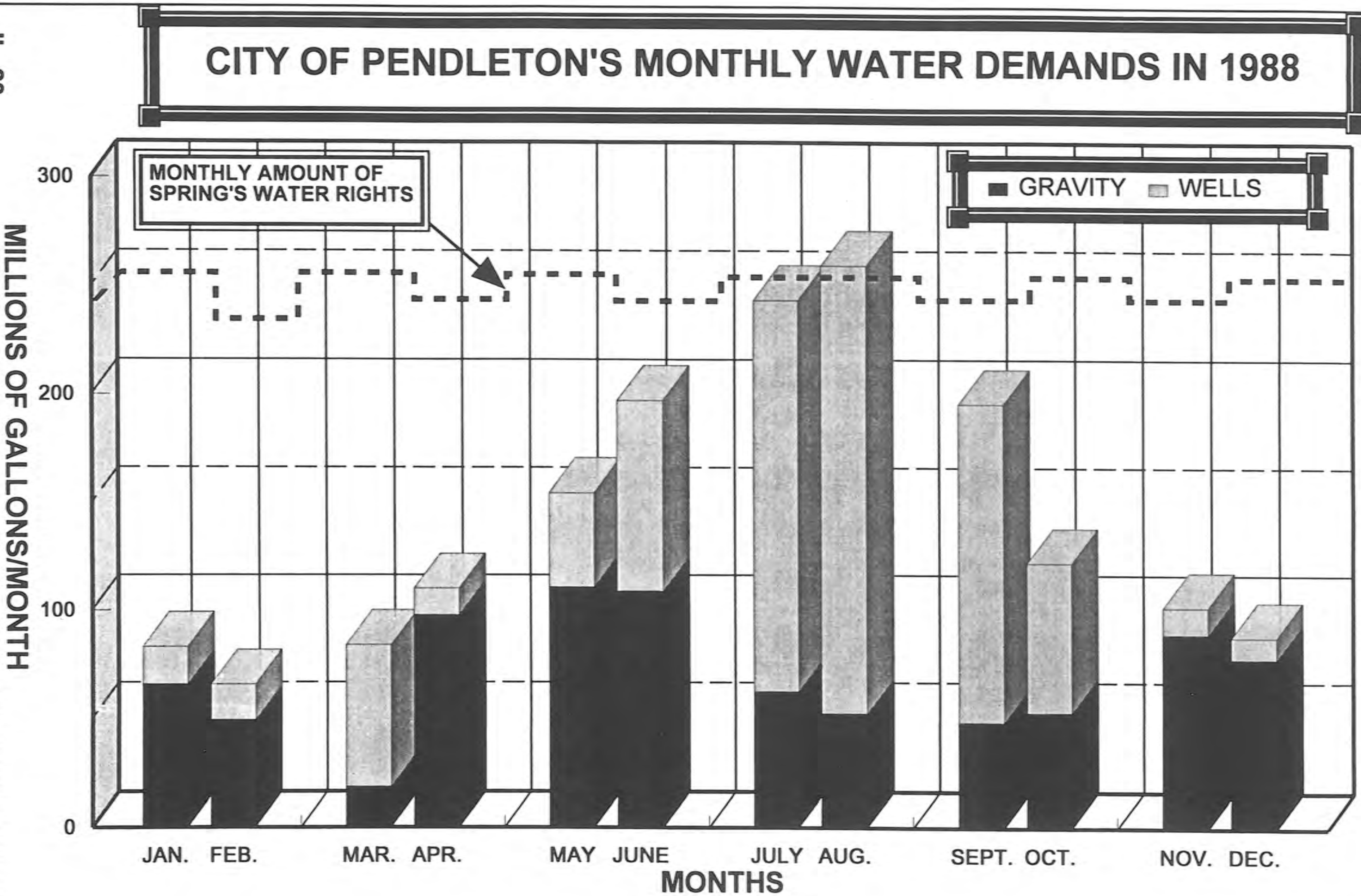

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TABLE II-10

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1987

IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	17.127	46.069	63.196		27.10	72.90
FEB.	0.000	77.629	77.629		0.00	100.00
MAR.	0.000	86.344	86.344		0.00	100.00
APR.	37.262	83.626	120.888		30.82	69.18
MAY	121.000	44.192	165.192		73.25	26.75
JUNE	87.052	117.798	204.850		42.50	57.50
JULY	63.424	173.089	236.513		26.82	73.18
AUG.	50.645	209.050	259.695		19.50	80.50
SEPT.	46.840	155.916	202.756		23.10	76.90
OCT.	49.649	80.071	129.720		38.27	61.73
NOV.	54.418	24.894	79.312		68.61	31.39
DEC.	65.963	16.105	82.068		80.38	19.62
YR. TOTAL	593.380	1,114.783	1,708.163	**YR. AVERAGE**	34.74	65.26
MAX. MO.	121.000	209.050	259.695	**MAX. MO.**	80.38	100.00
MIN. MO.	0.000	16.105	63.196	**MIN. MO.**	0.00	19.62

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max . month	4.033	6.744	8.377	COMBINATION OF SPRINGS & WELLS
Min. month	0.000	0.520	2.039	COMBINATION OF SPRINGS & WELLS

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1987

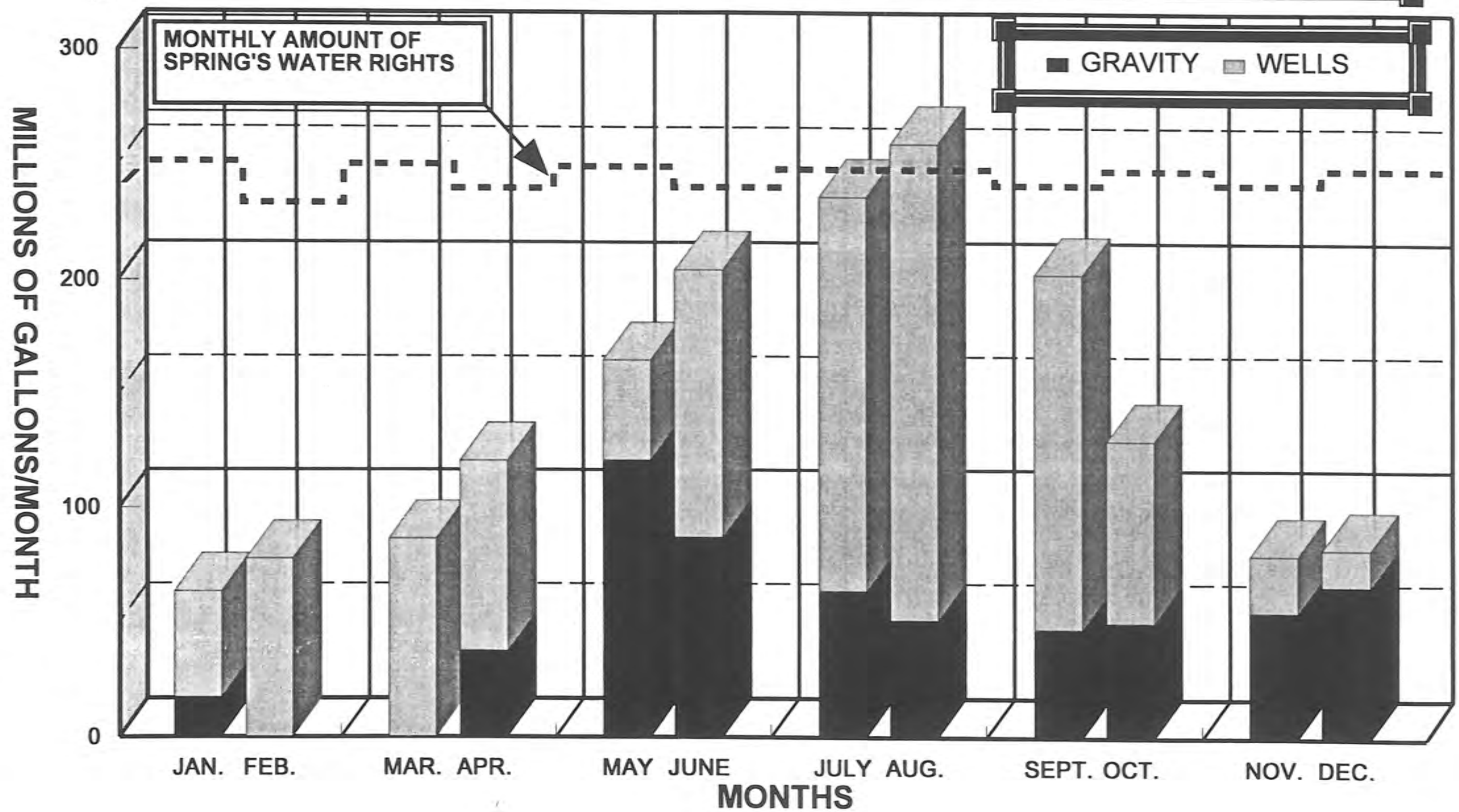

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TABLE II-11

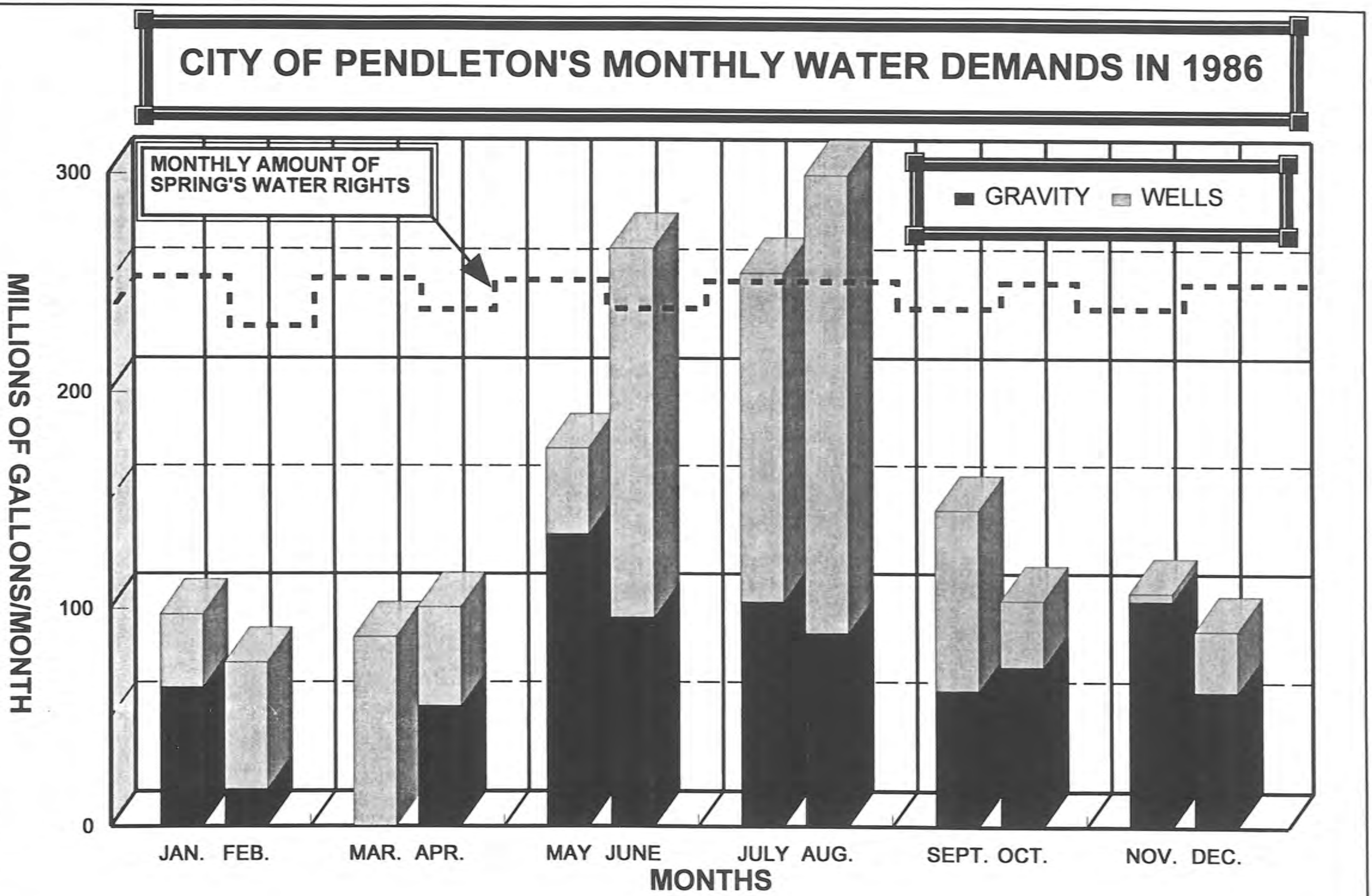
CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1986

IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	63.629	33.817	97.446		65.30	34.70
FEB.	16.851	58.366	75.217		22.40	77.60
MAR.	0.000	87.015	87.015		0.00	100.00
APR.	54.955	45.702	100.657		54.60	45.40
MAY	134.600	39.624	174.224		77.26	22.74
JUNE	96.062	170.539	266.601		36.03	63.97
JULY	103.300	152.152	255.452		40.44	59.56
AUG.	88.800	225.425	314.225		28.26	71.74
SEPT.	62.200	83.352	145.552		42.73	57.27
OCT.	73.209	30.629	103.838		70.50	29.50
NOV.	103.700	3.631	107.331		96.62	3.38
DEC.	61.654	28.338	89.992		68.51	31.49
YR. TOTAL	858.960	958.590	1,817.550	**YR. AVERAGE**	47.26	52.74
MAX. MO.	134.600	225.425	314.225	**MAX. MO.**	96.62	100.00
MIN. MO.	0.000	3.631	75.217	**MIN. MO.**	0.00	3.38

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max. month	4.487	7.272	10.136	COMBINATION OF SPRINGS & WELLS
Min. month	0.000	0.117	2.426	COMBINATION OF SPRINGS & WELLS



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The water demands for the year 1985 and the sources utilized, are shown in Table II-12, on page II-26 and graphically on the chart on page II-27. The springs should have been able to supply all of the City's water demands the first five months of year. During the months of January to May, the City's wells supplied 84%, 95%, 96%, 90% and 48% respectively.

The water demands for the year 1984 and the sources utilized, are shown in Table II-13, on page II-28 and graphically on the chart on page II-29. The springs should have been able to supply all of the City's water demands the first five months of year and the month of December. During the months of January to May, the City's wells supplied 96%, 100%, 98%, 63% and 33% respectively, plus 100% in December.

The water demands for the year 1983 and the sources utilized, are shown in Table II-14, on page II-30 and graphically on the chart on page II-31. The springs should have been able to supply all of the City's water demands the first four months of year. During the months of January to April, the City's wells supplied 100%, 100%, 100% and 64% respectively.

The water demands for the year 1982 and the sources utilized, are shown in Table II-15, on page II-32 and graphically on the chart on page II-33. The springs should have been able to supply all of the City's water demands the first four months of year. During the months of January to April, the City's wells supplied 83%, 95%, 72% and 41% respectively.

Even a cursory review of the these eleven charts (years), shows that there were several months that **turbidity either severely limited or completely prevented the use of the spring sources**. Over these eleven years, the City's deep well sources were required every month to augment the spring sources. This pumping placed a stress on the underlying water table and prevented them from stabilizing long enough to get an accurate static determination of the water table level.

Annual peak summer water demands vary considerably from year to year. The climate each summer creates varying irrigation demands, and this is the principal cause of the variations in summer demands. During unusually long and cold winters, several customers leave some of their taps running to avoid freezing and bursting of water pipes. These are two of the principal reasons for changes in the annual water demands. During population growth periods, additional water demand is generated as new homes are built and lawns are being established.

To be prepared for an event such as a: major fire conflagration; the accidental breaking of a major distribution/transmission water line; power outages disabling the well sources; etc., the City has, and continues to bring a sufficient amount of water from the springs to keep the City's reservoirs full with some overflow out of the South Hill Reservoir(s). Depending on the quantity of water and which of the springs are involved, the transport time can be as much as 12 hours. Prudent management dictates the continuance of the practice of utilizing and transporting all the usable water available from the spring sources.

TABLE II-12

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1985

IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	14.101	71.508	85.609		16.47	83.53
FEB.	4.281	78.158	82.439		5.19	94.81
MAR.	3.612	86.563	90.175		4.01	95.99
APR.	9.200	85.672	94.872		9.70	90.30
MAY	70.100	63.509	133.609		52.47	47.53
JUNE	100.032	117.740	217.772		45.93	54.07
JULY	60.900	236.093	296.993		20.51	79.49
AUG.	32.722	197.843	230.565		14.19	85.81
SEPT.	31.188	99.191	130.379		23.92	76.08
OCT.	37.381	50.960	88.341		42.31	57.69
NOV.	74.943	5.654	80.597		92.98	7.02
DEC.	81.000	19.451	100.451		80.64	19.36
YR. TOTAL	519.460	1,112.342	1,631.802	**YR. AVERAGE**	31.83	68.17
MAX. MO.	100.032	236.093	296.993	**MAX. MO.**	92.98	95.99
MIN. MO.	3.612	5.654	80.597	**MIN. MO.**	4.01	7.02

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max. month	3.334	7.616	9.580	COMBINATION OF SPRINGS & WELLS
Min. month	0.129	0.182	2.600	COMBINATION OF SPRINGS & WELLS

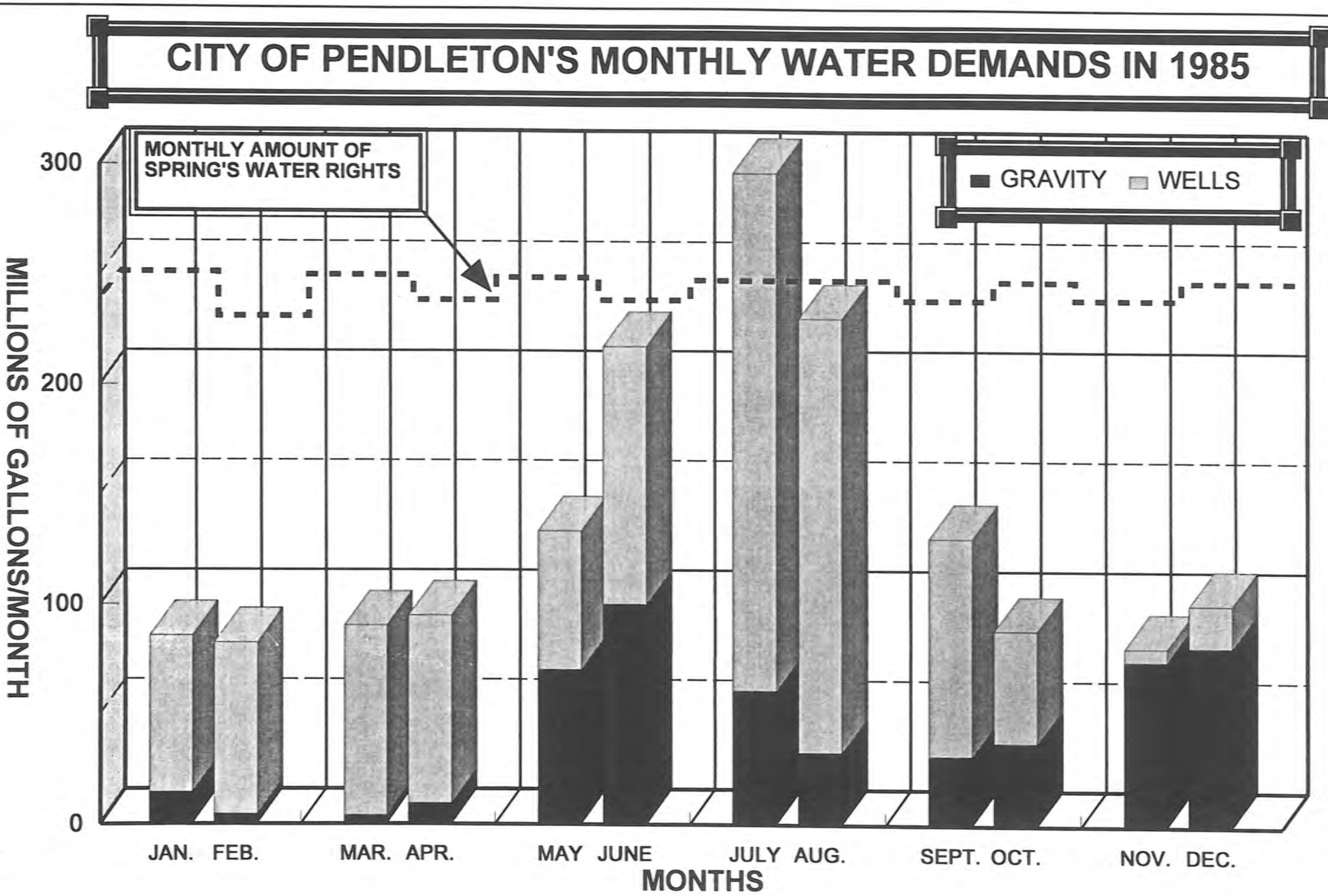

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TABLE II-13

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1984

IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	3.800	89.600	93.400		4.07	95.93
FEB.	0.000	83.108	83.108		0.00	100.00
MAR.	1.771	86.066	87.837		2.02	97.98
APR.	30.277	52.084	82.361		36.76	63.24
MAY	77.579	38.079	115.658		67.08	32.92
JUNE	136.942	28.722	165.664		82.66	17.34
JULY	95.009	159.947	254.956		37.26	62.74
AUG.	66.893	181.214	248.107		26.96	73.04
SEPT.	64.630	54.882	119.512		54.08	45.92
OCT.	69.300	22.756	92.056		75.28	24.72
NOV.	86.587	13.529	100.116		86.49	13.51
DEC.	0.000	81.636	81.636		0.00	100.00
YR. TOTAL	632.788	891.623	1,524.411	**YR. AVERAGE**	41.51	58.49
MAX. MO.	136.942	181.214	254.956	**MAX. MO.**	86.49	100.00
MIN. MO.	0.000	13.529	81.636	**MIN. MO.**	0.00	13.51

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max. month	4.565	5.846	8.224	COMBINATION OF SPRINGS & WELLS
Min. month	0.000	0.436	2.633	COMBINATION OF SPRINGS & WELLS

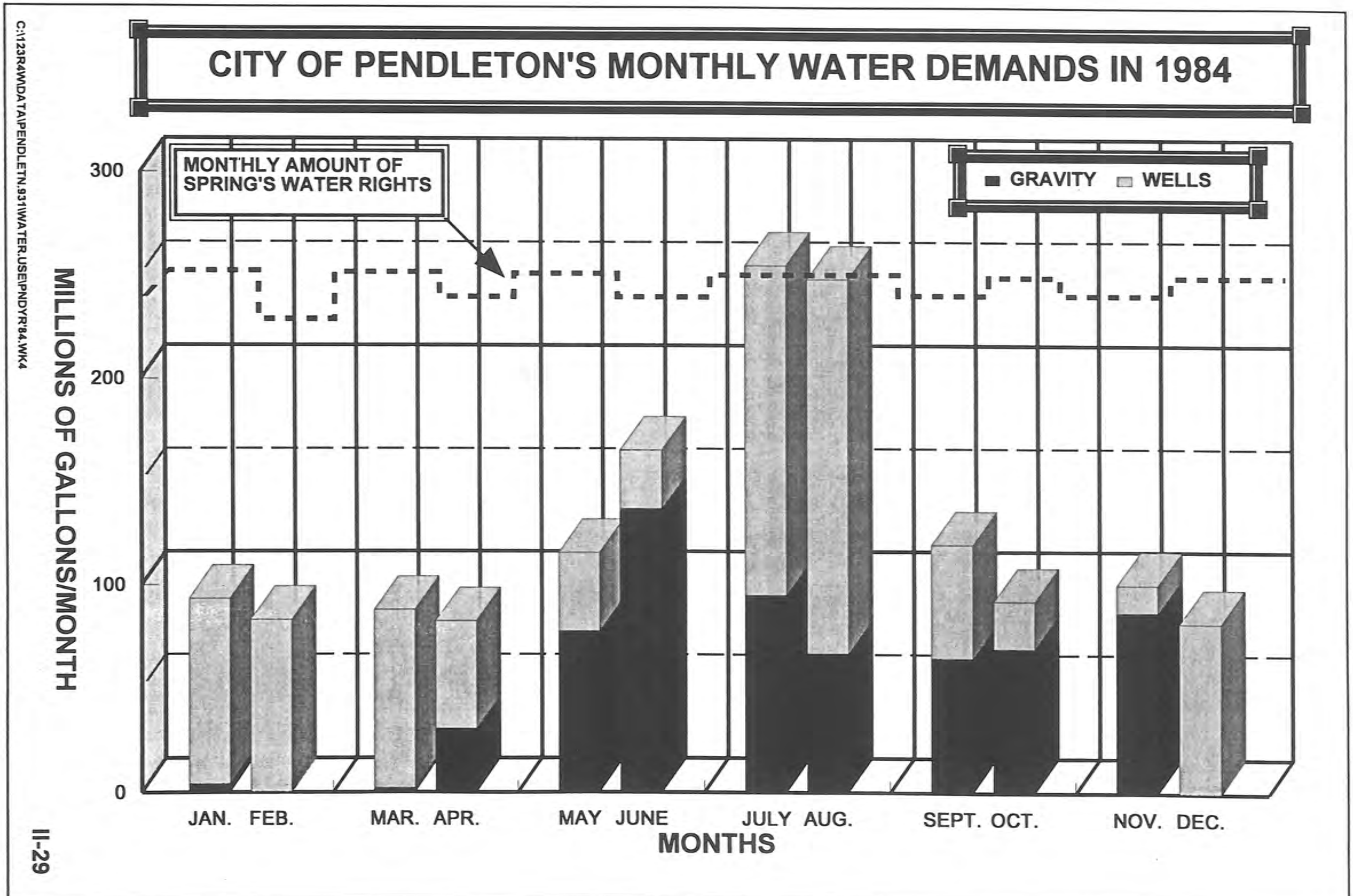
CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1984
MONTHLY AMOUNT OF SPRING'S WATER RIGHTS
GRAVITY
WELLS
MILLIONS OF GALLONS/MONTH
300
200
100
0
JAN. FEB.
MAR. APR.
MAY JUNE
JULY AUG.
SEPT. OCT.
NOV. DEC.
MONTHS
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TABLE II-14

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1983

IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	0.000	84.609	84.609		0.00	100.00
FEB.	0.000	70.765	70.765		0.00	100.00
MAR.	0.000	84.254	84.254		0.00	100.00
APR.	34.450	61.049	95.499		36.07	63.93
MAY	111.876	45.596	157.472		71.05	28.95
JUNE	108.245	69.825	178.070		60.79	39.21
JULY	85.725	118.778	204.503		41.92	58.08
AUG.	62.918	159.161	222.079		28.33	71.67
SEPT.	62.657	84.082	146.739		42.70	57.30
OCT.	63.660	38.538	102.198		62.29	37.71
NOV.	80.388	12.743	93.131		86.32	13.68
DEC.	61.348	45.292	106.640		57.53	42.47
YR. TOTAL	671.267	874.692	1,545.959	**YR. AVERAGE**	43.42	56.58
MAX. MO.	111.876	159.161	222.079	**MAX. MO.**	86.32	100.00
MIN. MO.	0.000	12.743	70.765	**MIN. MO.**	0.00	13.68

AVERAGE DAY--- MAXIMUM AND MINIMUM MONTHS:

Max. month	3.729	5.134	7.164	COMBINATION OF SPRINGS & WELLS
Min. month	0.000	0.411	2.283	COMBINATION OF SPRINGS & WELLS

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CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1983

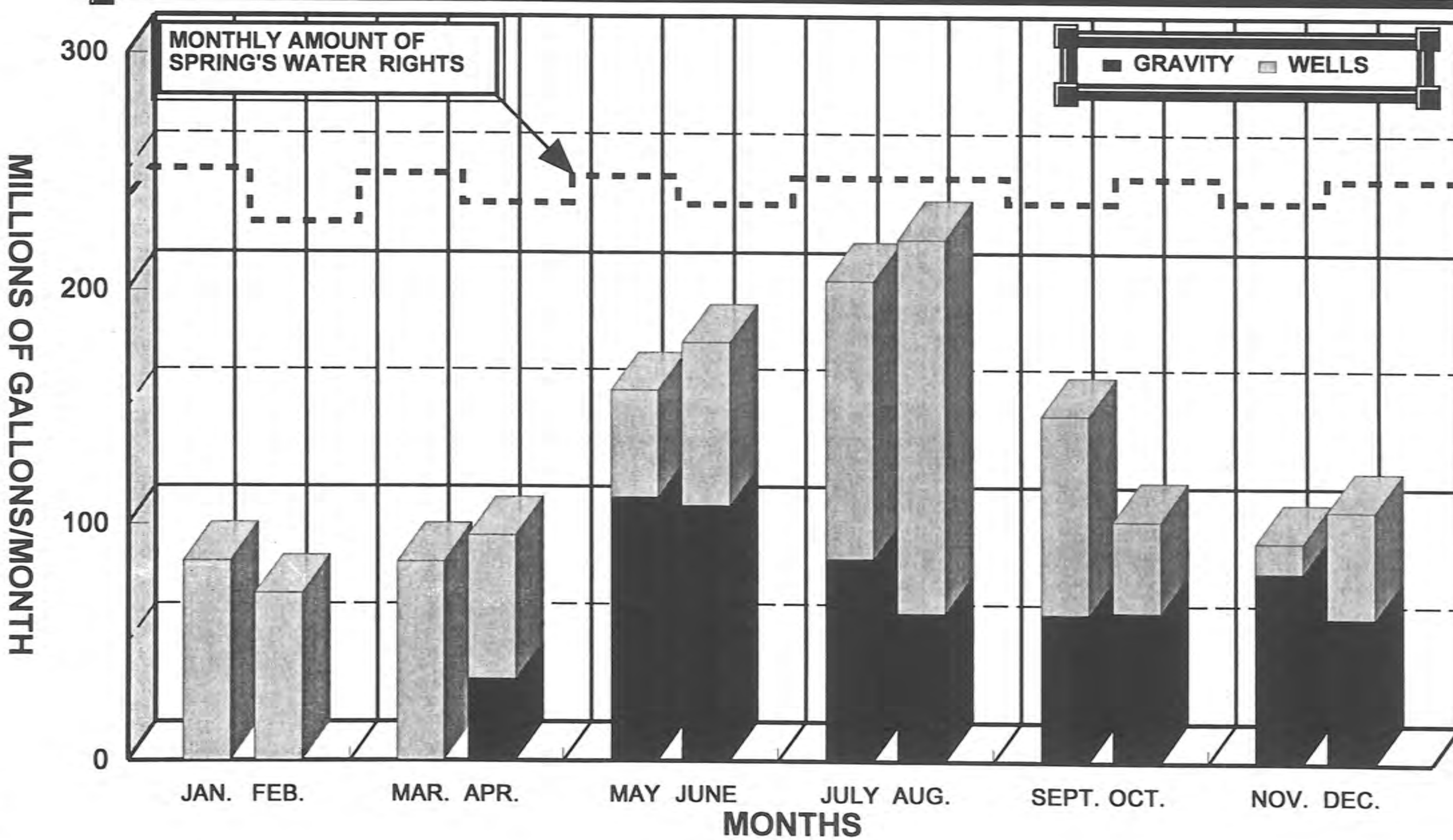


TABLE II-15

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1982

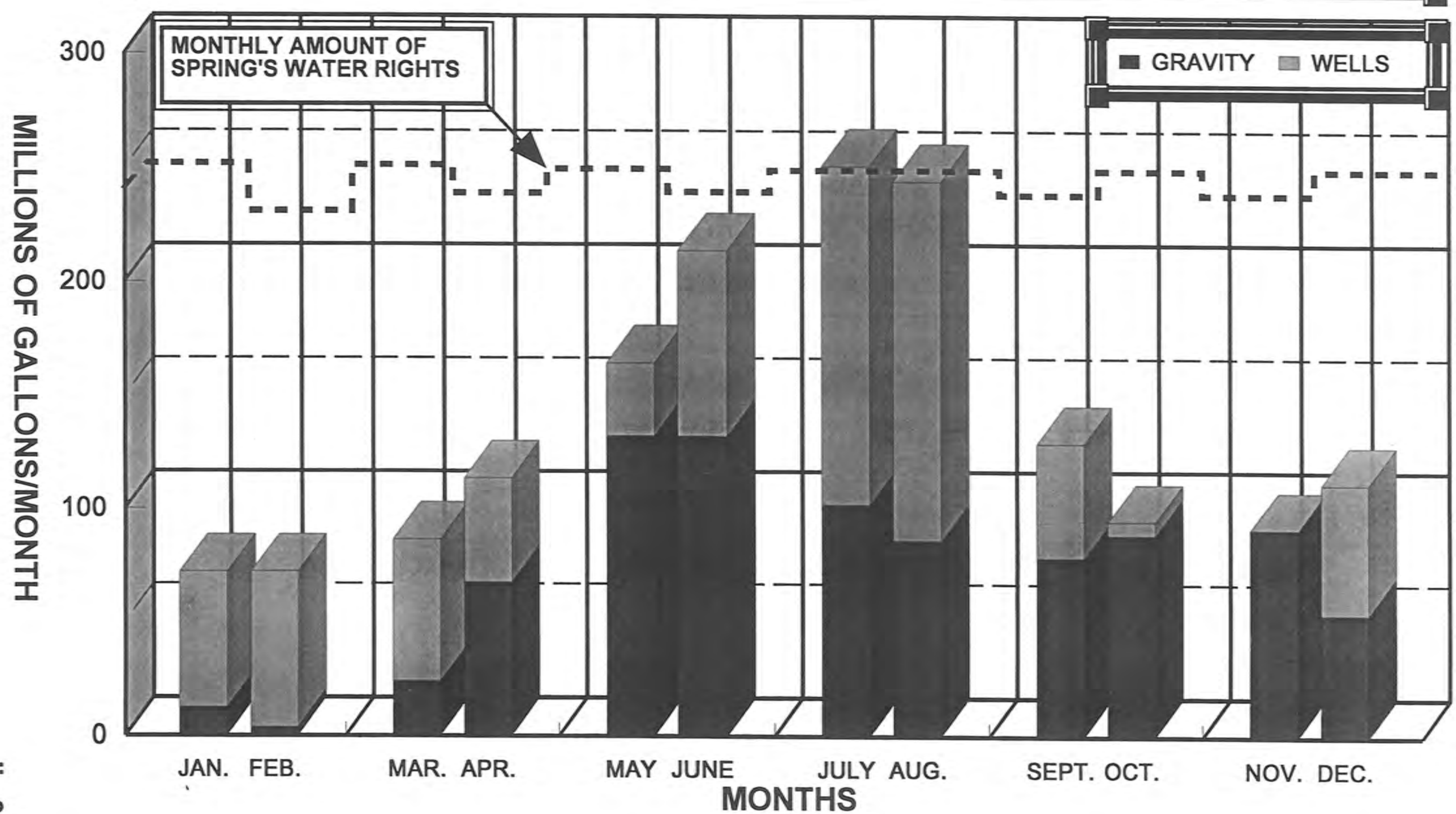
IN MILLIONS OF GALLONS PER MONTH

MONTH	SPRINGS GRAVITY	DEEP WELLS	TOTAL		% SPRINGS	% WELLS
JAN.	12.410	59.428	71.838		17.27	82.73
FEB.	3.710	68.219	71.929		5.16	94.84
MAR.	23.919	62.481	86.400		27.68	72.32
APR.	67.461	46.133	113.594		59.39	40.61
MAY	132.477	31.797	164.274		80.64	19.36
JUNE	132.338	81.504	213.842		61.89	38.11
JULY	101.966	149.074	251.040		40.62	59.38
AUG.	85.951	158.352	244.303		35.18	64.82
SEPT.	78.577	50.615	129.192		60.82	39.18
OCT.	88.550	6.074	94.624		93.58	6.42
NOV.	91.140	0.000	91.140		100.00	0.00
DEC.	53.712	57.633	111.345		48.24	51.76
YR. TOTAL	872.211	771.310	1,643.521	**YR. AVERAGE**	53.07	46.93
MAX. MO.	132.477	158.352	251.040	**MAX. MO.**	100.00	94.84
MIN. MO.	3.710	0.000	71.838	**MIN. MO.**	5.16	0.00

AVERAGE DAY---MAXIMUM AND MINIMUM MONTHS:

Max. month	4.416	5.108	8.098	COMBINATION OF SPRINGS & WELLS
Min. month	0.133	0.000	2.317	COMBINATION OF SPRINGS & WELLS

CITY OF PENDLETON'S MONTHLY WATER DEMANDS IN 1982



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E. WATER DEMANDS

The per capita average daily use is 307.5 gallons/per day/person on an annual basis (see Table II-3, page II-6) includes some water from the springs that has been bypassed around the South Hill Reservoir(s) overflow weirs (1 on east and west sides). A Supervisory Control and Data Acquisition (SCADA) system was installed in the fall of 1993 which includes the software, hardware and telemetry capability to monitor and meter the amount of water bypassed to the Umatilla River. There still needs to be a small software program developed based on actual height of water over the weirs and the amount of flow being bypassed.

The Fire Department made a review of the areas that they felt were deficient in the distribution system. Based on this review, the Fire Department recommended the addition of some hydrants and additional supply piping improvements. A careful check with Jerry Odman, Public Works Director, revealed almost without exception, the improvements recommended by the Fire Department were not the responsibility of the City Water Department, but the entity served by the City; i.e. Pendleton Junior High, Pendleton Senior High, Harris Pine Mills area, Colby Plastics, Pendleton Grain Growers, Pioneer Implement, Grecian Heights, PP&L's substation, Sherwood School, Shady View Trailer Park, Blue Mountain College, etc.

The Insurance Services Office (ISO) conducted a survey in the winter of 1992 of the City's water distribution system and the fire fighting capabilities of the Fire Department for the purpose of establishing fire insurance rates for the City. As in past surveys by the ISO, the water distribution system again received a favorable rating.

The 1979 Water Study excerpted from the ISO publication "Guide for Determination of Required Fire Flow" and a new "Grading Schedule for Municipal Fire Protection". Rather than repeat this information again, those in need of such information can obtain the same from the earlier study or from the ISO.

F. RECENT MAJOR IMPROVEMENTS TO THE WATER SYSTEM

In the last few years, the City has constructed several major improvements to the water system. All of these improvements were funded by a sinking fund established following the 1979 Water Study. The improvements funded solely by this sinking fund included:

1. The addition of a 1.15 million gallon reservoir to service the southwest area,

2. An additional 0.5 million gallon reservoir at the airport,

3. The re-coating of the existing 0.5 million gallon reservoir at the airport,

4. Construction of a high pressure transmission intertie line from the central interchange to the southwest area,

5. A pressure reducing station to maintain pressures in the Tutuilla valley floor,

F. RECENT MAJOR IMPROVEMENTS TO THE WATER SYSTEM (Cont.)

6. A new larger booster station to serve the south and southwest areas,

7. The installation of a SCADA system which via remote telemetry receives and transmits data via radio frequencies. The SCADA system provides supervisory control and analysis of data to automate the operation of the total system (springs, wells, reservoirs, pump stations) plus an alarm status at the wastewater treatment plant.

In addition to the above improvements, design and contract documents are currently being prepared for the re-lining of the South Hills two 1.0 million gallon reservoirs, and the North Hill 1.0 million gallon reservoir. The above improvements have significantly improved the water distribution system since the 1979 Water Study[1]. A computer analysis of the water distribution system will not be required until there is a major planned expansion of the water system.

G. FUTURE MAJOR IMPROVEMENTS DRIVEN BY POPULATION GROWTH

It is difficult to determine in advance when and which area of the City will be impacted first by population growth. Likewise the rate of population growth in the future can not be predicted with any degree of certainty. All the individual elements of a water utility are capital intensive and the wisest investments are made when the needs are well defined i.e. water transmission lines to service one of the four growth areas. Based on the population projections in Table II-1, the anticipated additional population growth in the future years are as shown in Table II-16 below.

TABLE II-16

YEAR	LOW POPULATION PROJECTION	MEDIUM POPULATION PROJECTION	HIGH POPULATION PROJECTION
2,000	1,025 = + 6.7%	2,875 = +18.7%	4,725 = +30.7%
2,010	2,445 = +15.9%	4,295 = +27.9%	6,145 = +39.9%
2,020	3,865 = +25.1%	5,715 = +37.1%	7,565 = +49.1%

Instead of extending water lines into the four possible growth areas, this Firm recommends that the City develop a sinking fund for the express purpose of providing a pool of cash for this future need. This approach places the City in a posture to immediately respond to a need and avoids the delay of having to obtain a vote of the electorate to sell bonds, selling the bonds and incurring the costs of selling bonds plus the debt service. This approach assures that the physical improvements are neither under or over sized maximizing the City's return on it's investment. Maintaining a sinking fund sufficient to construct the equivalent of 2,000 feet of a 16" diameter transmission line should be adequate to meet future of needs.

1 Water Study for the City of Pendleton, Oregon. Wallulis and Associates, Inc. September 1979

Development and treatment of water sources, whenever possible and practical, should be added incrementally with some margin for future growth. A significant economic benefit is derived as the capacity of treatment facility approaches a constant annual production capacity. Both the initial capital investment and the operational costs are substantially reduced as the constant annual production capacity approaches uniformity. Constant uniform production capacity is one of the principal advantages of a successful Artificial Recharge and Recovery (ARR) program by storing surplus water in the underlying basalt aquifers in the months of low water demand.

Existing water sources were unable to meet the water demands in 1992. To meet current water demands the City needs to improve production capacity from one or more of the following alternatives: existing sources; develop additional water sources; encourage conservation; and/or treatment of the spring sources to gain agency approval for the implementation of an ARR program.

We recommend a design population of 20,000 persons for the design of a water treatment plan. With the implementation of a successful ARR program, the actual production capacity of the treatment plant facility could be considerably less (no peak demands). An effective conservation plan can also reduce the size requirements of a water treatment facility. This design approach would be sufficient to meet the water demands of the City to:

- The year 2,000 for the high population projection,
- The year 2,010 for the medium population projection, and
- The year 2,020 for the low population projection.

CHAPTER III -- MASSIVE WATER STORAGE

A. MASSIVE STORAGE OPTIONS

There are two basic ways to store massive amounts of water to meet a one year seasonal peak water demand, or for multiple years.

- The historic method has been to construct an above ground dam over a stream and capture the majority of the water for later release. A variant of this is to construct a diversion structure at the stream and to channel portions of the stream flow to a dam site away from the stream channel. This method is normally limited to meeting a seasonal water demand for one year.

- The second method is the artificial injecting of water into subsurface aquifers for later withdrawal by pumping from a well. This method is referred to throughout this report as Artificial Recharge and Recovery (**ARR**). ARR is presently being implemented on an experimental basis at several locations. This method of storage can provide the seasonal peaking demand requirements for several years.

It is also noteworthy that the state has for several years referred to the water in the underlying Columbia River basalt aquifers, as a reservoir instead of basalt aquifers. <u>We will also refer to the water in the underlying basalt as being both in a reservoir and/or in basalt aquifers (synonymous)</u>.

A brief comparison of the attributes of these two mass storage alternatives are:

CONSTRUCTED STORAGE	NATURAL STORAGE - ARR
<u>LEAKAGE:</u> Varies with type of construction and site specific conditions.	<u>LEAKAGE</u>: Carbon dating of the water in the basalt aquifers in the Umatilla Basin indicate the water transport velocity at about 5 feet per year. This indicates the leakage of injected water away from the area should be a small percentage. The Salem, Oregon ARR Project when discontinued, documented: a 64.4% recovery rate, an increase in the water table elevation of 10', and increased the wells productivity by 20%.This was in a geological formation that appears to be less favorable than the Pendleton area with the Reith anticline to the west of the City.
<u>EVAPORATION:</u> Dependent on surface area and climate at the locale.	<u>EVAPORATION:</u> Zero loss.

CONSTRUCTED STORAGE	NATURAL STORAGE - ARR
SILTATION: Varies with watershed characteristics, i.e. Cold Springs Reservoir has lost 23% of it's storage capacity because of siltation and is projected to be 50% silted in by the year 2050[1].	SILTATION: With clean recharge water, this should be zero. If sediments from the pipelines become dislodged and are carried with the artificial recharge water, they can be removed by pumping to waste during the withdrawal cycle.
Another impoundment between Pendleton and Echo completely silted up in a very few years. The remnants of this dam are probably still there today.	At the Salem ARR Project which had considerable amounts of sediment, 3% of the water injected was utilized for periodic surge pumping to eject the sediment.
WATER QUALITY: Currently the State[1] will require future impoundments to be multipurpose and include provisions for municipal, fish, wildlife, and recreation. These required provisions place the quality of the stored water at risk for human consumption. Water quality will vary with site specific conditions (i.e. boating, fishing, swimming, etc.) and the type of construction.	WATER QUALITY: Water withdrawn from the areas deep wells have been age dated to be several 1,000's (up to 30,000) of years old.
The stored water is also subject to contamination from wild and farm animals that would populate the watershed. Some of the diseases that have been transferred to municipal customers include: Yersinia, Giardia and Cryptosporidium.	Possessing exceptional quality the water from the municipal deep wells in the area are exempt from conventional treatment. The water that would be injected into the deep wells would be required to be of equal or better quality. This storage has a very limited exposure to the introduction of contamination (via deep wells). It appears to offer unequaled advantages for the long term storage of a potable water for subsequent reuse.
STORAGE CAPACITY: Usually, the amount of storage constructed is equal to the maximum seasonal demand within the projected design period.	STORAGE CAPACITY: The immensity of the available storage in the underlying basalt aquifers defies qauntification. **The City's deep wells are a very small percentage of the number of wells penetrating the basalt aquifers in the sub-basin receiving natural recharge.**
With recent State mandates[1], however, additional indirect benefits for others (i.e. fish, wildlife and recreation) are now required. These requirements adversely effect the cost/benefit ratio of constructing an impoundment for any single purpose.	The City records since 1952 document that enough water has been withdrawn to fill a canal 100 yards wide, eight feet (8') deep from Pendleton to Portland. This is discussed in more detail in this Chapter.

1 Page 143. Umatilla Basin Report, Oregon Water Resources Department. August 1988.

CONSTRUCTED STORAGE	NATURAL STORAGE - ARR
MAINTENANCE: Varies with the type of structure constructed and on: size, geometry, algae control, and seasonal management during the recreational period.	MAINTENANCE: None, except for possible periodic surge pumping if sediments are allowed to enter the deep wells.
STRUCTURAL LIABILITY: Potential failure from: earthquake; landslides displacing the water in the dam; and/or an unusual amount of rainfall and a massive snow melt which when combined can top the structure. These events present risks of downstream damage to life and property.	STRUCTURAL LIABILITY: Earthquake may miss align or collapse material around the borehole of the well. This event could require the re-drilling or the drilling of a new well. Risk of property damage is minimal and limited to the well house.

B. AREA GEOLOGY - GENERAL

"One of the largest accumulations of basaltic rock in the world is located in the northwestern United States in the region known as the Columbia River Plateau."[1] The basaltic aquifers have provided a large reservoir of water that has been utilized for municipal, industrial, agricultural and domestic purposes.

Several geological studies and papers have been prepared on the geology of the Columbia River basin. **It is of the utmost importance** to know that there are several differing opinions in this particular professional field. Most all of the information is generated from records of well logs. The experience of those who entered data on the well logs varied from apprentices to well drillers with several years of experience. Because of economics, most of the data recorded was by laborers without any background in geology. It is indeed rare that when a well is drilled, a geologist is on site to collect representative samples, catalog and store them, and prepare an accurate log. Then there is always the consideration that some wells permit the flow from the upper aquifers into the lower aquifers and vice versa.

There is also a considerable amount of different interpretations of the same data which leads to conflicting professional positions. It is not unusual, when provided with additional information, for professionals to revise their previous positions taken on a geological area. For example, some certified engineering geologists have changed their previous position that the center of the basalt flows in the Umatilla Basin were impervious, and now their position is that a considerable amount of water is leaking from the upper aquifers to the lower aquifers. Others adamantly maintain that the center of the basalt flows are completely impervious. Professionals in this field have and will continue to modify their previous reports, nomenclature and geologic maps as they find more data. This can easily be verified by comparing early reports by the U.S. Geological Survey Reports, other federal and state agencies, plus private firms with the most recent reports, maps, etc.

1 Groundwater, R. Allen Freeze and John A. Cherry, 1979. Publisher, Prentice-Hall, Inc. Englewood Cliffs, N.J. 07632

In the immediate Pendleton area, there have been several instances of homeowners on small tracts (down to 1/2 acre) that have had their original well go dry, drill a new well a few feet away and obtain a producing well. The City after securing prior advice on where to drill wells, drilled wells #3, #6, #7, & #11 which produced far less yield than the expectations. Re-stated, four out of the seven wells (57%) commissioned by the City for drilling are poor or marginal producers.

Recently the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), drilled two wells 1,100' and 1,057' deep, #3 & #4 respectively. These two appear to be excellent artesian producing wells (see the Geological Base Map, Plate 4 on page V-8 in Chapter V).

The CTUIR wells have not been in service or pumped long enough to know if these wells will be able to sustain their yield. Some wells, in eastern Oregon, have had similar promising initial yields and then experienced a rapid dropping water table.

A review of the geological reports encompassing the area around Pendleton, document that there are a multitude of wells at various depths in the watershed upgradient from Pendleton. These wells have the first opportunity to intercept the water naturally being recharged from the Blue Mountains before reaching the Pendleton area. **It is entirely possible that if the City of Pendleton ceased use of all it's deep wells, that the water table in the deep wells would continue to drop.**

In summation, there is no assurance that a well drilled anywhere will meet the expectations. The Pendleton area geology is discussed in more detail in Chapter V.

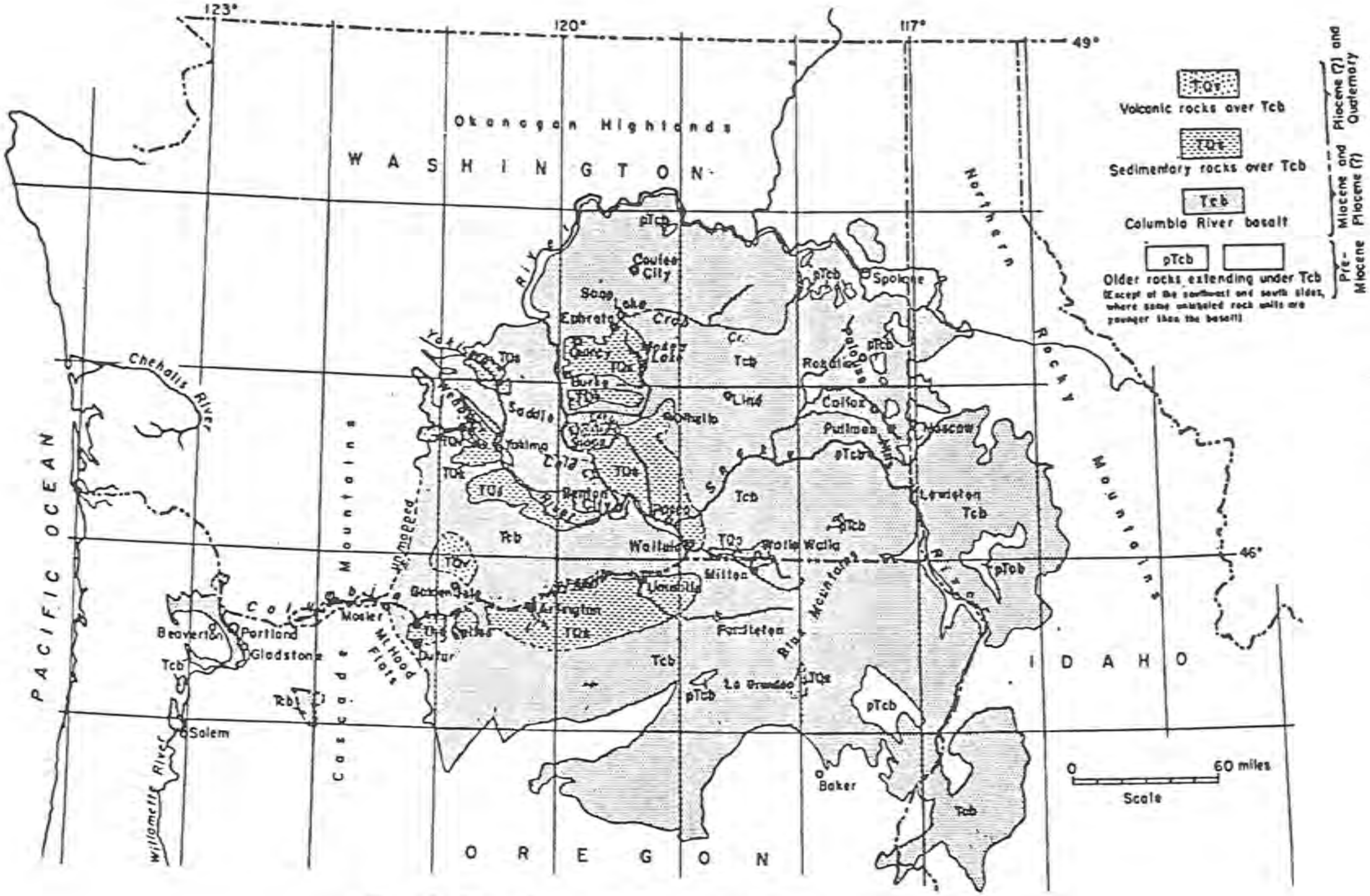
B.1 COLUMBIA RIVER BASALTIC LAVA FLOWS

The Columbia River basaltic lava flow encompass a broad area over three states covering approximately 50,000 square miles as shown on the map on page III-5.

The depth of the lava flows varies considerably and is known to be in the central part of the flow as much as 5,000 feet thick. The total thickness of the basalt is the result of a series of individual sequential flows of lava ranging from 5 to 150 feet thick.

The basalt in the Umatilla River basin, which covers some 2,700 square miles, either underlies the surface at a shallow depth or crops out above the surface. Individual lava flows have been identified for distances up to ten miles in the immediate area and a total combined thickness ranging from zero to more than 2,500 feet.

The top of each lava flow cooled more rapidly than the lower portion of each individual flow. This resulted in the entrapping of gasses in the upper portion of each individual flow, leaving behind honey combed sponge like layers of rock, which along with vertical cooling joints (contraction of rock) provide the means for ground water to travel over great distances. Unfortunately, successive lava flows often completely "melted" this "honey combed" layer, interrupting the ability of ground water to follow predictable routes.



Map of the main area of the Columbia River basalt

REPRODUCED FROM: "Hydrology of Volcanic-Rock Terranes", a Geological Survey Professional Paper 383-A, by R.C. Newcomb. U.S. Government Printing Office, Washington: 1961

SHEET 1 OF 1	COLUMBIA RIVER BASALT FLOWS: OREGON, WASHINGTON & IDAHO

N

Subsequent to the issuing of lava over this large land area, the earths surface in these areas underwent subsidence and up-lift. Deep layers of lava rock have a considerable bending property and, to a significant degree, react to applied forces similar to more pliable materials.

When the bending stresses of lava rock were exceeded, both the vertical and horizontal shearing of the rock occurred. Along these shearing lines, the forces were of such magnitude that the rock interfaces were ground into a homogeneous mass of fine lava and coarse rubble. This resulted in the decomposition of lava along the shear lines into impermeable zones (faults) or subsurface dams.

The identification of a particular subsurface water bearing (hydrologic) boundary requires a significantly more extensive geologic study than is currently available for the immediate study area. This report, however, adequately documents that the amount of water withdrawn in the vicinity of Pendleton has exceeded the amount of annual natural recharge.

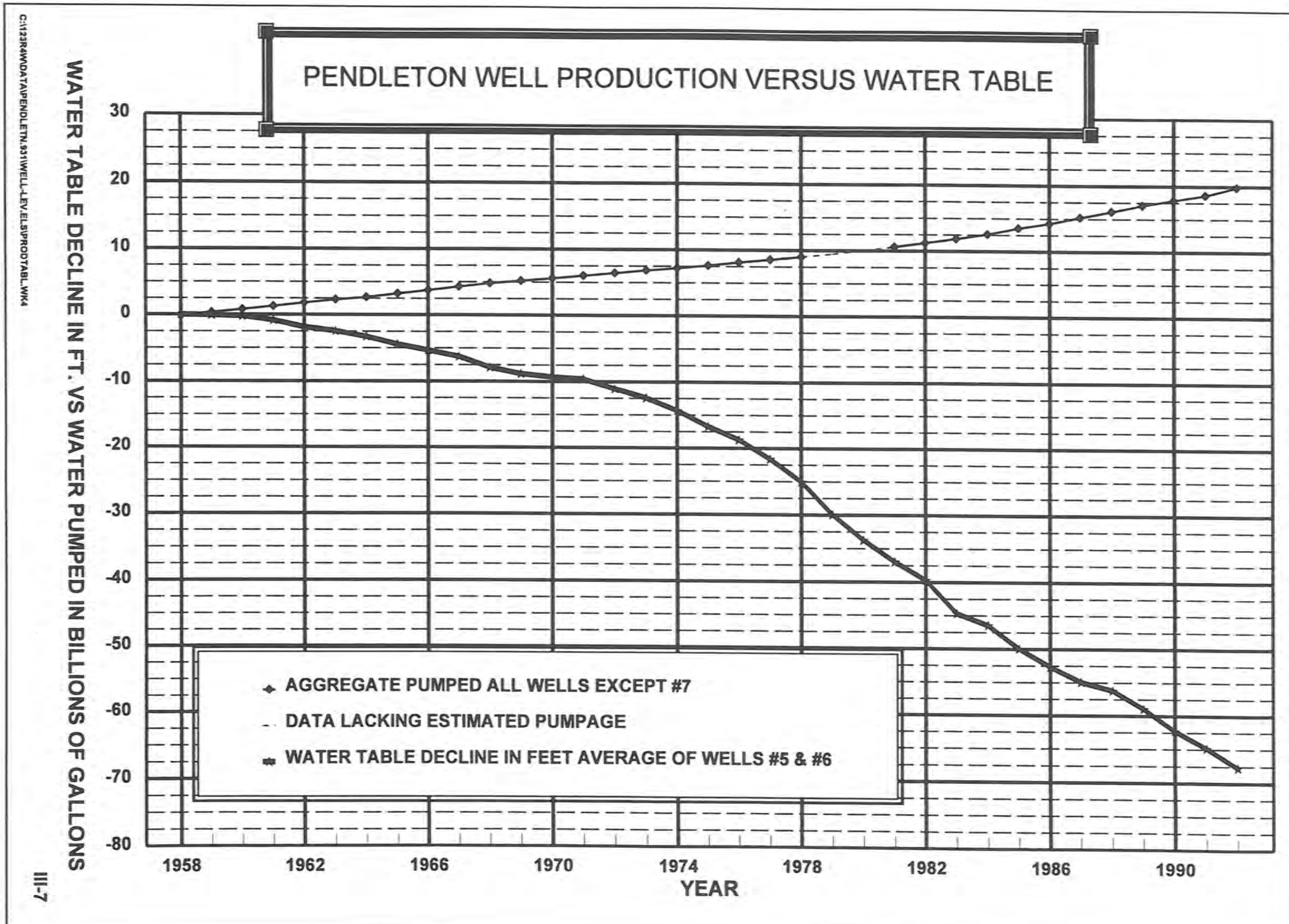
The City is but one of several entities withdrawing water from the underlying basalt aquifers. The City's first well was drilled in 1946. The records of the water table levels of the deep wells from 1946 to 1952 have been lost and were not available for this report.

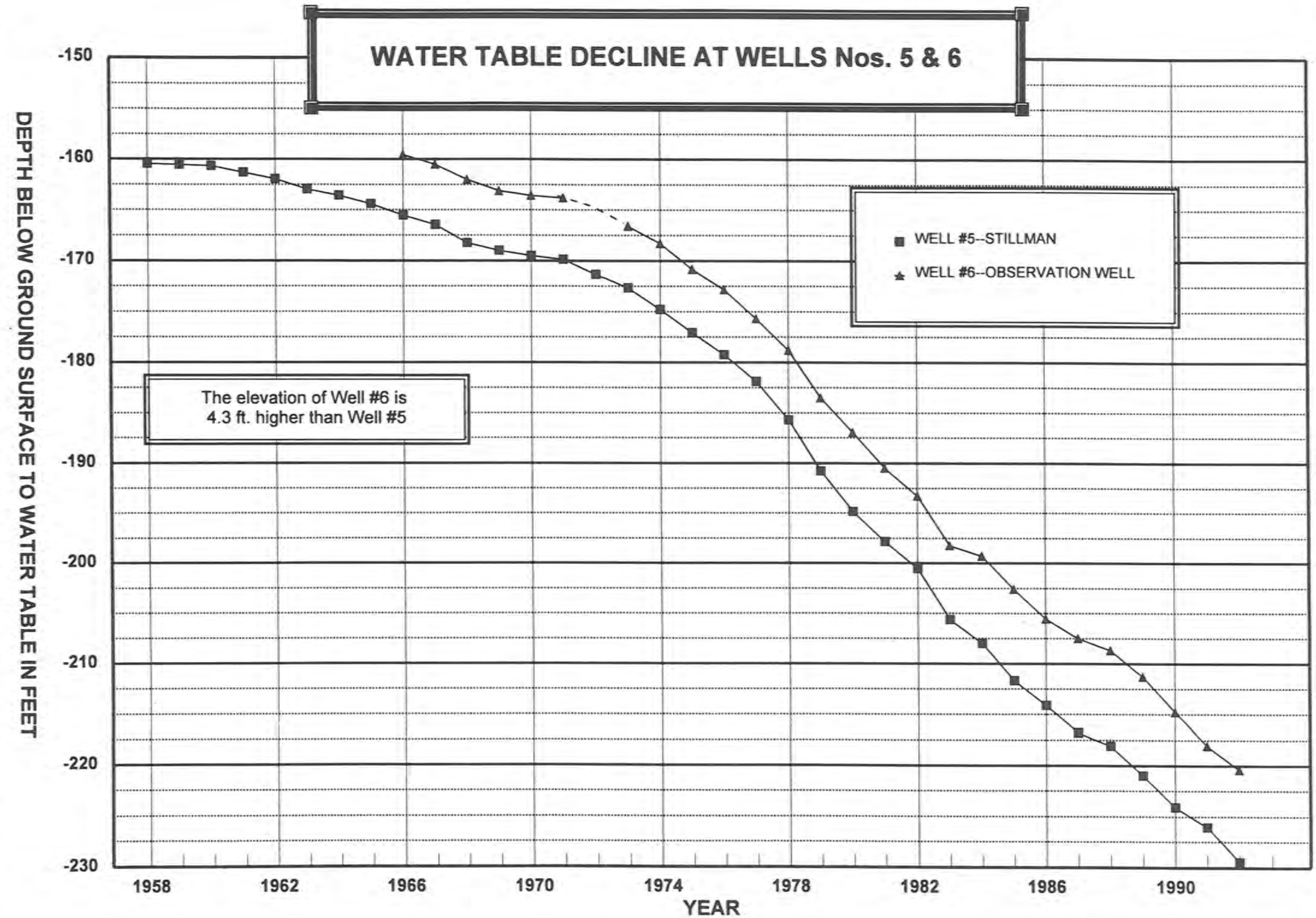
The amount of water the City has withdrawn from it's wells (except Well #7) in the underlying basalt aquifers from 1953 to 1992 is 19.817 billion gallons of water (estimated quantities 1989-91 incl.), or 60,819 acre feet. Based on age dating of the water in the 1979 Water Study[1], the majority of the water came from stored old water (2,570 years +/- 135 years) versus natural recharge with modern water. The graph on page III-7 depicts the effect of the depletion of the water in the underground basalt aquifers by the lowering of the water table from 1959 -1992, versus the metered amount of pumpage. The period from 1953 to 1958 is not shown, because of lack of data on the well water table elevations.

Well #7 is excluded, because it is situated approximately 7 miles east of the geometric center of the other City wells (see Chapter I, page I-4). The original static elevation of this well when drilled in 1966 was 1' below the surface. Currently the static water table level is 60' below the surface for a decline of 59'. Factors responsible for the lesser rate of decline are probably the diminished use in recent years and the reduction in yield available from this well.

On page III-8, a graph shows the individual declines in the water table levels at City Wells #5 and #6. These two wells provide the best available historical documentation on the decline of the water table in the reservoir underlying the City. The recorded elevation of the ground levels for Wells #5 and #6, from which the measurements are made are 1,070.73' and 1,075' M.S.L. respectively. A Supervisory Control and Data Acquisition (SCADA) system is now continuously monitoring the water table levels at all of the City's production wells.

[1] Appendix A-10, Water Study for the City of Pendleton, Oregon. Wallulis and Associates, Incorporated. September 1979.


PENDLETON WELL PRODUCTION VERSUS WATER TABLE
WATER TABLE DECLINE IN FT. VS WATER PUMPED IN BILLIONS OF GALLONS
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1958
1962
1966
1970
1974
1978
1982
1986
1990
YEAR
AGGREGATE PUMPED ALL WELLS EXCEPT #7
DATA LACKING ESTIMATED PUMPAGE
WATER TABLE DECLINE IN FEET AVERAGE OF WELLS #5 & #6
C:\123R4W\DATA\PENDLETN.931\WELL-LEV.ELS\PRODTABL.WK4



C:\123R4\DATA\PENDLETN.93\WELL-LEV.ELS\PRODTABL.WK4

C. ARTIFICIAL RECHARGE'S (ARR) WATER RIGHT STANDING PAST AND PRESENT

In the prior 1979 Water Study[1], the status of an ARR water permit/right was discussed at some length. At that time, Oregon Water Resource Department's (OWRD) Administrative Rules (OAR) and the Oregon Revised Statutes (ORS) only permitted an ARR project that was documented to have an available surplus waste surface water source. Also the permits and water rights, at that time, were inferior and junior to all other rights. Under these rules, a recharge project could have been easily curtailed or terminated. These rules were also a substantial deterrent for anyone to make the substantial investment required to implement a project based on this concept.

The author of this report, with the support of the members of the Umatilla Sub-Basin Citizens Advisory Committee, convinced the OWRD staff and members of the Oregon Water Resources Commission (OWRC):

- That a successful artificial recharge program could be a valuable water management tool in water short areas,
- To elevate the status of this type of permit and water right to an equal standing as any other right, and
- Eliminate any special requirement on the source of the water (i.e. surface, waste, etc.). This permitted the Hermiston, Oregon ARR project to proceed, utilizing a shallow well as the source for recharging the deep wells.

The OAR rules and ORS statutes pertaining to ARR, now recognize and prominently mention ARR as an acceptable method of massive storage of water as will be seen in direct quotations in this report.

In the interim, the State has also adopted a non-degradation policy of all water injected underground. This is administered by the Oregon Department of Environmental Quality (DEQ).

D. SELECTED OWRD RULES PERTAINING TO ARR

Bold type added in this report to emphasize references that directly or indirectly apply to artificial recharge.

D.1 OREGON WATER DEPARTMENT ADMINISTRATIVE RULES (OAR)

690-11-010-(4) "Artificial groundwater recharge " means the intentional addition of water to a ground water reservoir by diversion from another source.

690-11-010-(37) "Recharge Permit" means a permit for the appropriation of water for the purpose of artificial ground water recharge.

1 "Water Study for the City of Pendleton, Oregon", September 1979. Wallulis and Associates, Inc.

690-11-010-(42) "Stored recharge water" means the retention or impoundment of surface or groundwater by artificial means for public or private uses and benefits.

690-11-010-(43) "Storage account" means a net volume of artificially recharged ground water which is calculated for a single recharge activity from a formula specified in a single recharge permit which records additions to a ground water reservoir by artificial recharge and depletions from a ground water reservoir by pumping and natural losses.

D.2 UMATILLA BASIN PROGRAM SELECTED OAR's

Chapter 690 - Division 570, Policies - 690-507-020 (5)

(5) Municipal water supplies, interstate cooperation in water management, instream needs, out-of-stream needs, water quality and watershed management are issues of concern in the Umatilla River Basin, it shall be the Commission policy to:

(a) Municipal water supply: in addressing the issue of municipal water supply in the Umatilla River Basin, it shall be the Commissions policy to:

(A) Assist cities with limited financial resources secure needed capital to develop, expand and improve municipal supplies.

(B) Promote and aid municipal water conservation and encourage cities to plan for water service emergencies.

(C) Encourage the use of artificial ground water recharge to supplement city ground water supplies and help reduce water level declines in the basalt ground water reservoir.

(D) Encourage and promote the concept of regional municipal water supply systems and preserve the options for proposed systems.

(E) Promote and support the purchase and transfer of water rights to municipal use.

(F) Promote the continued viability of municipal water systems reliant on the basalt ground water reservoir.

D.3 UPPER UMATILLA RIVER SUBBASIN (in it's entirety) 690-507-050

690-507-050 (1) Objectives: in developing a program for the management, use and control of the surface and ground water resources of the Upper Umatilla River subbasin, the Commission has the following objectives:

(a) Protect instream values by closing streams to future appropriations during the low-flow season and limiting future appropriations during the high-flow season to selected non-irrigation uses.

(b) Acknowledge the Confederated Tribes of the Umatilla Reservation have an unquantified claim to water and preserve the opportunity for the Tribes to store excess winter flows for Tribal use or purposes.

(c) Preserve the opportunity for future upstream storage for all beneficial uses.

(d) Promote municipal use of surface waters.

(e) Permit artificial ground water recharge to offset declining ground water levels and supplement existing ground water uses.

(f) Protect municipal ground water supplies.

(g) Prevent new appropriations from causing ground water/surface water interference.

(2) Surface Water: appropriation and use of surface water in the Upper Umatilla River subbasin shall comply with the following provisions:

(a) Subject to the rights existing on March 8, 1941, the waters of the North Fork Umatilla River and its tributaries were set aside by the Oregon Legislature for the exclusive use of the City of Pendleton, ORS 538.450. **Nothing in the statute prohibits the City of Pendleton from using the main stem Umatilla River to convey this water to the City.**

(b) The Upper Umatilla River and tributaries are withdrawn from further appropriation of unappropriated waters during the period June 1 through October 31 each year. The withdrawal does not apply to domestic, livestock. fish and wildlife uses or water released from storage. This action was taken by the Commission on December 2, 1985.

(c) Classification: permits to use surface water may be issued only for the following classified uses:

(A) **Natural flows** of the Upper Umatilla River and tributaries **are classified for** domestic, livestock, irrigation of noncommercial lawn and garden not to exceed 1/2 acre, municipal, industrial, power development (subject to the limitations of OAR Chapter 690, Division 51), mining (including sand and gravel mining), fish life, wildlife, recreation, pollution abatement, **artificial ground water recharge**, and public instream uses during period November 1 through May 31 each year. This classification rescinds the Commission's order of December 2, 1985, withdrawing the Umatilla River and tributaries from further appropriation from November 1 through May 31 each year until December 31, 1988.

(B) Until there is a final quantification of any reserved water rights of the Confederated Tribes of the Umatilla Indian Reservation, up to 75,000 acre feet of water in the Upper Umatilla River subbasin are classified for storage for the exclusive use of the Tribes. This classification applies to storage on or off the reservation in a single or multiple impoundments. Storage of this water is subject to the rights and priorities existing on June 24, 1988, and the withdrawal of the Umatilla River and tributaries from June 1 through October 31. All natural flow rights issued on the Umatilla River and its tributaries upstream from Pendleton and on the Umatilla main stem downstream from Pendleton after June 24, 1988, shall be subordinate to this classification. This classification shall be superior to the classification for storage contained in paragraph (C) of this subsection; and

(C) Subject to the rights and priorities existing on June 24, 1988, the withdrawal of the Umatilla River and tributaries from June 1 through October 31, and the 75,000 acre foot classification in paragraph (B) of this subsection up to 100,000 acre feet of annual yield if the Umatilla River above Pendleton are classified for all beneficial uses in conjunction with storage. All natural flow rights issued on the Umatilla River and its tributaries upstream from Pendleton and on the Umatilla main stem downstream from Pendleton after this date shall be subordinate to this classification, **except that up to a total of 20,000 acre feet of additional permits may be granted for artificial ground water recharge without subordination under this paragraph**. Any storage project built under this classification shall include provisions for municipal, fish, and wildlife, and recreation uses acceptable to the Commission.

(d) Storage: Surface waters legally stored during the period November 1 through May 31, and legally released, may be used for any beneficial purpose.

(e) Artificial ground water recharge: use of surface water for groundwater recharge shall be subject to the following conditions:

(A) Recharged water used under a secondary permit for irrigation may only provide supplemental water to lands with existing irrigation rights or permits on June 24, 1988; and

(B) Diversion of surface water for recharge for irrigation under a secondary permit shall not exceed 2.25 acre feet per acre to be irrigated; and

(C) If the recharged water is to be used for municipal or industrial purposes under a secondary permit, the applicant shall demonstrate to the satisfaction of the Commission that it has an active water conservation program.

(f) Minimum perennial streamflows: minimum streamflows may be established to support aquatic life, minimize pollution, or maintain recreation values:

(A) To support aquatic life in accordance with Section 3, Chapter 796, Oregon Laws 1983, no appropriation of water shall be made or granted by any state agency or when flows are below the levels specified in Table 1. This limitation shall not apply to domestic and livestock use or to waters legally stored or released from storage; and

(B) To support aquatic life, no appropriations of water except for domestic and livestock uses or waters legally stored or released from storage shall be made or granted by any state agency or public corporation of the state when flows are below the specified levels for the streams listed in Table 1 with priority dates of 3-31-88.

(3) Ground Water: appropriation and use of ground water in the Upper Umatilla River subbasin shall comply with the following provisions:

(a) Classification: permits to use ground water may be issued only for the following classified uses:

(A) The ground water resources of the Upper Umatilla River subbasin are classified statutorily exempt ground water uses (see definition), irrigation, municipal, industrial, power development, low temperature geothermal mining, fish life, wildlife, recreation, pollution abatement, and **artificial ground water recharge**; and

(B) Ground water from the basalt reservoir in a five-mile radius around any municipal well of the cities of Adams and Pendleton is classified for municipal, group domestic and statutorily exempt ground water uses (see definition) only. Other uses may be permitted if it is documented that a barrier to ground water movement separates a proposed well from municipal wells and there will be no interference with municipal wells. Applications for other uses of ground water within a five-mile radius of a municipal well shall automatically be referred to the Commission for review and consideration of public interest unless the affected city affirms that it is in favor of the proposed appropriation. **This classification applies only when the affected city(ies) have a full-time conservation program in effect.**

(b) Permits issued to appropriate ground water that may be hydraulically connected with surface water shall be specially conditioned. The condition shall specify that when exercise of the permit unduly interferes with surface water, the permit shall be regulated in favor of the surface source.

E. PRIOR EXPERIMENTAL RECHARGE PROJECTS INTO THE BASALT AQUIFERS

Previous experimental recharge experiments were conducted at Walla Walla, Washington; The Dalles, Oregon; and a Water District adjacent to the City of Salem, Oregon, which was subsequently annexed by the City.

E.1 WALLA WALLA, WASHINGTON, EXPERIMENTAL ARR PROJECT

There were two papers published on this first experimental ARR project in 1957-58 injecting a surface source into the underground basalt aquifers at the City of Walla Walla, Washington. This experiment was jointly sponsored by the State of Washington and the United States Coast and Geodetic Survey (USGS). One of the papers was published by the state and the other by the federal government. Source of water for this injection experiment was the City of Walla Walla's gravity supply source (Mill Creek) which was injected into City Well No.3.

Surplus water from Mill Creek was utilized to re-charge the underlying basaltic aquifers. During this experimental period, 23 million gallons of Mill Creek water was injected into the deep ground water of Well No. 3. The injection rate varied from 630 to 670 gpm. Mill Creek water supply was analyzed prior to injection and found to be of excellent chemical and bacteriological quality with sediment ranging from 2 to 6 mg/*L* (ppm) [1 mg/L or 1 ppm = 8.34 lbs. of silt per million gallons of water]. The general compatibility of the surface water and the deep ground waters was verified prior to injection by blending the waters and checking for the formation of precipitates.

As a result of this experiment, the subsequent yield and specific capacity of Well No. 3 was temporarily reduced by 5% (1,540 gpm vs. 1,630 gpm). The temporary decrease in yield was attributed to:

- The fine particulate (sediment) in the Mill Creek surface water with sediment ranging from 2 to 6 mg/*L* (ppm). A total of 390 pounds of sediment was injected into the well during the recharge experiment and less than half was removed at the close of the experiment. The residual sediment is the probable cause for reduction in the yield.
- Dissolved air in the colder surface water being released when coming into contact with the warm lava and mixing with the warmer deep ground water causing air binding in the basalt aquifer.
- Release of entrained or entrapped air that originated from leaks, bends, fittings, and valves. A continuous blast of air was evident during the recharging through the measuring port to determine the level of the water table.

The conductance (ability to transmit electrical current) was considerably higher in deep ground waters, which have been in intimate contact with mineralized rocks (basalt), than that of the surface water source. Based on the specific conductance differential in the two waters, it was possible to document that recovery of the injected surface waters could be accomplished. After the injection test period, withdrawals were made from Well No. 3 for one and one-half months. At the start of the pumping cycle, the water withdrawn had the specific conductance of the Mill Creek surface water and with a gradual blending of the deep ground waters taking place, the characteristic of the surface supply shifted to that of the deep ground water.

The report suggested, that with refinements on the injection process, that continuing the recharge program would be worthwhile. City staff, with an impaired well, chose not to pursue the experimental program. The well did with normal pumping subsequently recover the capacity it had prior to the ARR experiment and currently produces 3,000 gpm (1,370 gpm more than at the time of the experiment).

A recently completed groundwater study performed for the City recommends ARR. The City has added ARR as a viable option that merits another experiment utilizing improved recharge practices after a water treatment plant has been built to remove the sediment in the water.

The following has been excerpted State of Washington "Water Supply Bulletin No. 7"[1].

Page 10: "An important factor in planning a program of artificial recharge is whether conditions are favorable for the recovery of the water after it has been injected into the aquifers. Water introduced into an aquifer by means of an injection well raises the water level or artesian pressure in the aquifer adjacent to the well and creates a mound of water, or a piezometric high, around the well. As a result of the recharge, local hydraulic gradients are established which allow water to spread out through the aquifer, away from the well, at the same rate it is injected into the well. If injection is discontinued and the well is pumped, the hydraulic gradients in the vicinity of the well will be reversed so that the water will then move toward the well. In this manner some of the water recharged can be recovered by pumping the injection well or nearby wells. Some of the water injected usually cannot be recovered because it has passed beyond the area of influence of the pumped well; the amount so lost depends upon the rate of movement, the physical characteristics of the aquifer, the natural hydraulic gradients in the vicinity of the well, and the time that has elapsed since injection. **However, part of any water not removed by pumping the injection well may be recovered by pumping wells down gradient from the recharge well."**

Page 15 "Sediment is one of the major problems when unfiltered surface water is injected directly into a well, therefor, water used for recharging ground-water reservoirs should be as free of sediment as possible."

Page 16 "Air introduced into a well during recharge may lessen the water-carrying capacity of an aquifer by both physical and chemical processes. Air entrapped in the interstices of the aquifer materials, in the form of minute bubbles, may impede the flow of water in the aquifer. Also, under certain conditions air may react chemically with native ground water to produce insoluble precipitates which can clog an aquifer."

Page 30 "The air entrapped in the Mill Creek water could be removed by passing the water through deaeration equipment prior to its injection into the well. Use of a regulator foot valve at the bottom of the pump column would prevent the free fall of water and would virtually eliminate the problem of air coming out of solution above the water level in the pump column. Filter beds could be used to remove the sediment prior to injection of the water into the well."

From the USGS Report[2] on the above 1957-58 Walla Walla Recharge Project, the following is quoted verbatim from:

Page A-1 "The chemical and bacteriological quality of the injected water was excellent, and the water contained only 2 parts per million of suspended sediment."

1 Artificial Recharge of a Well Tapping Basalt Aquifers, Walla Walla, Washington. Water Supply Bulletin No.7 by Charles E. Price, 1960. State of Washington Department of Conservation, Division of Water Resources, Prepared in cooperation with the United States Geological Survey, Ground Water Branch.

2 Artificial Recharge Through a Well Tapping Basalt Aquifers Walla Walla Area Washington. Geological Survey Water-Supply Paper 1594-A. By Charles E. Price. 1961. Prepared in cooperation with the State of Washington Department of Conservation.

Page A-14 "Water flowing in a stream invariably takes some air into solution. In deciding whether a surface water is suitable for artificially recharging a ground-water body, consideration should be given to the amount of dissolved air in the water, inasmuch as it is a potential source of trouble."

Page A-15 "The amount of air that can be held in solution is an inverse function of temperature of the solvent."

Page A-19 "Injection of water from Mill Creek into city well 3 was started on December 11, 1957, and terminated on January 8, 1958, after 71.3 acre-feet had been injected."

Page A-25 "The Specific Conductance sample collected on February 26 was more nearly that of native ground water."

Specific conductance was the primary means of determining the proportion of blending that occurred between the injected water and the native ground water. By February 26 there apparently was no longer any evidence of the artificial injected water in the pumped water.

Page A-26 "During the whole period of discontinuous pumping which began at 8:00 a.m. on January 11 and ended at 6:50 a.m. on February 26, city well 3 yielded 108 acre-feet of water (table 7). About 38 acre-feet of Mill Creek water was recovered in that time. This amount is about 53 percent of the 71.3 acre-feet injected into city well 3 during the artificial-recharging experiment."

Page A-28 "Data obtained during the recharging experiment show that the performance of city well 3 deteriorated somewhat during this period, for a decline in both yield and specific capacity was noted. Three potential causes of yield deterioration have been recognized in this report: (a) sediment in the injected water, (b) dissolved air in the injected water, and (c) entrained air that originated from leaks or undetected openings in the piping system. The relative importance of the three in causing the observed deterioration cannot be evaluated on the basis of the data now available."

E.2 EXPERIMENTAL ARR PROJECT AT THE DALLES, OREGON

In 1960-61, the United States Geological Survey with the permission of the City of The Dalles, conducted a second experimental recharge ARR project into the deep basalt aquifers. The Dalles' surface water supply also happens to be named Mill Creek. Mill Creek, the recharge water source was: filtered, chlorinated, and fluoridated prior to being injected at an average rate of 1,500 gpm. A total of 81.4 million gallons was injected over a period of six months into the underlying basaltic aquifers. The surface water supply and the deep ground waters were checked for their compatibility prior to injection and found to be compatible. Sediment concentrations of the injected water ranged from 0-3 mg/*L* (ppm) throughout the experimental period. The water was injected into the City's Jordan Street Well about 1 mile west of City center.

The injected surface water supply ranged from 13 to 25 degrees Fahrenheit cooler than the deep ground water. As the injected water was cooler than the deep ground water, stratification occurred (cooler water being more dense settled to the lower parts of the underlying aquifer).

Colder surface water also has a greater viscosity (less fluid-like) than the warmer deep ground waters and this resulted in the underground aquifers being less permeable in both accepting the cooler surface waters and during the pumping or withdrawal cycles. This cooler surface water with the higher viscosity diminished the specific capacity (yield) of the well during the withdrawal of injected waters until the native ground waters with a higher temperature moved in. In the range of temperatures (40° - 62° F) encountered in this recharge experiment, the effect of lowering the water temperature 1° F was computed to effectively reduce the specific capacity (yield) of the well by 1.8 percent.

During this experiment at The Dalles, the injection of surface waters was stopped whenever the water table raised rapidly indicating a plugging of the aquifers. The well would then be pumped and surged to restore the specific capacity of the well. The sediment concentration of the water withdrawn at the end of injection periods ranged from 0 to 18 mg/*L* (ppm) except for one occasion when coagulating chemicals (alum floc) at the treatment plant passed through the filters and was injected into the deep well. Withdrawal of the injected surface waters after this accident had a sediment content of 618 mg/*L* (ppm) or 5,154 lbs./million gallons of water.The well after 7.5 hours of surge pumping still had a sediment content of 4 mg/*L* (ppm).

To minimize the problems of air entrainment as evidenced at Walla Walla by permitting the water to freely fall into the pump column, the water at The Dalles was injected under 50 to 70 pounds per square inch of pressure. During recharge, however, crackling noises could be heard at several points along the pipe-line from the well back to the system. As water is forced backwards through the pump bowl assembly (the impellers), there is great resistance to the backward flow of the water (creating negative pressures), and this was presumed to be the major cause for the air to have come out of solution.

In this experiment, the surface water and the deep well ground water was analyzed for dissolved oxygen content. The Mill Creek surface water ranged between 11-14 mg/*L* (ppm) and the deep well ground water was 1.2 mg/*L* (ppm). During pumping cycles following injection periods, the withdrawn water was positively identified as predominantly surface water by its temperature and conductivity. Analysis of the withdrawn water, based on several tests, revealed however that the typical proportionate blend of surface water and well water which should have had: a dissolved air content of 9.0 mg/*L* (ppm), had a dissolved oxygen content of 0.3 mg/*L*. Four possible explanations given for the removal of dissolved oxygen were:

- That the dissolved oxygen in solution chemically reacted (oxidation) with minerals in the basaltic rock (iron), or

- That the dissolved oxygen could have come out of solution as air bubbles in the aquifer, or

- That the air could have come out of solution during the surface water injection process or during the pumping cycle, or

- That with the high water velocities during the injection cycle the air could have come out of solution at several locations such as meters, bends, valves, other fittings.

Clogging of the underground aquifer (with the exception of the alum incident) was attributed chiefly to the release of air in the form of air bubbles during the injection process. Higher levels of sediment content which were noted at the start of the pumping cycles were probably also a contributing factor.

The well selected for surface water injection had high specific capacity of 100 gpm/ft. of drawdown. This indicated that the underground aquifer was highly porous and would readily accept the injection of surface water. Tests later documented this fact as the cooler (denser) surface water occupied the lower portion of the aquifer and readily escaped from the immediate area. This was verified by the rapid decrease in the level of the mound of water created by the injection process and the ability to recapture only small portions of this water during pumping cycles. Geologists were not concerned at the inability to reclaim substantial amounts of the recharge water as the geologic and hydrologic conditions precluded the escape of the injected water from the immediate ground water basin. At the conclusion of the experiment, the specific capacity of the well was 91 gpm/ft of drawdown versus a specific capacity of 100 gpm/ft prior to the experiment. The geologists were not concerned about this short term reduction in the specific capacity and recommended that the project be continued to evaluate the recharge experiment over a longer term.

<u>The following has been excerpted the USGS Report on The Dalles ARR Experiment[1].</u>

<u>Page E1</u> "The recharge water was filtered, chlorinated, and fluoridated prior to injection; preliminary tests showed it to be chemically compatible with native ground water and free of harmful bacteria. The temperature of the recharge water was cooler than the normal ground water by 13° to 25° F."

<u>Page E18</u> "The presence of even a small amount of sediment in water that is injected into a well can, in time, seriously clog the well and the aquifer materials adjacent to the well. The degree of clogging that will result from the injection of sediment-bearing water depends not only upon the amount of sediment but also upon the composition of the sediment, the size of the particles, the composition of the aquifer materials, and the size of the interstices in the aquifer."

"Air introduced into a well during recharge may lessen the water carrying capacity of an aquifer by both physical and chemical processes. Gases in air may react chemically with native ground water to produce precipitates that can clog an aquifer or well screen. Also, even relatively small volume of air, in the form of bubbles, may markedly reduce the permeability of an aquifer."

<u>Page E19</u> "Another possibility was that dissolved air might come out of solution as the recharge water flowed to and discharged into the well. In rapidly moving water, dissolved gases are likely to come out of solution at points of sharply increased velocity where pressure is reduced. Such pressure reduction occurs at sharp bends in pipes, valves, water meters, and any other constrictions of or projections into pipelines. The bubbles thus formed may be carried great distances without being redissolved in the water."

[1] Artificial Recharge Through a Well Tapping Basalt Aquifers at The Dalles, Oregon. Geological Survey Water-Supply Paper 1594-E. By B.L. Foxworthy and C.T. Bryant. 1967. Prepared in cooperation with the City of The Dalles.

Page E20 "If water is allowed to cascade freely into the well, large amounts of air may become entrained in the falling water and be carried out into the aquifer as bubbles. In the recharge tests at the Dalles, however, the water was injected under pressures ranging from about 50 to 70 pounds per square inch at the well head and discharged below the water level in the well."

Page E33 " Most of the dissolved oxygen that was present in the recharge water entering the well came out of solution or otherwise was removed before the water was pumped back to the surface.

The marked reduction in dissolved-oxygen content is apparent from a comparison of the dissolved-oxygen contents in samples of the recharge water and of the water pumped from the recharge well during pumping tests.... ."

Page E34 ".....Thus, the dissolved-oxygen content, if none had been dissipated, should have been about 9 ppm rather than the 0.3 ppm determined from the sample collected at that time ..... .

There are two possible explanations for the removal of dissolved oxygen from the recharge water: (1) Some of the oxygen could have entered into a chemical reaction in the aquifer, such as oxidation of ferrous iron to the ferric state, or (2) the dissolved oxygen along with other gases could have come out of solution as air bubbles, either while in the aquifer or during recharge or pumping.

Because of the low content of dissolved iron in both surface and ground water at The Dalles, precipitation of iron and any resultant depletion of dissolved oxygen by this means probably was insignificant, although at times the apparent iron content of the water pumped was more than twice that of either the recharge water or* the native ground water." *corrected original document was "on".

Page E36 "Also, during all the recharge tests, crackling sounds, believed to have been caused by air coming out of solution in the form of bubbles, could be heard at several points along the pipe line to the well. By far the greatest local reduction of pressure on the water moving to the well occurred as the water passed through the turbine impellers, where air must have come out of solution."

Page E38 "Determinations of specific conductance of the water pumped from the well following the four periods of recharge show that more than 85% of the water withdrawn was recharge water."

"With any system for subsurface injection, every effort should be made to prevent the entrainment of air and to keep in solution air that is already dissolved in the recharge water. To this end, the recharge water should be injected into the well in a full pipe under pressure and not allowed to enter by free fall. During the recharge tests previously described, this condition was achieved by injecting the water through the impellers of the pump; the restriction of flow there was sufficiently great that a large pressure drop was created in that section.

If injection is through a separate pipe or pipes, adequate back pressure can be produced by means of a fixed nozzle (reducer) or a controllable valve at the lower end of the injection pipe. At other points in the pipeline conveying the recharge water, sharp pressure reductions should be prevented where possible."

Based on a discussion with C. Dean Smith, former City Manager of The Dalles at the time of the experiment, the City decided not to continue the experiment primarily because of complaints from private individuals, water districts and industries who were aware of the accidental injection of the alum floc incident. The complainants, concerned about contaminants being introduced into the deep ground waters, threatened to sue the City if they continued with the ARR experiment.

Brian Stahl, current Public Works Director, stated that the City will again be looking to ARR as a water management tool after the City has maximized the water production from their present wells. The previous incident of permitting alum floc to break through the water treatment plant into the distribution system and the recharge well was attributed to unskilled operational personnel at the water treatment plant. There is no longer a threat of repeating this incident.

E.3 ARR EXPERIMENT AT SALEM, OREGON

In 1962, the U.S. Geological Survey, with the consent of the Salem Heights Water District, conducted their third experimental artificial recharge of the underlying basalt aquifers. During this three month experiment in 1962, a total of 24.5 million gallons of winter surplus water (low cost 50% of the summer rate) was purchased from the City of Salem and injected into the District's Park Well #2. The water was injected under pressure at an average rate of 830 gpm.

The City of Salem's water supply was obtained from infiltration galleries on Geren Island in the North Santiam River. The only treatment this water received consisted of chlorination and fluoridation. The purchased recharge water contained 11.7 mg/*L* (ppm) of dissolved oxygen and during each injection the sediment in the water greatly exceeded the anticipated 0.3 mg/*L* (ppm).

During the first injection cycle, the injected surface water had a recorded high sediment content of 40 mg/*L* (ppm). On the second injection the sediment in the water had a high of 216 mg/*L* (ppm) and on the third injection cycle a high of 119 mg/*L* (ppm). The high sediment counts were attributed to sand in the water.

The well's, specific capacity (yield) at the completion of the experiment was considerably better than it was before the experiment. The specific capacity prior to the experiment was 14,3 gpm/ft of drawdown and at the conclusion of the experiment by surging it was improved to 17.1 gpm/ft of drawdown. This reflects a 20% increase in the productivity of this well.

Tests of the deep ground water also revealed a high dissolved oxygen content that ranged from 6.8 to 9.3 mg/*L* (ppm) which was attributed to water cascading down from upper water bearing aquifers above the static level of the well. The surface and well waters were analyzed prior to the experimental recharge and found to be compatible.

The temperature of the surface water supply and the temperature of the ground water were close to each other. Therefore, a reduction in the specific capacity of the well because of temperature, which was encountered at The Dalles, would not be a material factor in the Salem ARR experiment.

To partially overcome the release of air from the water related to high water velocities through piping, valves and fittings, long radius bends were installed. Although a complete modification of the piping would have been desirable, the cost on an experimental basis couldn't be justified.

In contrast to the experiment at The Dalles, where practically all the air in solution in the water disappeared, the water withdrawn after each injection typically contained over 80 percent of the dissolved air during the injection cycle. With the incorporation of these piping changes, it was believed that the release of air out of the water was greatly minimized and that clogging attributable to air was minor in this experiment. The high levels of sediment in the water was determined to be the chief cause of clogging of the aquifer.

Even with the excessive amounts of sediment (dislodged from system piping) in the recharge water, the pumping and surging cycles required only 3% of the total volume injected for this purpose. The net volume of water added to the underground reservoir was 97% of the total amount injected.

Similar to The Dalles, the local geologic and hydrologic conditions in the immediate area at the Salem Heights area precluded the escape of substantial volumes of recharge water from the general area. The selected well site was situated approximately 3,400 feet easterly of a local depressed basin in the underlying basalt aquifers. Near the center of this depressed basin the Water District owned another well which would be the primary beneficiary from the artificial recharge experiment.

In subsequent years, the area served by the Salem Heights Water District, was annexed to the City of Salem. Spurred by the low precipitation in the winter of 1976 the City decided to duplicate the 1962 experiment of artificially recharging the underlying basalt aquifers. The ARR experiment conducted by the City of Salem started on March 1, 1977 and terminated on October 17, 1977. During this experiment, the earlier test well and the well near the center of the depressed basin in the underlying basalt aquifers were both utilized as injection wells. During this second artificial recharge of the underlying basalt aquifers, a total of 150,441,000 gallons of surface water were injected into the basalt aquifers. Of this amount 1,658,700 gallons of water was used for surging and cleaning of the underground aquifer. The net volume added to the underground aquifer was 148,782,300 gallons or 98.9% of the total.

Based on monitoring of subsequent withdrawals, 95,577,600 gallons (64.24%) of the surface water was recovered and the water table was 10 feet higher at the end of the withdrawal period, some of which may be attributed to natural recharge. The rest of the findings in the second experiment generally reaffirmed the findings of the first experiment.

<u>The following has been excerpted from the USGS Report[1] - Salem Heights ARR Experiment</u>

<u>Page F1</u> "The recharge water contained abundant dissolved air and, at times, excessive sediment; in other respects it was of excellent quality and was compatible with the native ground water. Before the experiments, water in the main aquifer contained unusually large amounts of dissolved oxygen, which apparently was introduced by water cascading from higher zones within unlined intervals of the wells."

[1] Hydrologic Conditions and Artificial Recharge Through a Well in the Salem Heights Area of Salem, Oregon. Geological Survey Water-Supply Paper 1504-F. By Bruce L. Foxworthy. 1970. Prepared in cooperation with the Salem Heights Water District.

Page F18 "Clogging of a well or the adjacent aquifer materials is almost universally experienced to some degree in recharge through wells. In various subsurface-injection operations, including previous operations in Oregon and Washington (Price and others, 1965), clogging has been attributed to (a) sediment in the recharge water, (b) chemical reactions in the aquifer, (c) growth of organisms in the well or aquifer, and (d) air in the recharge water."

Page F19 "Undesirable chemical precipitation may be caused by the different chemical and physical characteristics of the waters mixed during subsurface injection. Even small changes in pH, Eh (reduction-oxidation potential), temperature, pressure and concentration of some dissolved gases (such as air) can cause the precipitation of chemical constituents such as iron, aluminum, calcium carbonate, and silica. For example, ground water commonly contains some dissolved iron that is in the ferrous, or lower oxidation, state. If water containing ferrous iron is mixed with oxygen-rich water or is exposed to oxygen in the atmosphere, much of the iron is oxidized to the ferric state and precipitates in the form of ferric hydroxide, which is virtually insoluble at normal pH values of ground water (Hem, 1959, p60). Likewise if ground water that contains abundant silica in the ionic state is cooled, as by cold recharge water, some of the silica may precipitate (Siever, 1962, p. 128-134). When this chemical precipitation is substantial, aquifer permeabilities may be greatly reduced."

Page F19-20 "Of many chemical reactions that might occur when an outside water is added to an aquifer environment, one that has been considered to be a potential cause of clogging is an ion-exchange reaction involving certain clay minerals (Sniegocki,1963a, p. 12). Some clays, when exposed to a water with a high sodium-ion content, tend to release calcium or other ions and adsorb the sodium ions. As a result, the clays swell in volume or are dispersed in a semi-colloidal suspension. Either result may decrease the permeability of an aquifer and, therefore, must be evaluated as a potential problem in subsurface injection. Calcium clays of the montmorillonite group are most likely to react in this way."

Page F20 "Certain organisms can be troublesome if they are injected underground. Pathogenic bacteria, of course, can render a ground-water body unfit as a source of drinking water. However, other organisms, the so-called nuisance bacteria, although not disease producing in humans, are also undesirable because they may color the water, cause unpleasant taste and odor, or produce slimes or other products that clog recharge wells and aquifers.

The Salem city water supply is chlorinated at both the withdrawal works and the Franzen Reservoir and so is considered to be effectively free of pathogenic organism when it reaches the booster pumping station. Before the injection tests, the existence of nuisance bacteria was tested in a series of samples of (a) chlorinated water from the booster-pump station and (b) water pumped from the injection well. The samples were tested by the public health laboratory of the Oregon State Board of Health. Laboratory cultures of the samples failed to reveal any nuisance bacteria in the waters. Therefor, no problem of water deterioration nor of clogging of the aquifer or recharge well was anticipated as a result of nuisance bacteria."

"Air that is introduced into a well during artificial recharge not only can cause clogging by producing the chemical reactions mentioned previously, but also can reduce the permeability of the aquifer by physically blocking the pore spaces with bubbles."

"Even a relatively small volume of air in an aquifer may markedly reduce its permeability by blocking the main routes of water movement through the aquifer (Orlob and Radhakrishna, 1958, p.648). Such bubbles normally are tightly held to the aquifer materials by molecular attraction, and high velocities are required to displace them. Furthermore air occurring as bubbles in an aquifer can dissolve only very slowly, even in water that has a very low dissolved-air content."

Page F22 "Commonly, some of the injected water moves away from the recharge well far enough that it cannot be pumped back through that well and can only be recovered from wells located down gradient."

Page F35 "The specific-conductance determinations (table 4) indicate that roughly two-thirds of the water withdrawn during the pumping tests was recharge water."

Page F36 "In any system for subsurface injection, every effort should be made to prevent the entrainment of air in the recharge water; also, unless the recharge water is deagassed before injection, any dissolved air should be largely kept in solution. To this end, the recharge water should be injected into the well in a full pipe under pressure, rather than being allowed to enter by free fall. During the recharge tests previously described, the desired condition was achieved by injecting water through the impellers of the pump; the restriction of flow through the impellers was sufficient to create a large pressure drop there.

If future injection is undertaken through a separate pipe or pipes, adequate back pressure can be produced by means of a fixed nozzle (reducer) or a controllable valve at the lower end of the injection pipe. Where possible, sharp pressure reductions should be prevented at other points in the system conveying the recharge water."

Page F39 "4. The artificial-recharge tests caused some decrease in the specific capacity of the recharge well. The principal cause of the decrease was a clogging of the aquifer materials in the vicinity of the well by (a) sediment carried out of solution from the recharge water and (b) probably by air bubbles of air that came out of solution from the recharge water. Virtually all the injected sediment was removed by surging (intermittent pumping) with the existing pump, and the specific capacity was thereby restored to values greater than pre-recharge specific capacity."

As the impact of the drought diminished and with a subsequent year of adequate rainfall, this artificial recharge of the deep basalt aquifers was suspended. A continuation of the ARR concept would also probably benefit other private wells within the boundaries of the confined aquifer without their bearing any share of the financial burden. This area is now incorporated within the City of Salem and the City is pursuing the reactivation and expansion of this project to determine the feasibility constructing 30 ARR wells capable of yielding 1 million gallons per day each. The current ARR experiment utilizing the same well with some modifications is indicating that the goal of injecting over 1 million gallons per day can be achieved.

E.4 USGS REPORT[1] ON THE UMATILLA PLATEAU AND HORSE HEAVEN HILLS AREA

The area encompassed by this investigation included both sides of the Columbia River in the states of Oregon and Washington. The following are selected excerpts from that report.

From page 8 "During the period of deposition of the Columbia River Basalt Group, the volume of successive flows diminished and the time interval between flows increased. As a result, the thickness of sedimentary interbeds tends to be greater between the younger basalt flows."

From page 17 "Mean values of hydraulic conductivity, as determined from well data where the well is completed only in each unit are 0.28 ft/s (feet per second) for the sediments overlying the basalt, 0.00021 ft/s for the Saddle Mountain Basalt, 0.00197 ft/s for the Wanapum Basalt, and 0.00075 ft/s for the Grande Ronde Basalt. These values are comparable to those determined from aquifer tests conducted by OWRD (Oregon Water Resources Department, written commun., 1981)". From the above information relative basalt unit conductivities:

Saddle Mountain/Wanapum 10.66%
Wanapum/Saddle Mountain 938.10%

Saddle Mountain/Grande Ronde 28.00%
Grande Ronde/Saddle Mountain 357.14%

Wanapum/Grande Ronde 262.67%
Grande Ronde/Wanapum 38.07%

E.5 CITY OF HERMISTON ARR EXPERIMENT

ARR projects are currently being investigated on a national scale as a means of collecting and storing of water in times of surplus for later withdrawal at times of need. There were 21 ARR projects that received 80% federal funding to demonstrate the feasibility of this concept for different subsurface aquifers.

The Hermiston, Oregon project was the only project approved to receive federal funding that artificially injects water into the basalt aquifers. This project was designed to avoid the specific inadequacies encountered in the earlier ARR experiments. As a model for future ARR projects injecting into the Columbia River Basalt aquifers, sophisticated and extensive testing was required to document the water qualities, and report on interactions between the water being injected and the water that has been stored in the basalt reservoir for several thousand years.

The Hermiston ARR project is being terminated this year because trace volatile organics were detected (at levels too low to be quantified) in the recharge water source (City shallow Well #5). The current DEQ's interpretation of the non-degradation of the sub-surface waters would have required the aeration of Well # 5 at a cost of +/- $100,000. The federal government refused to provide the federal matching funds, which resulted in aborting the $3,000,000 project. The City will at the close of the project benefit from substantial improvements to the distribution system, a SCADA system, a new deep well built to current standards with twice the yield, and new booster pumping station that will be readily convertible to an ARR well. The City of Hermiston has "blazed a trail" for several other cities in Oregon now planning ARR projects, including the City of Salem which is studying the feasibility of constructing 20 to 30 ARR wells.

1 Geohydrology and Digital Simulation of the Ground-Water Flow System in the Umatilla Plateau and Horse Heaven Hills Area, Oregon and Washington. U.S.G.S Investigation Report 87-4268. Dated: 1988

E.6 SUMMARY AND FINDINGS ON PRIOR ARR EXPERIMENTS

- Prior experiments have demonstrated that artificial recharging of the deep basalt aquifers is technically feasible over short periods of time.

- Long term comparability of mixing of surface and deep waters has not been documented as of this date.

- That a specially designed artificial recharge facility could overcome several of the problems encountered in previous recharge experiments.

- The underground basaltic aquifers have tremendous storage capacities for water that can be injected during low demand periods.

- In Critical Groundwater Areas, it would be desirable and equitable to have state legislation to assure equitable financial participation from all individuals who would benefit from a successful artificial recharge project similar to local improvement project (LID).

- The implementation of a recharge project would require an ongoing supervisory, monitoring and maintenance program to maintain the capacity of the well and the quality of the underground deep water.

- That in prior experiments large degrees of sediment were dislodged from existing pipelines because of reversal of historical flow patterns and the high water velocities in pipes during the injection process. On permanent installations, the use of new large transmission lines leading into the recharge well and mechanical screening would partially or completely eliminate this problem. Screening should reduce the amount of periodic pumping to waste during periods of plugging of the borehole walls.

- Some means other than injection of the surface water through the pump impellers in a reverse direction be utilized for permanent installations. Hydraulic wear over an extended period of time could materially reduce the useful life of the impellers. Also, in the pump bowl assembly, there is a substantial restriction in the cross sectional area for the passing of the injected water which results in the formation of air bubbles.

- Higher specific capacity wells would be the best wells for an artificial recharge program. The higher specific capacity wells penetrating the more porous aquifers are capable of higher rates of injection with less risk of clogging.

- It is preferable to have a small diameter monitoring well constructed near the injection well. The purpose of the monitoring well would be to verify that changes occurring in the water table level were also occurring in the general area. A large rise in the water table in the injection well without a proportional rise in the monitoring well would indicate clogging taking place in the injection well and the need for surging and cleaning.

F. PROCESSING AN ARR PERMIT AND WATER RIGHT

Each ARR project requires a preliminary meeting with the OWRD and a negotiating process to establish the parameters prior to the submittal of an application for a recharge permit. These include:

- Degree of research and documentation needed to determine it's potential impact on the underlying water table.
- Compliance with the non-degradation policy administered by the DEQ.
- Estimated percentage of the injected water to be recaptured.
- Financial, administrative and managerial capabilities of the applicant.
- The rate at which the water will be injected. Rates over 5.0 cfs (2,243 gpm) requires the approval of the Water Resources Commission.
- Conditions under which the water may be withdrawn.

The negotiations for the Hermiston ARR Project did not require stopping the decline of the water table, or a reversal of the decline. Any decrease in the agreed upon annual historic lowering of 3.5 feet per year would have been credited as "banked" water for subsequent withdrawal. An analysis of this project, indicated that there are over 500 million gallons of surplus water available for storage in the underlying basalt aquifers in the average year. The surplus water would be available during the late fall, winter and early spring months from the City's shallow Well #5 .[1] Water once "banked" can be withdrawn at a higher rate then allowed by the permit.

G. ARR PROJECT OBJECTIVES AND GOALS

The objective of the Pendleton ARR project would be to inject the available treated surplus water from the City's spring supply and/or the Umatilla River into one or more of the City's existing deep wells. The water stored in the deep basalt aquifers would then be withdrawn during the late spring, summer, and early fall months to meet the periods of higher demands.

Based on prior geologic studies, the City of Pendleton's deep (basalt) wells are in the bottom of a geologic trough with an anticline (sub-surface dam) at the West side of the City. The deep wells have been experiencing substantial annual declines in the water table for several years. One or more of the goals would be to accomplish: diminishing the rate of decline, reach equalization, or reversal of the decline. The latter two goals probably are not achievable without the declaration of a Critical Groundwater Area.

Full development of the water permits at the City springs, and the 1885 and 1890 water rights on the Umatilla River, properly treated may provide a sufficient surplus during the periods of low water demand (late fall to spring) to inject more water than needed for later withdrawal during the high summer demands. With a successful ARR, project there would no longer be a net withdrawal of the water from the basalt aquifers. In Chapter VII - Improvements, the amount of the recapture rate to eliminate net withdrawals of the deep well supply is discussed in detail.

The specific objectives and goals of the ARR project are:

- Store enough water in the winter months to supply the average annual summer demands, without withdrawing any water in excess of the amount injected,
- Arrest, or reverse the decline in the water level in the underlying basalt aquifer(s), or
- Materially decrease the historic rate of decline in the underlying basalt aquifer(s), and
- Eliminate the practice of deepening and enlarging the well boreholes to chase and capture the water at lower and successively lower depths, and
- Avoid the costs associated with pumping well water from deeper levels, and
- Select a City deep well for artificial recharge that would be upgradient from the other City wells.

Accomplishing most of the above objectives would preserve in perpetuity the use and investment in City's deep wells. The continued utilization of these deep wells will have the following addit-ional economic and environmental benefits:

- Avoids the construction of costly cross town transmission facilities through built up areas will be avoided to meet area demands that are now satisfied by the deep wells in these areas.
- Provide the safest and most economical means of storing potable water by placing the water in the underground reservoir. The water in the deep basalt has been age tested and found to be 1,000's of years old. This attests to the safety of storing massive quantities of water in the deep basalt aquifers.
- A successful ARR program will provide the long term storage capacity for the City to provide water through droughts (for several successive years), and the capability of meeting unusually high summer peak water demands. This would provide a stable water source for municipal and industrial users. In contrast to an ARR project, a surface impoundment has to bypass water during high run-off years and is unable to fill reservoirs in the low run-off years. An ARR project can store treated surface water during consecutive years of surplus stream flows for withdrawal in later years to bridge the drought years, or any extra ordinary water demand.

- Water treatment facilities can be substantially reduced in size, if the existing deep wells can continue in existence and satisfy the localized high demand periods. The water treatment plant would be operated at a constant uniform production rate, optimizing plant performance. Plant staffing would also be consistent instead of having short hours of operations or shutdowns during winter; and high treatment production rates during summer to meet peaking demands. In summation an ARR project can:

  Provides for stable and uniform year around staffing at a water treatment facility.

  Permits optimum design and sizing of all components in the treatment train, and the transmission lines to the distribution system.

  Avoids high power rates and demand charges.

Additional benefits of a successful ARR project to level off seasonal peaking are further developed in Chapter VII -- Improvements.

CHAPTER IV -- WATER SOURCES

A. OVERVIEW OF CITY'S WATER SOURCES, RIGHTS, AND PERMITS.

The City has a variety of water rights and permits of record. It is important to keep in mind that the basalt aquifers, which the City's wells are withdrawing from, continues to experience significant lowering of the water table each year. The water table has lowered to the point where attempts to pump Well #1 (Byers Ave.) results in the water level dropping below the pump's suction. Pump bowls at Well #1 are as low as they can go because of the existence of a smaller diameter steel cased borehole immediately below the present pump bowl settings. Further lowering of the water table in the basalt aquifers will have similar future effects in the other City wells. The City's water sources have been divided into three categories as follows:

A.1 Developed Sources

City's Springs: Wenix, Shaplish, Three Simon, and Long Hair (includes Squaw Creek) have 11.7 cfs (7.56 mgd) aggregate water rights. The gravity transmission line from these springs is only capable of delivering a maximum of 5.25 mgd or only 69.4% of the existing water rights. The 2.31 mgd available from the springs offers an opportunity to alleviate the deficiency in supply during the summer months if captured during the late fall, winter, and early spring months and placed in long term mass storage. Basalt aquifers underlying the City with a successful Artificial Recharge and Recovery (ARR) project as discussed elsewhere in this report may provide mass storage.

Deep Wells: Wells Nos. 1, 2, 3, 4, 5, 7, and 8. These wells have a current combined yield of 13.9 mgd (21.51 cfs), and without use of Well #1 is reduced to 11.3 mgd (17.5 cfs). These wells have a combined water rights and permits for 20.43 mgd (31.62 cfs).

A.2 Partially Developed Sources.

Deep wells: Well #6, a large diameter well, 1,501 feet deep, was drilled as a production well and is currently in use as a monitoring well. The well log indicated that this well had a yield of 0.76 mgd (1.17 cfs) with 36 feet of drawdown. This well was one of three other wells (Nos. 9, 10 & 12) submitted with an aggregate permitted yield of 12.92 mgd (20.0 cfs), with no individual well's yield to exceed 4.33 mgd (6.7 cfs). This well should be pump tested to determine it's yield. Well #11 was drilled as a test well for the drilling of another City well in a new area. The well is currently being put to a very limited used by the City's wastewater treatment plant as a potable water supply. The well log and other data recorded shortly thereafter on this well are in substantial conflict as discussed later in this chapter. The water permit for this well is 4.33 mgd (6.7 cfs).

A.3 Undeveloped or Unused Water Sources

Umatilla River: The City's first water source was the Umatilla River with a water right in the amount of 1.29 mgd (2.0 cfs) and a priority date of 11/11/1885. Its original point of diversion was in the general vicinity of the southwest corner of the railroad bridge on the easterly side of the City. With the construction of the water supply from the springs, the river supply fell into disuse.

The City obtained, via a transfer from a private individual, a water right in the amount of 0.32 mgd (0.5 cfs) with a priority date of 12/31/1890 for irrigation, stock and domestic use at the Round Up Grounds.

A permit was granted from the Umatilla River to the City for 5.17 mgd (8.0 cfs) with a priority date of 11/10/1910. Its point of diversion is at the North Fork of the Umatilla River.

The Oregon State Legislature withdrew for the City from future appropriation all water rights of the North Fork of the Umatilla River after March 8, 1941. Several years ago the federal government designated the North Fork's watershed as a wilderness area. The constraints that this designation places on the development of these water rights and permits needs to be explicitly established.

The relative merits of these different sources, plus the consideration of incorporating an Artificial Recharge and Recovery (ARR) project with each of the alternatives will be discussed in the other chapters of this report.

B. WATER SOURCES: PERMITS & CERTIFICATE NUMBERS, PLUS GENERAL DATA

During a detail review of the records, it was found that the Certificate Numbers of City Wells #2 and #3 had been transposed wrongly in the City's and the States records according to copies of the Certificates. Also, the State's record on the location of Well #12 (Permit G 11326) lists the location of the well 470' West of the North 1/4 corner of Section 9, instead of the 47' stated on the permit. The 47' listed in the application is in close agreement with the permit G 6773.

Well #6's point of diversion (POD) was changed by a letter to the OWRD dated December 5, 1963. The re-location of the POD was probably legal then, but according to Robert O'Rourke, this would have been contrary to the OWRD's and the OWRC's policy.

The City, as a matter of operational convenience, changed some of the well numbers from those assigned on their original permit applications. A detailed summary of the status of the City's corrected water rights certificate and permit numbers are shown in Table IV-1 on the following pages.

TABLE IV-1

UMATILLA RIVER IN ORDER OF THEIR PRIORITY DATES

	Cert. No.	Permit No.	Rate cfs	Priority Date	Pendleton's Identification/Description	Location Legal Description	Remarks
1.	2604	D 2604*	2.0	11/11/1885	Umatilla River	Approx. @ Well #1	POD @ SW cor. RR Bridge, **CPED**??
2.	2582	D 2582**	0.5	12/31/1890	Umatilla River	Round-Up Grounds 10 Ac.	**POD** ???? Usage irrigation, domestic, and stock. Municipal (??? maybe)
3.	None	458	8.0	11/12/1910	North Fork Umatilla River	Campgrounds	**NCTD**--Approx. 450' upstream of fork.
4.	Withdrawal		???	03/08/1941	North Fork Umatilla River	Sub-basin--All	Set aside by ORS 538.450 of all rights junior to this date in North Fork basin. No **POD** stated or **CPED** req'd. **NCTD**
	SPRINGS IN ORDER OF THEIR PRIORITY DATES						
5.	3927	S 472	4.0	11/28/1910	Wenix Springs near Thorn Hollow	T2N, R35 E.W.M Sec. 6, SE of NE	**POD**@ Gate House and Weir
6.	7993	S 1197	3.0	05/20/1912	Shaplish Spring Sec. 34 SE of SE	T3N, R35 E.W.M.	Description is for **POD**
7.	8052	S 9007	2.7	04/22/1929	Three Simon Springs	T2N, R35 E.W.M. Sec. 4 SW of N.E.	Description is for **POD**

* Recorded in State Record of Water Right Certificates, Volume #3, page 2604
** Recorded in Volume 34, Pages 208 & 209 Decree of the Circuit Court.

POD--Point of Diversion **CPED**--Current Permit Extension Date **NCTD**--No Construction to date.

TABLE IV-1 (Continued)

	Cert. No.	Permit No.	Rate cfs	Priority Date	Pendleton's Identification/Description	Location Legal Description	Remarks
8.	8051	S 9006	2.0	04/22/1929	Long Hair Spring and Squaw Creek Spring	T3N, R35 E.W.M. Sec. 36 SE of NW	Description is for **POD**
					DEEP WELLS IN ORDER OF THEIR PRIORITY DATES (EXCEPT FOR SUPPLEMENTAL)		
9.	20838	U 152	3.1	02/23/1944	Well #1--Byers Well	T2N, R 32 E.W.M. Sec. 2 SE of SE	Probable site of original pumping plant of 1885 Water Right.
	46096	G 2204	0.9	07/16/1962	Well #1--Byers Well	T2N. R32 E.W.M.	Supplemental permit & right 600'N & 200' W of SE Corner of Section 2
10.	20839	U 418	1.11	12/31/1951	Well #3--SW 21st Street Sec. 10 SW of SW	T2N, R32 E.W.M.	
	46094	G 2202	0.2	07/16/1962	Well #3--SW 21st Street SW of SW	T2N, R32 E.W.M.	Supplemental permit & right 600'N & 920' E of SW Cor. of Sec. 10
11.	20840	U 579	2.51	09/16/1953	Well #2--Round-Up Well	T2N, R 32 E.W.M. Sec. 10 SE of NW	1410' S & 100' W of N 1/4 Cor. Sec. 10
	46095	G 2203	3.1	07/16/1962	Well #2--Round-Up Well	T2N, R 32 E.W.M. Sec. 10 SE of NW	
12.	23741	U 670	2.0	10/18/1954	Well #4--Eastern Oregon Corr. Institution (EOCI)	T2N, R32 E.W.M. Sec. 9 NW of NE	Previously called Hospital Well.
13.	29147	G 1160	5.3	10/03/1958	Well #5--Stillman Well Sec. 2 SW of SW	T2N, R 32 E.W.M.	350'N & 875'E of SW Cor. Sec. 2

TABLE IV-1 (Continued)

	Cert. No.	Permit No.	Rate cfs	Priority Date	Pendleton's Identification/Description	Location Legal Description	Remarks
14.	None	G 2410	6.7*	10/10/1962	Well #6--~~Tutuilla Well~~ Sherwood Well **POD** changed by City	T2N, R 32 E.W.M. Sec. 15 NW of NE	**CPED** ??? now a monitoring well. 820'S & 2240'W of NE Cor. Sec. 15 See City letter to OWRD 12/5/63
15.	None	G 2410	6.7*	10/10/1962	Well #9--South Hill Well	T2N, R 32 E.W.M. Sec. 11 SE of SW	**NCTD**, **CPED** ?? Undeveloped. 1640'S & 1900'E of SW Cor. Sec. 11
16.	None	G 2410	6.7*	10/10/1962	Well #10--Crispin Well *Original Permit as #7*	T2N, R 32 E.W.M. Sec. 6 SE of SW	**NCTD**, **CPED** ?? Undeveloped. 180'N & 2200'E of SW Cor. Sec. 6
17.	None	G 2410	6.7*	10/10/1962	Well #12-McCormack Well *Original Permit as #8*	T2N, R 32 E.W.M. Sec. 11 NE of SE	**NCTD**, **CPED** ?? Undeveloped. 1500' N & 48'W of SE Cor. Sec. 11
18.	None	G 3225	6.7	04/04/1966	Well #7--Mission Well *Original Permit as #10*	T2N, R 33 E.W.M. Sec. 14 NE of SE	Previously called Well #7. N30°00'40"W, 2275' of SE Cor. Sec. 14
19.	None	G 3225	6.7	04/04/1966	Well #11, McKay Creek	T2N, R 32 E.W.M. Sec. 8 SW of NE	**NCTD**, **CPED** ?? Sewage Plant well. S38°33"W, 2706.51' of NE Cor. Sec. 8
20.	None	G 6773 G 11326	1.52 5.18	04/16/1976 12/05/1984	Well #8--Prison Well With well transfer. *Original Permit as #12*	T2N, R 32 E.W.M. Sec. 9 SE of NW	In Use. **CPED** ?? Formerly Well #8. 1640'S and 47'W of NW 1/4 Sec. 9 Transferred from State Permit T 5605

* Intent and allowed to develop a yield of up to 6.7 cfs at each well with a maximum aggregate yield of 20.0 cfs.

POD--Point of Diversion **CPED**--Current Permit Extension Date **NCTD**--No Construction to date.

Each of the water sources current yield and the additional yields available as determined by their water right certificates and permits is presented in Table IV-2 below. The wells are arranged in the order of their initial priority dates instead of their numeral identity.

TABLE IV-2

WATER SOURCE	PRIOR-ITY DATE	CURRENT RATE IN MGD	ALLOWABLE RATE IN MGD	UNUSED AND/OR UNDEVELOPED RATE IN MGD
River @ City	11/11/1885	0.0	1.29	1.29
River @ City	12/31/1890	0.0	0.32	0.32
River @ N. Fork	11/12/1910	0.0	5.17	5.17
River @ N. Fork	03/08/1941	0.0	?.??	?.??
Sub Totals		0.0	6.78 +?	6.78 +?
Flows are not measured individually at each of the springs.				
Wenix Springs	11/28/1910	?.?	2.59	?.?
Shaplish Spring	05/20/1912	?.?	1.94	?.?
3-Simon Springs	04/22/1929	?.?	1.74	?.?
Long Hair Spring	04/22/1929	?.?	1.29	?.?
Sub Totals		5.25	7.56	2.31
Well No. 1 can only pump at the permitted rate for a very few minutes.				
Well No.1	02/23/1944	0.00	2.00	0.00
Well No.3	12/31/1951	0.72	0.72	0.00
Well No.2	09/16/1953	1.62	1.62	0.00
Well No.4	10/18/1954	1.15	1.29	0.14
Well No.5	10/03/1958	3.31	3.42	0.11
* *Well No. 1*	*07/16/1962*	*0.08*	*0.58*	*0.00*
* *Well No. 3*	*07/16/1962*	*0.13*	*0.13*	*0.00*
* *Well No.2*	*07/16/1962*	*1.42*	*2.00*	*0.58*
Well No.6	10/10/1962	0.00	0.00**	0.00
Well No.9	10/10/1962	0.00	4.31	4.31
Well No.10	10/10/1962	0.00	4.31	4.31
Well No.12	10/10/1962	0.00	4.31	4.31
Well No.7	04/04/1966	0.60	4.31	3.71
Well No.11	04/04/1966	0.00	4.31	4.31
Well No.8	04/16/1976	0.98	0.98	0.00
* Well No.8	12/05/1984	0.60	3.35	2.75
Sub Totals		10.53	37.64	27.11
GRAND TOTALS		15.78	51.98+?	36.20+?

* Supplemental Certificates & Permits

**Re-allocated the total 12.93 mgd available equally to the other 3 wells. Change if this well is utilized.

From Table IV-2 the 51.98 mgd in water rights and permits, plus the withdrawal of the North Fork sub-basin, is far in excess of the amount needed in Pendleton's foreseeable future. Unfortunately, some of the sources have diminished capacity in the late spring, summer, early fall months when Pendleton water demands are the highest; some are subject to senior superior water rights, and others are probably not cost effective or possible to develop to the full amount of the water rights and/or permits. The City's springs have not been regulated to date in the summer months because of the conflicting claims to jurisdiction of water on the Umatilla Indian Reservation by the State of Oregon and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Negotiations between the State and the CTUIR is scheduled for 1997, and the final resolution could have a significant negative impact on the viability of the City's springs.

C. WATER SUPPLY COMMITMENT OF WATER SOURCES TO THE CTUIR

In exchange for easements across the Reservation for the gravity water line from the City's springs, the City agreed to provide the CTUIR with water for specific purposes at no charge. The most recent amendment to this agreement provides the CTUIR with the ability to obtain 100,000 cubic feet/per month (748,000 gallons/month) of free water for administrative offices and some housing. During periods when turbidity is over 5 NTU, the water from the springs is bypassed completely. The location of the water line servicing the CTUIR is shown on page I-4, Sheet 2 of 5, approximately one half mile westerly of the chlorination station. Fluoride was formerly injected into the water supply at the same location as the chlorination station.

The CTUIR modified and expanded it's own water system capabilities to supply fluoridated water to all of its users, when the City abandoned the practice of injecting fluoride in the gravity line upstream of the CTUIR's service line approximately 8 to 10 years ago. The patterns of the CTUIR's use as a percentage of the City's total water production over the more recent years are as shown in Table IV-3 below.

TABLE IV-3 CTUIR'S CITY WATER USAGE

YEAR	MONTHS OF USE	MONTHS ABOVE FREE AMOUNT OF 100,000 CU. FT.	ANNUAL USAGE OVER MONTHLY 100,000 CU. FT.	% OF CITY'S TOTAL USAGE
1992	3	1 -- June	28,476 Cu. Ft.	0.30 %
1991	2	0	None	0.05 %
1990	5	2-- June & August	1,124,465 Cu. Ft.	0.61 %
1989	4	4 -- April & July to Sept.	1,075,535 Cu. Ft.	0.64 %
1988	1	1 -- November	1,323,663 Cu. Ft.	0.62 %
1987	4	3 -- July to September	804,278 Cu. Ft.	0.53 %
1986	6	2 -- June & August	373,128 Cu. Ft.	0.32 %
1985	4	2 -- June & August	182,754 Cu. Ft.	0.20 %
1984	3	2 -- July & August	498,529 Cu. Ft.	0.36 %
1983	9	5 -- Jan.-Feb./ June-Aug.	686,631 Cu. Ft.	0.62 %
1982	1	1 -- December	86,096 Cu. Ft.	0.08 %

D. WATER RIGHTS - ADMINISTRATIVE RULES AND REVISED STATUTES

This section is presented without the benefit of legal counsel and to demonstrate the need for the City to retain legal counsel with expertise in the water rights field. The significance of knowing when the Oregon Water Resources Commission (OWRC), the Oregon Water Department's Rules (OAR), and legislatively Oregon Revised Statutes (ORS) changed the rules, policies, and statutes probably can not be overstated. The material presented is therefore for general information on the current rules, statutes, and policies and to provide some general information on the status of the City's water permits and rights, plus areas that may require legal research and opinions.

D.1 OWRC'S APPROVAL OF A CHANGE IN OAR DEFINITION OF RESERVOIRS

OAR: Chapter 690, Division 11, Applications and Permits.

"Definitions 690-11-010 The following definitions apply in OAR Chapter 690, Divisions 11 and 15, and to any permits, certificates or transfers issued under these rules:"

Page 5. "(41) 'Storage' means the retention or impoundment of surface or groundwater by artificial means for public or private uses and benefits."

The Oregon Water Resources Commission (OWRC) at their meeting on October 1, 1993 recommended deletion of "natural or" which was previously included in the above definition just before the word artificial. The amended rule was then published with an effective date of October 1, 1993. This revision was probably made to distinguish between water stored in underground aquifers by artificial recharge versus impoundments (dams) and/or reservoirs (enclosed type) and probably disqualifies artificial recharge into the basalt aquifers from the reservation of 100,000 acre feet in OAR 690-507-050 (2) (c) (C) recited verbatim in the subsection below.

D.2 SELECTED OAR's PERTAINING TO ARTIFICIAL RECHARGE

From the same division of the OAR's in D.I the following definitions:

690-11-010-"(4) 'Artificial groundwater recharge' means the intentional addition of water to a ground water reservoir by diversion from another source."

690-11-010-"(37) 'Recharge Permit' means a permit for the appropriation of water for the purpose of artificial ground water recharge."

690-11-010-"(42) 'Stored recharge water' means the retention or impoundment of surface or groundwater by artificial means for public or private uses and benefits."

690-11-010-"(43) 'Storage account' means a net volume of artificially recharged ground water which is calculated for a single recharge activity from a formula specified in a single recharge permit which records additions to a ground water reservoir by artificial recharge and depletions from a ground water reservoir by pumping and natural losses."

D.3 UMATILLA BASIN PROGRAM SELECTED OAR's .

In the previous Chapter III:

- Page III - 10, subsection D.2, the policy encouraging Artificial Recharge of the Oregon Resources Commission is recited as a management tool for municipalities.
- Page III - 10, subsection D.3, the objective cited in the Upper Umatilla River Subbasin encouraging Artificial Recharge as a means of offsetting the declining water table in basalt aquifers is quoted in full.

D.4 WATER RIGHT TRANSFERS, SELECTED OAR'S

Chapter 690, Division 15, Water Right transfers.

"Change in Point of Diversion: 690-15-010

(1) An application for a change in point of diversion is not required if:

(a) The change is due solely to the movements of a naturally changing stream channel;

(b) The new diversion point stays within 500 feet of the diversion point of record;

(c) The change does not move the diversion point upstream or downstream beyond the diversion point of another appropriator.

(2) A change in point of diversion is restricted to the same natural source of water. Whether or not a protest is filed, whenever a change in point of diversion along a stream channel would move the diversion point past a point of substantial inflow, the applicant shall submit evidence showing how the transfer can be effected without injury to existing rights and minimum stream flows."

"(3) A water supply authority may change the points of diversion or move the water intake sources of the water use permits conveyed to it by the districts and municipalities that formed the water supply authority. Moving a water intake source is the same as changing the location of a point of diversion:

(a) A change in the location of a point of diversion from that authorized by a certificate of water right requires a transfer in accordance with ORS Chapter 540 and OAR 690, Division 15 transfer rules:

(b) A water supply authority shall submit a written request to the Director requesting a change in the location of a point of diversion authorized by a water use permit. The written request shall include a completed Department water right transfer application form:"

D.4 WATER RIGHT TRANSFERS, SELECTED OAR'S (Cont.)

"(c) A request by a water supply authority to change the location of a point of diversion authorized by a water use permit shall be subject to the same statutory and administrative review criteria prescribed by ORS Chapter 540 and OAR 690, Division 15 transfer rules for perfected water rights; and

(d) Upon approval of a change in the location of the point of diversion authorized by a water use permit, the Director shall issue and order amending the water use permit to reflect the approved change in the location of the point of Diversion."

D.5 POINT OF DIVERSION CONSTRAINTS

From OAR: Chapter 690, Division 11, Applications and Permits.

Definitions 690-11-010 The following definitions apply in OAR Chapter 690, Divisions 11 and 15, and to any permits, certificates or transfers issued under these rules:

Page 5. "(50) 'Water right subject to a transfer' means a right established by a court decree or evidenced by a valid water right certificate, or a right for which proof of beneficial use of water under a water right permit or transfer has been submitted to and approved by the Director but for which a certificate has not yet been issued."

The above OAR specifically avoids the inclusion of water rights when they are in the permit status. I discussed this with Robert E. O'Rourke, local attorney specializing in water rights, and he informed me that some years ago (8 +/-) this definition was amended to bring the rules into conformance with the long standing policy of the OWRD and the OWRC. Prior to this time he cited a state supreme court ruling that a Point Of Diversion (POD) was transferable in a water right application while it was in the permit status. Apparently one of the few instances of an approved change in a POD by the OWRD was City's Well #6 (formerly Tutuilla Well, now the Sherwood Well).

The rationale for the OWRC and OWRD taking this position appears to defy logic. This essentially requires an applicant to construct the POD within a small area, which may for some unforeseeable reason, make it impossible to construct or prohibitively expensive. [1] Based on discussions with OWRD staff, the City would have to make material developments at the North Fork of the Umatilla River to validate the 1910 water permit on the North Fork of the Umatilla River before a change in the POD would be considered. [1] A similar question as to the appropriate location for POD might arise on the 1941 legislature's withdrawal of the North Fork drainage basin in favor of the City of Pendleton.

[1] Subsequent to the publishing of the first draft of this Master Plan, the 1955 Oregon Legislature passed legislation enabling the City to relocate these Points of Diversion without requiring the City to make improvements and place the water to beneficial use at the original Points of Diversion.

D.5 POINT OF DIVERSION CONSTRAINTS (Cont.)

"Compatibility with Acknowledged Comprehensive Plans: 690-15-057

(1) The Department and Commission shall meet requirements established in OAR 690-05-045 (Standards for Goal Compliance and Compatibility with Acknowledged Comprehensive Plans) in evaluating and taking action on transfer applications except as specified in OAR 690-05-025 and OAR 690-05-025 and OAR 690-15-05 (16).

(2) In the event of a land use dispute, as defined in OAR 690-05-015 (Definitions), the Department shall follow procedures provided in OAR 690-05-040 (Resolution of Land Use Dispute)."

"Municipal Water Rights: 690-15-140

(1) Water used by municipality for municipal use under a permit, perfected water right or conferred by ORS 538.410 to 538.450, may be used at any lands acquired by annexation, merger, consolidation, or by the formation of a water supply authority. A municipality also may use water beneficially on any lands so long as the use continues to be for municipal purposes and the place and nature of use are compatible with local comprehensive plans. Changes in the originally authorized place of use pursuant to ORS 540.510 may be made so long as the changes do not cause injury to other vested rights. The rate of use of water by a municipality shall not exceed that allowed by its existing rights.

(2) Interference with or impairment of any prior vested water right due to municipal use of water by a municipal supplier on lands other than those described by its water right is cause for the Director to restrict the use of water. Municipal use of water may be restricted to the lands described by previous water use authorizations if such an action eliminates the interference with or impairment of prior vested water rights."

From the above OARs it would appear that a transfer of a point of diversion could involve quite a few private and public entities.

D.6 SPECIAL MUNICIPAL WATER SUPPLY RIGHTS PRIOR TO 1909

The following is quoted from ORS 538.410.

MUNICIPAL WATER SUPPLY

"538.410 Confirmation of water rights acquired prior to February 24, 1909, for municipal supply; rejection of applications injurious to municipal supply; statements of supply. All rights to the waters lakes, rivers, and streams of this state acquired before February 24, 1909, for the purposes of municipal water supply are confirmed, and no rights acquired under the Water Rights Act (as defined in ORS 537.010) shall impair the rights of any municipal corporation to waters taken before February 24, 1909. The Water Resources Commission shall reject, or grant subject to municipal use, all applications where, in the commission's judgement, the appropriation of the waters applied for impairs a municipal water supply. Municipal corporations of the state, on request of the Water Resources Commission, shall furnish a statement of the amount and source of the municipal water supply, with probable increase or extension of same."

D.7 MUNICIPAL WATER PERMITS AND RIGHTS PROTECTED FROM CANCELLATION

In regards to the cancellation of a permit for appropriation of a municipal water right, the following is quoted from the Oregon Revised Statutes with bold type added for emphasis in selected excerpts. Boldness added for emphasis on municipal rights.

"Cancellation of Permit for Appropriation

537.410 Failure to commence or complete work, or to properly apply water as grounds for cancellation of permit; irrigation districts and **municipalities excepted**.

(1) Whenever the owner of a permit to appropriate the public waters of Oregon fails to commence actual construction work within the time required by law, or having commenced construction work as required by law, fails or neglects to prosecute the construction work with reasonable diligence, or fails to complete the construction work within the time required by law, or as fixed in the permit, or within such further time as may be allowed under ORS 537.230, or having completed construction work fails or neglects to apply the water to beneficial use within the time fixed in the permit, the Water Resources Commission may cancel the permit on the records in the Water Resources Department as provided in ORS 537.410 to 537.450.

(2) **However, permits issued by the commission to** irrigation districts for reclamation purposes under the irrigation district laws of this state, or **to municipal corporations for municipal uses of purposes, are not subject to cancellation under the provisions of ORS 537.410 to 537.450. [Amended by 1985 c.673§41]**."

also

"ABANDONMENT OF WATER RIGHTS

540.610 Use as measure of water right; abandonment or right for nonuse; **nonapplicability of section; confirmation of rights of municipalities.**"

"(1) Beneficial use shall be the basis, the measure and the limit of all rights to the use of water in this state. Whenever the owner of a perfected and developed water right ceases or fails to use all or part of the water appropriated for a period of five successive years, the failure to use shall establish a rebuttable presumption of forfeiture of all or part of the water right. Thereafter the water which was the subject of use under such water right shall revert to the public and become again the subject of appropriation in the manner provided by law, subject to existing priorities.

(2) Upon a showing of failure to use beneficially for five successive years, the appropriator has the burden of **rebutting the presumption of forfeiture by showing one or more of the following**:

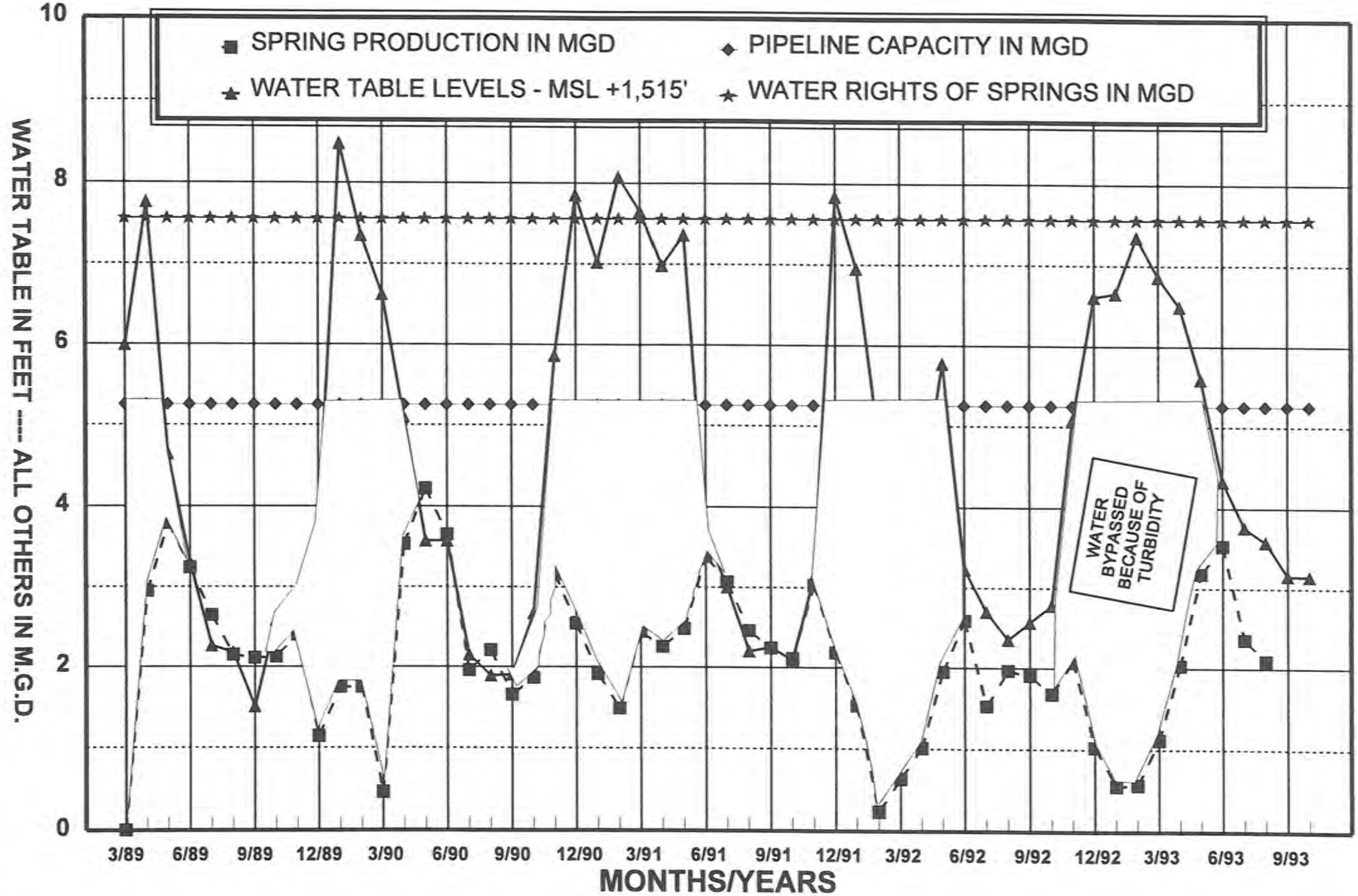
(a) **The water right is for use of water or rights of use acquired by cities and towns in this state, by appropriation or by purchase, for all reasonable and usual municipal purposes.**

(b) **A finding of forfeiture would impair the rights of such cities and towns to the use of water, whether acquired by appropriation or purchase, or heretofore recognized by act of the legislature, or which may hereafter be acquired.** ....

(3) The right of all cities and towns in this state acquire rights to the use of the water of natural streams and lakes, not otherwise appropriated, and subject to existing rights, for all reasonable and usual municipal purposes as may reasonably be anticipated by reason of growth of population, or to secure sufficient water supply in cases of emergency, is expressly confirmed."

In discussions with OWRD staff on the above OARs they cited other cities (Portland, Salem, etc.) which have yet to fully develop their water rights. They don't see any reason why Pendleton should not fully develop their water rights on the springs sources.

PENDLETON SPRING PRODUCTION VERSUS WATER TABLE DEPTHS



E. SPRINGS COMBINED SOURCES--- DEVELOPED AND UNDEVELOPED (Cont.)

Constraints imposed by state and federal regulations requires the City to blend water from the City's springs with water from Well #7 (Mission) whenever the turbidity measured at the Gate House and Weir exceeds 5 Nephelometric Turbidity Units (NTU). Well #7 can produce approximately 420 gpm (0.605 mgd). To stay within 5 NTU, the springs can only transmit 840 gpm with a turbidity of 7.5 NTU. This provides a maximum combined source capacity of 1,260 gpm or 1.814 mgd. Whenever the turbidity exceeds 7.5 NTU, the City bypasses the water from the springs to the river and uses Well #7 to supply the City and the Indian Agency with water.

On page IV-18 is another graph similar to the graph on page IV-16. This graph emphasizes the inability to utilize the City's springs water rights over the last 4 years. If it would be possible to fully utilize the springs water rights and store the water during periods of surplus in a successful ARR project for later use, the springs could meet the City's water demands for several years.

During 1990 and 1991, the City did some periodic sampling of the springs and the Umatilla River. This was in conjunction with the particulate sampling and testing regime it was following to document to the Oregon Health Division that the City did not have to provide filtration treatment for the spring sources. Table IV-4 on page IV-20 shows the results of that sampling, and contrary to what would be expected, most of the time the turbidity of the springs are higher in the winter than the Umatilla River. This is supportive of the City's position that the source of the spring supply is not influenced by the Umatilla River. However, the State Health Division has ruled that the City's springs are influenced by the Umatilla River.

A review of the City's water demands for the years 1967-1978 and 1982-1992, indicate that there is approximately an additional 1.5 to 1.7 mgd quantitatively available during the six winter months of the year from the City's springs. The additional amount available during the winter months was arrived at by reviewing pages 92 to 103 of prior 1979 Water Study[1] and in Chapter II, the Tables II-5 to II-15, pages II-10 to II-32 respectively of this report.

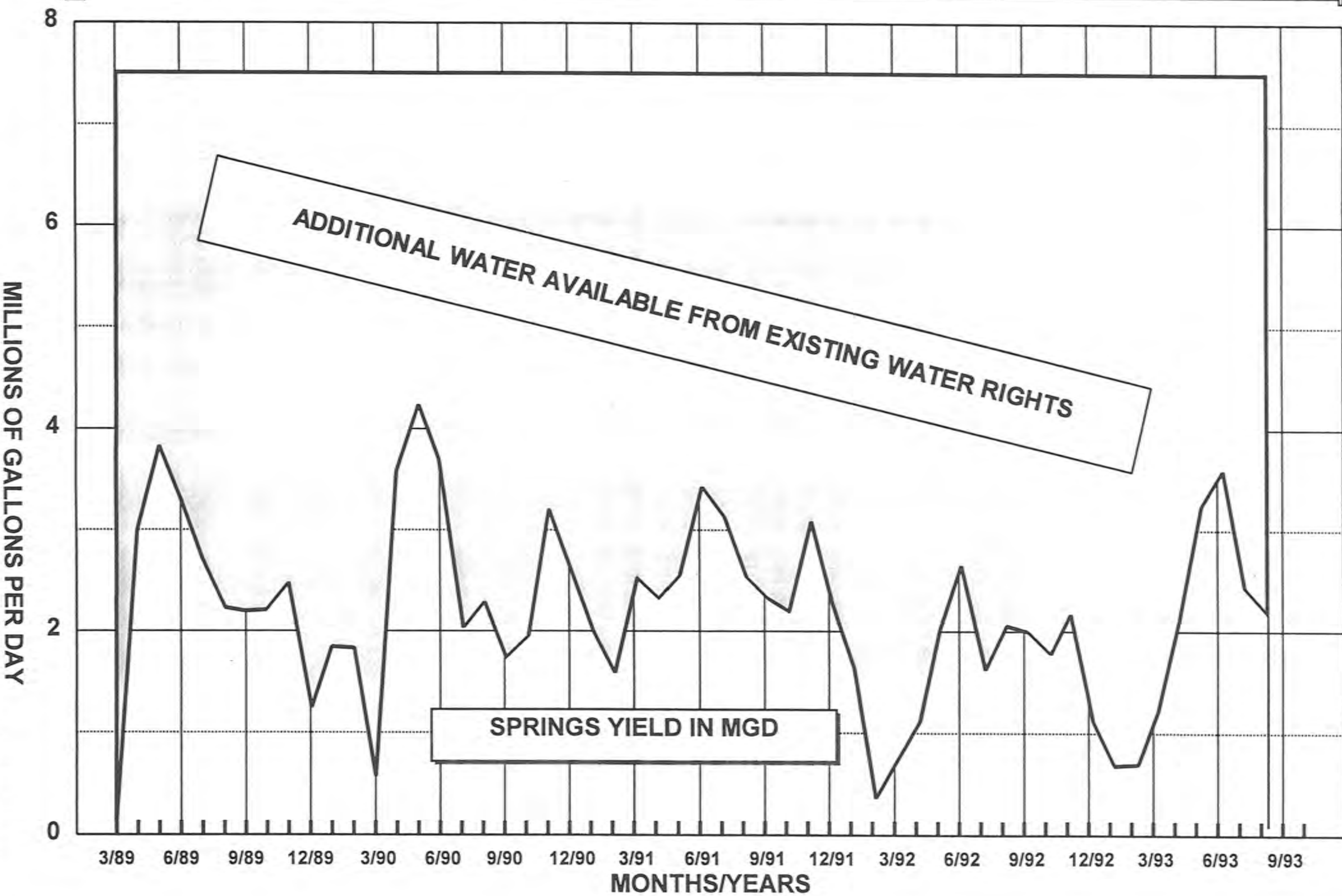
Based on one years data on turbidity monitoring, the spring sources should be easily treatable by either rapid rate filters or slow sand filters. Slow sand filters are more limited on their ability to treat highly turbid water sources. Conditions favorable to slow sand treatment are: turbidity over 50 NTU a few days/year, generally less than 20 NTU, and usually less than 5 NTU. From the one years turbidity data shown on page VII-15, the records show for one year:

% of the time turbidity is less than 5 NTU:	80.0%
% of the time turbidity is from 5+ NTU to 10 NTU:	13.7%
% of time turbidity data not recorded:	6.3%

There were times during this first year of operation of the Supervisory Control and Data Acquisition System that programming of the central computer prevented the recording of turbidity data from the springs. There was also some days when the springs were turned off because the turbidity was to high for blending down to 4.5 NTU with the output from City Well #7.

1 "Water Study for the City of Pendleton, Oregon", September 1979. Wallulis and Associates, Inc.

YIELD FROM SPRINGS VERSUS AVAILABLE WATER RIGHTS



C:\123R4W\DATA\PENDLETN.931\SPRINGBY.PAS\IND-WELL.WK4

The amount of surplus water from the spring source with different assumptions follows:

If all the spring supply is fully developed to equal the present water rights and permits (7.56 MGD), the annual yield would be:	=	2,759.9 MG/year
Average annual demand for the City from 1982 to 1992, inclusive:	=	1,695.0 MG/year
Annual surplus water available for storage (ARR):	=	1,064.9 MG/year

If all the spring supply is fully developed to equal the present water rights and permits (7.56 MGD), the annual yield would be:	=	2,759.9 MG/year
The highest year of water demand occurred in 1992 and was:	=	1,879.7 MG/year
Surplus available for storage even during the maximum year:	=	879.2 MG/year

If all the spring supply is treatable and partially developed **equal to the gravity pipeline capacity (5.25 MGD)**, the yield	=	1,916.3 MG/year.
Average annual demand for the City from 1982 to 1992, inclusive:	=	1,695.0 MG/year
Annual surplus water available for storage (ARR):	=	221.3 MG/year

The amount of water from the City's springs and pumped from Well #7 (Mission) that overflows at the South Hill Reservoir(s) is reflected in the City's annual production records. The amount of water that may not be retrievable in a successful ARR project could be less than the amount that has historically overflowed from the springs and pumped from Well #7.

An additional supply could be obtained by utilizing the 1885 Water Right (2.0 cfs) and the 1890 Water Right (0.5 cfs) from the Umatilla River which total 1.615 mgd (589.5 MG/year). These are year around rights and could accumulate a substantial surplus in mass storage over a period of years. As near as can be determined, the point of diversion for these two rights is located near the southwesterly corner of the railroad bridge across the Umatilla River on the easterly side of the City.

F. MISC. DATA/INFORMATION ON INDIVIDUAL SPRINGS & COLLECTOR LINES

The comments made in this section are not intended to serve as a sanitary survey of the spring sites. During the preparation of this report some comments were made that the springs are no longer surfacing and a question was raised as to the legality of changing them from their original state. It is generally known in the industry that the normal practice in developing a spring for potable use is to intercept the water at a level below the surface and transport it to a structure where it can be:

- Quality and quantity monitored,
- Placed in a transmission line,
- The surplus safely returned to a stream, and
- Provides a point of access to service the sub-surface collector piping.

By intercepting the spring supply below the surface, the risk of contaminating the spring source is greatly diminished. Larger springs, like Pendleton's, typically have access structures such as manholes and cleanouts for observation, control and service.

TABLE IV-4

BOLD Numbers = HIGH TURBIDITY (Note: springs higher in the winter than the River)

TEST DATES	TURBIDITY IN RIVER	TURBIDITY AT WEIR HOUSE
1/15/90	**5.20**	4.99
1/24-29 & 2/5/90	1.74/1.62/2.43	1.74/1.62/**4.5**
2/12-22/90	**7.52/6.50**	4.62/5.38
2/26/90	5.80	**6.50**
3/5-12-19/90	**NO READINGS, TURBIDITY TO HIGH, WATER TURNED OUT**	
3/26/90	2.60	**3.10**
4/2-9-16-25/90	2.00/2.30/1.98/1.65	**3.80/3.70/2.49/2.15**
5/2-7/90	**7.30/2.98**	3.25/2.40
5/14/90	2.10	**2.65**
5/21-30/90	**3.20/5.45**	2.00/1.70
6/6-13-20/90	2.19/1.95/1.87	**2.50/2.35/2.20**
6/27 & 7/5-11-18-27/90	**1.55/1.15/2.30/1.87/1.75**	1.35/1.00/0.95/0.85/0.80
7/5-11-18-27/90	**1.15/2.30/1.87/1.75**	1.00/0.95/0.85/0.80
8/1-8-15-24-29/90	**1.73/1.57/1.74/1.75/1.49**	0.80/0.85/0.85/0.85/0.85
9/5-10-17-24/90	**1.41/1.45/1.49/1.30**	0.89/0.85/0.80/0.80
10/1-10-17-21-30/90	**2.50/1.17/1.10/1.55/1.35**	0.85/0.90/1.01/1.15/1.25
11/7-14/90	**1.35/1.41**	0.95/1.15
11/19/90	1.04	**1.05**
11/28 & 12/5-12-19/90	**2.13/1.80/2.98/1.55**	1.10/1.25/1.20/1.22
12/26/90	1.25	**1.55**
1/4/91	**1.84**	1.15
1/9/91	1.01	**1.25**
1/14/91	**5.45**	3.49 **WATER TURNED OUT**
1/23/91	**7.55**	5.00
1/30/91	2.65	**3.90**
2/4-13-20-27/91	1.25/2.65/3.55/2.50	**3.25/3.40/4.40/4.49**
3/4-13-19-27/91	2.20/2.90/3.60/3.35	**4.20/4.45/4.10/3.85**
4/3-8-17-22-29/91	2.60/2.65/2.90/2.00/2.45	**4.35/4.05/3.45/3.05/2.95**
5/6-13/91	1.80/2.05	**2.45/2.40**
6/5/91	**3.90**	2.75
6/12/91	1.65	**1.90**
6/17-24/91	**1.72/1.71**	1.44/1.24

F. MISC. DATA/INFORMATION ON INDIVIDUAL SPRINGS & COLLECTOR LINES (Cont.)

The following comments are based on observations from a walk through with Bob Mahoney from the City's water department. The City's large maps (file # 24-4090) of the spring sites was used for this walk through of the springs. Some time was spent trying to find most of the manholes and sample wells without any success on the latter.

Since the earlier 1979 Study[1], the City has greatly improved the periodic maintenance of the spring sites by clearing practically all of the land surface of brush, blackberry vines, and a full array of wild growth. This has greatly reduced the need to remove rooted growth which formerly reached the collector lines. The improved fencing of the property with limited locked accesses has materially reduced trespassing.

F.1 WENIX SPRINGS (Often referred to as Thorn Hollow)

A search was made for some of the observation wells shown on the City's plan without success. Finding these observation wells will probably require some field surveying.

F.2 SHAPLISH SPRING SITE

Nothing was noted worthy of comment.

F.3 THREE SIMON SPRINGS SITE

During a field investigation as a part of this report, the water leaving Manhole #16-A did not go to Manhole #16 as it should have according to the most recent record drawings (1976). The next downstream Manhole #15 could not be found, and where this water went could not be determined. Several of the monitoring wells shown on the drawings could not be found and probably can only be found by an actual field survey, if they still exist.

F.4 LONGHAIR AND SQUAW CREEK SPRINGS

The Long Hair (Squaw Creek) Springs source has been used intermittently in recent years because the quality of water from this source varies considerably more than the other springs.

F.5 SUMMARY OF CITY'S SPRINGS AS A VIABLE SOURCE OF WATER

Tony Justus, Watermaster of the Pendleton Office, has stated that the City's springs have not been regulated to date in the summer months, because of jurisdictional claims by the CTUIR to the water on the Umatilla Indian Reservation. Negotiations between the State and the CTUIR could start before 1997, and the final resolution could have a significant impact on the viability of the City's springs. This could restrict or cease the use of these sources in the summer months. A reduction in the projected annual supply of water from these springs is a possibility.

[1] "Water Study for the City of Pendleton, Oregon", September 1979. Wallulis and Associates, Inc.

I. OTHER WATER SUPPLIES CONSIDERED IN PRIOR STUDIES (Cont.)

I.1 RESERVOIRS (Cont.)

The author of this report and several other members of the Umatilla Sub-Basin Citizens Advisory Committee objected to the OWRD's staff insisting on the multi-purpose requirement for the following reasons:

- ***There are no federal or state funds to fund or even participate in funding for the multi-purpose uses of fish, wildlife and recreation,*** plus all indications are that there will not be anymore funding of consequence in the future. State and federal representatives that attended the meetings concurred that future funding from either the state or federal government was highly unlikely.

- That municipalities should be offered the opportunity to participate in the project on a prorate basis, but not require the owner of the new storage impoundment to provide such municipal storage without any participating funding from the municipality(ies) that would need such water.

- The mandate requiring indirect benefit for others, may curtail the economic growth in Umatilla County. An otherwise financially sound commercial and/or industrial endeavor, ***that would need an economical stored water supply*** for their enterprise may have to abort their plans, resulting in a lost opportunity for economic growth.

- This requirement of multi-purpose uses has the same impact on a municipality as it does for a commercial or industry stated above. This in turn could materially restrict the growth of the city(ies) and have an adverse effect on the quality of water being stored for potable municipal use.

Unfortunately, the OWRD staff's position prevailed over that of the Advisory Committee. This new requirement only added to the negative cost/benefit ratio arrived at in the prior reports/studies. Therefore, the authors of this report and the City Staff reaffirm that no serious consideration be given to the construction of an impoundment until other projects with a better cost/benefit ratio have been completed. The different storage facilities in the earlier studies were as follows:

- McKay Reservoir - no water storage available and permit use restrictions.
- Mission Reservoir - not constructed, CTUIR objects to this reservoir.
- Columbia River - Moratorium by OWRD, for restoration of fishery.
- North Fork Reservoir on the Umatilla River - not constructed.
- South Fork Reservoir on the Umatilla River - not constructed.
- North Fork of Meacham Creek Reservoir - not constructed.
- Lick Creek Reservoir near the Umatilla River - not constructed.
- Squaw Creek Reservoir near the Umatilla River - not constructed.
- Ryan Creek Reservoir near the Umatilla River - not constructed.

I. OTHER WATER SUPPLIES CONSIDERED IN PRIOR STUDIES (Cont.)

I.2 CHENEY SPRINGS

This source was found to be directly responsive to the flows in McKay Creek and upstream irrigation on higher ground. When McKay Creek dried up in 1976 Mr. Cheney had to dig a trench to gain access to shallow ground water for his stock. This source is not a viable water source for the City.

1.3 BROGOITTI WELL

In the prior 1979 Study[1], this well was found to:

- Have a water table elevation similar to those of the City's
- Be experiencing water table declines similar to the City's

The above is indicative that this well is withdrawing water from the same underground basalt aquifer(s) as the City's wells.

John Brogoitti has indicated he would consider selling this well to the City. The primary benefit of ownership of this well is the obtaining a water right with an early priority date in the event that a Critical Groundwater Area is declared in and around Pendleton. The information on this well shown in Table IV-5 below was obtained from the Umatilla County Watermaster's office.

TABLE IV-5

	PERMIT #1	PERMIT #2	PERMITS #1 & #2
Priority Date	March 5, 1957	Sept. 27, 1965	N.A.
Permit Number	G 465	D 3044	N.A.
Certificate Number	28,602	40,893	N.A.
Irrigation Season	March 1 - October 31	March 1 - October 31	N.A.
Flow Rate	1.44 cfs/646 gpm 0.934 mgd	1.34 cfs/601 gpm 0.865 mgd	2.78 cfs/1,247 gpm 1.796 mgd
Duty (per year)	3.0 acre feet 112,410,936 gallons	3.0 acre feet 104,786,542 gallons	3.0 acre feet 217,197,478 gallons
Acreage	115 acres	107.2 acres	222.2 acres
Municipal Equiv.	214 gpm 0.308 mgd	199 gpm 0.287 mgd	413 gpm 0.595 mgd

If the City decides to acquire this well and convert it from a farm irrigation well to a municipal well the flow rate would be reduced from the current rate of 1,247 gpm (March 1 to October 31) to a rate of 413 gpm on a 12 month basis. As the City's seasonal water demands are somewhat similar to the farming irrigation season, it would be best to leave the well in its current status, change the place of use, and shut it down from November 1 to April 30 of each year.

1 "Water Study for the City of Pendleton, Oregon. September 1979." Wallulis and Associates, Inc.

I. OTHER WATER SUPPLIES CONSIDERED IN PRIOR STUDIES (Cont.)

I.4 MILTENBERGER WELL

This well was removed from consideration in the prior study because of it's close proximity to other City wells, and faulty construction (plumbness and cascading water from the upper to lower aquifer[s]).

In addition to the above, a new application would have to be processed for an increase in the amount of yield for it to have usefulness as a municipal well. With a continuing decline in the water table of the underlying basalt aquifers, there is a likelihood that there will be a Critical Groundwater Area (CGA) declared sometime in the not to distant future. A priority with a current date would be a candidate for early curtailment as there are several other deep wells with senior water rights. The development and/or re-development of the City's permitted wells #6, #9, #10, #12 with 1962 priority dates, undeveloped and partially developed wells, would be a more prudent course of action.

J. CITY'S SPRING'S WATER QUALITY ISSUES

Federal and state promulgations mandate that suppliers of water under the influence of surface waters treat their water by filtration. For several years the City has been gathering evidence and documentation to show that it has control over the watershed and that the City's springs are not influenced by the Umatilla River.

The City's documentation that there is no cross contamination from the Umatilla River consists of a **comparative particulate analysis** of water samples simultaneously collected at the springs and from the river. The City's position is that the test results to date, document that there is a significant and materially different and better quality of the water from the springs than from the river. Based on this analysis and the City's control over the watershed, the City's position has been that treatment by a water filtration plant is not required for customer acceptance, unless the springs are utilized at periods of high turbidity (5+ NTU without blending at Well #7).

However, the Oregon Health Division's position after reviewing the City's data, is that the data indicates that the City's springs are influenced by surface water and will not continue to be classified as groundwater. Such a determination would mandate turbidity limitations that would result in the shutting down of inflow from the collector piping sources with the highest turbidities and/or bypassing all the spring supply downstream to the Umatilla River for months at a time. This would then require increased usage of the City's wells on a year around basis and escalate the decline of the water table in the underlying basalt aquifers.

The City's springs must again become a viable and major water source in meeting the City's current and future water demands. The issue is no longer about whether the springs need treatment when the turbidities are above a 1.0 NTU by State mandate or 5.0 NTU for customer acceptance, but on the need of being able to utilize this source continuously at times when turbidities are higher. As a minimum, the springs should be treated by filtration to maintain turbidities below 1.0 NTU to eliminate the risk of the springs being determined by the Oregon Health Division to be under the influence of the Umatilla River.

J. CITY'S SPRING'S WATER QUALITY ISSUES (Cont.)

With the installation of the SCADA system this in the fall of 1993, the City is for the first time accumulating continuous data on the turbidity of the spring water supply. While this data is helpful to the design of a water filtration plant, the data will be skewed somewhat to yield results more favorable than actual conditions. This is because the City selectively turns out water at the Gate House and Weir and/or valves off the water from the collector piping at the spring that has the most turbid water during periods of high turbidity.

K. SUMMARY ON THE SPRING SOURCES

The water from the springs is a true replenishable supply as long as the area receives precipitation. Turbidity levels in the spring sources delivered to the consumers has been lowered in the past in response to governmental mandates and for customer satisfaction. This has resulted in a very substantial reduction in the availability of the spring sources for municipal uses. Ever since the City's first Well #1 went on line in 1948, this well and later ones were utilized at times of high turbidities in the water at the springs. With filtration of the City's springs, requiring pumping from the City's deep wells in the future because of turbidity at the spring sources, should be a rare event.

The treatment required to lower the turbidity of the spring supply to a level satisfactory to the Oregon Health Division, and the EPA to qualify as a potable water supply, will also qualify the treated water as a source for an Artificial Recharge and Recovery (ARR) project by the Department of Environmental Quality (DEQ), and the OWRD. We are recommending that the spring sources be given the highest priority and that they be developed to the maximum amount of their water rights.

K.1 HYDRAULIC ANALYSIS -- GRAVITY TRANSMISSION LINE, WEIR HOUSE TO CITY

Options to develop the full potential of the existing spring's water rights will be discussed in the balance of this chapter. However, before these options are pursued, the City's record data on the springs and the transmission line should be brought up to date. The data base indicates that there are multiple maps of the system that have been generated over the last 80 years. Some of these drawings could be scanned onto a floppy disk and others by the use of a digitizer transferred into a computer for the generation of one master computerized drawing.

Of particular interest is the gravity transmission line from the springs. During this report preparation, the pressurizing of the line to increase it's carrying capacity was considered, but determined to be not a cost effective solution (leakage at pipe joints). Preliminary hydraulic calculations revealed some interesting information and possible options on the future utilization of the gravity line from the City's springs weir and gate house.

Except for references to the 24" square pipe, the following data below is from prior studies[1,2]:

1 Pages 10 (Fig.4 a map),11 & 12 "Progress Report on a Water Supply Investigation" September, 1950 . Cornell, Howland, Hayes & Merryfield.

2 Pages 7 & 8 "A Report on an Engineering Investigation of the Water Supply System, Part I, City of Pendleton, Oregon", July 1962. Cornell, Howland, Hayes & Merryfield.

K.1 HYDRAULIC ANALYSIS--GRAVITY TRANSMISSION LINE, WEIR HOUSE TO CITY (cont.)

GIVEN DATA AND COMPUTATIONS BASED ON THE DATA:

Q or flow:	5.25 mgd or 3,646 gpm or 8.124 cfs
Transmission line sizes:	26", 24", 20" & 18" round pipe (+ 24" square pipe)
Velocities	2.20, 2.59, 3.73, 4.60 (2.03) ft/second respectively
Distance Springs to City:	16.37 miles = 86,434 lineal feet
Elevation difference Springs-City	1,583 - 1,327 = 256'
Average slope of gravity line:	0.00296 feet/feet
Friction factor for gravity piping:	n = 0.012 in the Manning Formula (1950 Report)
	n = 0.011 correction for flow adjustment (1962 Report)

Manning Formula: $Q = (A)(1.486/n)(R^{2/3})(S^{1/2})$ or $(A)(1.486/n)(D/4^{2/3})(S^{1/2})$

where: Q = flow in cfs, A = cross sectional area of pipe, R = hydraulic radius, S = slope in vertical feet/horizontal feet (head loss in feet/feet), and D = diameter in feet.

therefor: $8.124 \text{ cfs} = (A)(135)(D/4)^{2/3}(S)^{1/2}$, or

$S^{1/2} = 0.0601 \text{ cfs} /(A)(D/4)^{2/3}$ and solving for:

Head Loss per 1,000 feet when: The flow rate is 5.25 mgd and friction factor = 0.011 and solving for S (head loss required).

24" sq. pipe	26" pipe	24" pipe	20" pipe	18" pipe
0.6'	0.6'	0.9'	2.5'	4.3'

Taking this developed information a step further, we decided to determine what the sizes and lengths of piping might be representative of the gravity line. The following computations indicate one of several possible combination of the different pipe sizes. **It does however, point out that there is a large amount of 18" diameter piping in the gravity line which consumes a significant portion (+/- 80%) of the available head (256 feet)**.

PIPE SIZE	LENGTH IN FEET	LENGTH MILES	HEAD LOSS per 1,000 FT.	HEAD LOSS FOR LINE
26" Round or 2' Square	1,000	0.19	0.6	0.6
24" Round	27,624	5.23	0.9	24.8
20" Round	10,000	1.89	2.5	25.0
18" Round	47,810	9.05	4.3	205.6
	86,434	16.37		256.0

Now if the total length of the line were 24" in diameter, the pipeline based on the above data and computations would be capable of delivering the following flow rate:

$$Q = (3.14 \text{ sq. ft.})(135)(0.5')^{2/3}(0.00296)^{1/2}$$
= 14.54 cfs
= 6,525 gpm
= 9,396,000 gallons per day

City's springs combined permits: = 7,561,382 gallons per day

Additional line carrying capacity = 1,834,618 gallons per day

The existing pipe sizes may be determined by the grade it is laid to, which would make the above assumption correct only with pressurized pipe materials. One method of increasing the flow capacity of the 18" and 20" lines would be to lay an additional pipe line alongside them. A hydraulic analysis of the piping and ground line profile would be necessary to assure that other sections of the pipeline would not be subject to negative and/or excessive pressures. As this may be one of the viable options to the City we will determine what sizes of pipe would be required along side the 18" and 20" diameter pipes to bring these sections of the transmission line equal to a single 24" pressurized line.

FOR ALONGSIDE THE EXISTING 20" DIAMETER PIPE:

Find the flow in a 20" pipe for an allowable head loss of 0.00296 feet/foot

$$Q = (A)(135)(D/4)^{2/3}(0.00296)^{1/2}$$
$$= 2.18 \times 135 \times 0.558 \times 0.0544$$
= 8.93 cfs or 4,000 gpm or 5.76 mgd

Carrying capacity of new pipe and diameter required with head loss = 0.00296 feet/foot:

Additional carrying capacity required :

14.54 cfs capacity of 24" diameter pipe
-8.93 cfs capacity of 20" diameter pipe
5.61 cfs additional capacity required

$$(A)(D/4)^{2/3} = Q/(135)(0.00296)^{1/2}$$
$$(A)(D/4)^{2/3} = 5.60/(135)(0.0544) = 0.76$$

The required resulting pipe size = 16.75" diameter

A 16" diameter ductile iron pipe has a larger inside diameter than the nominal 16" size. The inside diameters are 16.72", 16.66", and 16.60" for pipe classes 50, 51 and 52 respectively. Any of the three classes are within the accuracy of these calculations.

FOR ALONGSIDE THE EXISTING 18" DIAMETER PIPE:

Find the flow in a 18" pipe for an allowable head loss of 0.00296 feet/foot

$$Q = (A)(135)(D/4)^{2/3}(0.00296)^{1/2}$$
$$= 1.77 \times 135 \times 0.52 \times 0.0544$$
$$= 6.76 \text{ cfs or } 3{,}030 \text{ gpm or } 4.37 \text{ mgd}$$

Carrying capacity of new pipe and diameter required with head loss = 0.00296 feet/foot:

Additional carrying capacity required :

14.53 cfs capacity of 24" diameter pipe
-6.76 cfs capacity of 20" diameter pipe
7.77 cfs additional capacity required

$$(A)(D/4)^{2/3} = Q/(135)(0.00296)^{1/2}$$
$$(A)(D/4)^{2/3} = 7.77/(135)(0.0544) = 1.06$$

The required resulting pipe size = 19.0" diameter

There are not any 19" diameter nominal sized pipes on the market. The spiral wound steel jacketed in a concrete cylinder may be a possibility. Nominal 20" diameter ductile iron pipe would probably be the closest comparable alternate.

We are not recommending that there be any upgrading of the carrying capacity of the transmission line by addition of the above parallel piping without:

- An accurate plan and profile map
- Based on accurate field data, including televising the full length of the line.
- Field verification of ground line and pipeline invert elevations, plus the pipe sizes.
- Representative inspection on pipe construction and condition.
- Recognize inflow capacity available at City Well #7.
- Include the 30" diameter piping installed during I-84 Freeway const.
- Verification of the amount of flow available from the springs. Televising of existing and any newly installed lines and appurtenances is recommended.

From the above, develop a complete hydraulic profile of the (gradient) gravity transmission line from the weir house to the City's South Hill Reservoir(s). This is essential to avoid the creation of negative pressures that could induce contaminants into the pipeline, or excessive pressures that may burst the pipeline. Implementing any significant changes to the gravity transmission line without fully appraising all the conditions and potential effects could have devastating consequences.

The cost of lining the existing pipe with a plastic material to make it capable of withstanding pressure was investigated and found not to be cost effective.

The staff at the Oregon Water Resources Department have given different opinions on the City being able to utilize the Umatilla River as a means of conveyance. A legal position should be determined on this issue and the quantitative amount of the water rights and permits that may have to be sacrificed as a result of evaporation and/or seepage into lower aquifers.

The analysis of the existing gravity line, and other options may lead to recommendations to:

- Remove and reinstall some sections of the existing gravity line,
- Lay additional parallel piping to increase the carrying capacity of the gravity line,
- Complete, or major replacement of the existing line with a 24" pressurized line,
- Abandonment of line and utilize the Umatilla River as a transport.

K.2 COMPILATION OF EXISTING DATA ON THE GRAVITY TRANSMISSION LINE

The City has several maps, charts and other data listed in a data base. Preliminary field checking during the preparation of this study found conflicting information within these documents. This information needs to be combined into as few documents as possible, preferably one computerized drawing, and with generous cross referencing to area maps and data.

With the City Engineering Departments Computer Assisted Design (CAD) system each of the old drawings (several, quantity unknown) could be placed on different layers (screens) with different colors. By selectively superimposing one or more layers on each other, they could be analyzed for conflicting information. All the conflicts should be properly noted for later resolution by a field survey. There may be other additional information in the form of text or field notes which may shed additional light on what actually exists in the way of physical facilities at the springs.

K.3 SITE INVESTIGATIONS AT THE CITY'S SPRINGS

It is recommended that all of the buried lines at the springs be televised and their courses at the surface be physically marked for accurate mapping. This would verify which of the collector lines are still active, the condition of the lines, highly turbid contributory areas (for remedial work), the high yield areas, and provide other general insight on the subsurface conditions. Efforts should be expended to find and restore to use, the observation wells shown on the City's map.

All of this information on existing conditions would mitigate against limiting the use of this source during any remedial work, removal, replacement and/or installation of new collector piping.

Capturing all of the available water permitted by the City's water permits and rights should be the highest priority in securing a reliable replenishable source for the City. One means of accomplishing this may require digging trenches down and into the underlying bedrock for placement to the collector lines. This would capture all of the water flowing across the top of the underlying basalt surface. This may then require a pumping station to lift the spring supply lines to it's former elevation, or installing a larger transmission line at a flatter grade.

Based on inspections made by the City's water departments staff, the existing transmission line from the springs Gate House and Weir to the City is in excellent condition.

K.4 PILOT TESTING OF VIABLE TREATMENT OPTIONS

Each water supply may have individual and peculiar characteristics different from other sources. These characteristics can be relatively consistent or undergo dramatic changes seasonally or over time because of climatic changes, watershed changes, etc.

K.4 PILOT TESTING OF VIABLE TREATMENT OPTIONS (Cont.)

The prior and present practice is to turn off the spring collector lines generating the most turbidity and bypassing the spring supply to the Umatilla River during periods of turbidity above 5.0 (with dilution by Well #7). The lack in the prior years of monitoring the quality of the spring sources not utilized and/or bypassed to the Umatilla River makes it difficult to recommend with any degree of certainty the size and type of water treatment plant for the City.

We are recommending a pilot testing program for a period of one year be performed for each of the treatment methods under consideration to determine the best water treatment alternative for the City. During this time, the quality of all the water at the spring sources available for treatment and municipal use would be sampled periodically and analyzed for organic, inorganic, parasites, bacteria, virus and chemical compounds.

With the recent technological advances several additional sources of pathogenic contamination have been identified in recent years that are harmful to humans. e.g.

Parasites: Giardia lamblia and Cryptosporidium parvum

Bacteria: Yersinia enterocolitica and Campylobacter jejuni

Virus: Norwalk

Any treatment option considered, should be able to treat all of the above effectively.

L. DEEP WELL SOURCES

L.1. ACTIVE CITY WELLS

From February through September 1961 an investigation was conducted to confirm that the City's Wells 1, 2, 3, 4, and 5 were all pumping from the same underground reservoir.

At the First Interstate (formerly National) Bank, which had an abandoned deep well, a float recorder was placed in the well to determine what, if any, responses would be recorded.

As each of the five wells were operated, an immediate response was noted on the float recorder even though considerable distances between the wells were involved as shown below. Prior to this test, there was also noted sympathetic responses between the City's wells as each new well was drilled and yield tested (See map on page I-11 for well locations). The distances from the First Interstate (formerly National) Bank Well and the other wells are shown in Table IV-6 on the following page.

TABLE IV-6 -- INTERRELATIONSHIPS BETWEEN THE CITY'S WELLS

Well No.	Well Name	Distance from the First National Bank Well
1	Byers Street	5,200 feet
2	Round-up	2,900 feet
3	S. W. 2lst Street	5,700 feet
4	State Hospital	7,000 feet
5	Stillman	1,500 feet

The outer boundaries of this underground reservoir had a minimum east-west dimension of 12,000 feet (2.27 miles), and a minimum north-south dimension of 5,000 (0.95 miles).

Well No. 6, which is presently being utilized as a monitoring well, also immediately responds to pumping at any of the other City Wells. This information effectively extends the east-west dimension of the underground reservoir to a minimum of 14,100 feet (2.67 miles) and the north-south dimension to 6,300 feet (1.19 miles).

A hydraulic interconnection may or may not exist between Well No. 7 (Mission Well). There are several other private and public wells between Well No. 7 and the other City's wells. These other intervening wells mask the effect of pumping at Well No.7.

Monitoring of the City's current on-line Wells Nos. 1,2,3,4,5 and 8 are currently being continuously monitored by the new Supervisory Control and Data Collection (SCADA) system. The SCADA system also has documented that the six City wells are drawing water from a common underground reservoir underlying the City.

Records indicate that all of the City's wells, shortly after being placed in service, have been in an over drafting condition (mining or depletion of ground water). Overdrafting is defined as when the annual withdrawal rate exceeds the amount of annual recharge.

L.2. AGE DATING OF THE WATER IN THE CITY'S DEEP WELLS

As a part of the 1979 Water Study[1] Well No. 4 (State Hospital) and Well No. 7 (Mission) were analyzed for the age of the well water. The age dating was performed by Washington State University, utilizing the Carbon ^{14}C method. The results of these test indicated that the age of the water was approximately 2,570 years +/- 135 years for Well No. 4 and 5,840 years +/- for Well No. 7. The wells were classified as rather young and the accuracy of this method of age dating is claimed to be better when the water is 10,000 years or older. For the indication of rather young water in the City's wells, the following alternative interpretation of the complicating factors of the test results were given as follows:

- The ages are correct as cited above with no complicating factors, or

1 "Water Study for the City of Pendleton, Oregon. September 1979." Wallulis and Associates, Inc.

L.2. AGE DATING OF THE WATER IN THE CITY'S DEEP WELLS (Cont.)

- The water is not of recent recharge water, because it does not have a value approaching contemporary ^{14}C. If the water was totally "modern", it would have a ^{14}C counting rate approaching 140 percent of our pre-H-bomb reference material (NBS Oxalic acid).

- The age may reflect water mixed from two or more aquifers or with some "contemporary" water. If the ^{14}C in these water samples is derived from a mixture of "old" and "contemporary" water Well #7 and Well #4 water samples contain 34% and 73% modern, past-H-bomb ^{14}C respectively.

- These water samples could be younger than the reported values because of chemical reactions of the type:

$$Ca^{12}CO_3 \text{ (limestone)} + H_2O + {}^{14}CO_2 = Ca^{2+}\ H^{14}CO_{-3} + H^{12}CO_{-3}$$

  Reactions of this type essentially dilute the ^{14}C in the water making the radiocarbon age falsely old. The maximum effect would be on ^{14}C half-life or 5,740 years.

Since the completion of the 1979 Water Study, there has been found an additional method for age dating of well water. The following paraphrased information was published on page 3 of the December, 1992 publication of the U.S. Water News.

Chlorofluorocarbons (CFCs) were first synthesized in the 1930's and concentrations present in groundwater can be measured to indicate the rate of recharge during the post-1940 period. Under ideal conditions this method claims it can determine the age of water within +/- 2 years. The testing with this method in Oklahoma's deep wells generally agrees with age dating from two radioactive decay methods known as tritium/helium 3 and krypton-85 analysis. To the surprise of researchers the presence of CFCs was found in some of the deep wells indicating that shallow water was induced into the deeper aquifers during pumping. The methodology of dating groundwater with CFCs was not commercially available at the time the article was published.

L.3. WELL YIELDS AND THEIR PHYSICAL ATTRIBUTES

Table IV-7 on the following page shows the Specific Capacity (SC) which is the yield in gpm/ft. of drawdown of all of the wells in the immediate Pendleton area. All appear to be withdrawing water from the same underground reservoir. The information in this table is taken from the 1979 Water Study[1]. It is recommended that the City Water Department alternate wells as lead wells and pump them for extended periods of time to determine the present SC of each well. The wells are arranged in a descending order of their relative SC.

TABLE IV-7 -- WELL SPECIFIC CAPACITIES

WELL	Well Ground Elev. M.S.L.	Test Pumping Rate GPM	Specific Capacity gpm/Ft Drawdown
City Well #8 (Prison)	1,027	945	189
Brogoitti Well	1,109+/-	720	144
*City Well No. 1 (Byers Avenue)	1,093?	1,155	129
City Well No. 2 (Round-Up)	1,053	1,670	46.8
City Well No. 5 (Stillman)	1,070?	2,390	25.0
City Well No. 4 (Hospital)	1,048	810	15.4
City Well No. 3 (S.W.2lst St.)	1,062	420	6.08
*City Well No. 6 (Sherwood)	1,075	525	5.4
City Well No. 7 (Mission)	1,463	800	5.24
Glendale - Sunset	?????	170	3.40
*City Well No. 11 (Sewage Plant)	?????	68.75	2.86

* Data may be in error and should be verified: a well pump test of Well #6 (log shows SC of 14.6 gpm/ft draw down); depths and borehole diameters of Wells #1 & #11; Well #7 presently can only pump 420 gpm (see the 1979 Water Study[1] for a detailed history on Wells #7, #8 and #11).

In reviewing the above table, it is important to recognize that wells can be relatively close together, be poorly hydraulically interconnected, and have a substantial difference in static water levels.

The Salem, Oregon area is also a part of the same Columbia River basaltic flow as shown on the map on page III-5. During several pumping and recharge cycles two wells spaced 483 feet apart were hydraulically interconnected but one of the wells consistently maintained an elevation of 15 to 25 feet higher than the other one.

1 "Water Study for the City of Pendleton, Oregon. September 1979." Wallulis and Associates, Inc.

TABLE IV-8 -- CITY WELL'S BOREHOLE DIAMETER DATA -- INCHES

#1	#2	#3	#4	#5	#6	#7	#8
*30+" 0'-22'	22" 0'-14'	20" 0'-93'	18" 0'-56'	30" 0'-127'	36" 0'-13'	16" 0'-157'	16" 0'-37'
22" 22'-273'	18" 0'-20'	16" 93'-1,009'	15.5" 56'-852'	24" 127'-442'	27" 13'-396'	12" 157'-515'	12" 37'-325'
16" 273'-774'	17.5" 20'-200'			20" 442'-615'	20" 396'-500'	8" 515'-800'	6" 325'-500'
	16.5" 200'-428'			16" 615'-700'	16" 500'-1,000'		
	15.5 428'-761'				12" 1,000'-1,501'		

* The plus sign is shown to indicate that the well borehole diameter is probably 4" larger to provide a 2" annular space for the placement of a cement seal between the borehole and the casing. Needs field verification when pump pulled.

TABLE IV-9 -- CITY WELL'S CASING AND LINERS DATA -- INCHES

#1	#2	#3	#4	#5	#6	#7	#8
*30" 0'-22'	22" 0'-14'	20" 0'-20'	16" 0'-56'	24" 0'-30'	***30" 1'-10'	12" 0'-157'	16" 0'-37'
*20" 0'-147.5'	18" 0'-20'	16" 0'-84"			***24" 0'-186'		
*12" 295'-620'	**12" 679'-761'						

* Considerable conflicting data of record, needs field verification.
** Perforated liner
*** From original well log, at variance with other City records.

The conflicts in the data on some of the City's wells can be illustrated by the records for City Well #1 as follows:

- The well is 934'/935' deep instead of 774' and that caving occurred within well then subsequently cleaned out to the 774' depth.
- That there was a 20" diameter borehole to the 133' depth instead of 273'.

L.3. WELL YIELDS AND THEIR PHYSICAL ATTRIBUTES (Cont.)

- That there was installed a 16" casing to the 124' depth instead of a 20" casing to the 147.5' depth.

- There was no mention in one of the records of a 12" liner being installed at the 295' to the 620' depth.

- There are different specific capacities of record for this well.

City Well #1 has seen very limited service in recent years because shortly after pumping the water level drops below the bottom of the column tail pipe and breaks suction. The pump bowls being larger in diameter and close to the top of the 12" liner prevents the lowering of the present pump bowls to a lower level. The inability to fully utilize Well #1 during the 1992 unusually high water demand contributed to the City's inability to satisfy irrigation demands and a comfortable reserve capacity.

City Well #1 may be able to be placed back on line to its full capacity or less for at least a few additional years.

- To restore the well back to it's previous capacity would require the installation of a smaller pump: column, bowls, tail pipe, screen plus the use of a higher RPM motor and water velocities higher than recommended for a permanent municipal application.

- To continue the use of the well at a reduced yield would be similar to the above at a reduced RPM motor speed and at acceptable water velocities for a permanent municipal application.

- Should either of the above be considered, there is a risk to be considered of a piece of rock falling down from the above uncased borehole permanently wedging in any pump placed down in the smaller steel casing. A special variance of the existing rules from the Oregon Water Resources Department would be required, if obtainable, to case the upper portion of the borehole.

Before either of the above was implemented a complete **geophysical borehole analysis** and **plumbness and alignment test** should be performed. This would provide for an accurate assessment on the true characteristics of this borehole and suitability of this well for different future uses.

The feasibility of determining if the borehole is really 934'/935' deep and the removal of the 12" liner would also be desirable. With the advent of rotary drilling equipment the boring out of this hole to 22" with a slightly smaller perforated liner may dramatically improve the future role of this well as a production well or as a combination recharge/withdrawal well.

L.3. WELL YIELDS AND THEIR PHYSICAL ATTRIBUTES (Cont.)

In Tables IV-8 and IV-9 there are other significant variances in the records on the status of the some of the City's deep wells. Those that can not be resolved by a further search of the records should be field verified.

Field verification is rather expensive but essential if the City is to know what is the quantity and reliability of the City's well sources. There are no records on tests for the plumbness and alignment on any of the City's wells and this should be accomplished whenever the well pumps are pulled off of the boreholes or preferably sooner.

Since the prior 1979 Water Study[1] the Oregon Water Resources Commission has declared the Butter Creek and Stage Gulch areas as Critical Groundwater areas. These areas are scheduled for a reduction in pumpage of wells based on seniority. This will result in the termination of some wells and restricted pumping on some of the others.

The stated objective in each of these Critical Ground areas is to reach an equilibrium in the basalt aquifers (no further reduction in the water table levels). The Stage Gulch Critical Groundwater area is immediately west of the City of Pendleton. It may not be very long before a Critical Groundwater proceedings is initiated for the Pendleton area, and may be to the City's benefit depending on the seniority of the City's wells.

1 "Water Study for the City of Pendleton, Oregon. September 1979." Wallulis and Associates, Inc.

CHAPTER V -- AREA GEOLOGY

A. REGIONAL GEOLOGY

This Chapter on geology and ground water provides an overview of the geologic conditions in the general area and to address in more detail the geology in and around Pendleton's municipal wells. The overview will begin with a description of the Columbia Plateau Province in Section B below and conclude with the geology under and around the City of Pendleton.

B. COLUMBIA PLATEAU PROVINCE

B.1 Physiography

The Columbia Plateau is located between the Rocky Mountains to the east and the Cascade Mountains to the west and north. The southern extension is marked by the basin and Range Province. Columbia Plateau is a very large area approximately 250 miles north-south and 260 miles east-west. The Province contains mountainous uplands and high plateaus along with numerous valleys and basins. The one common feature is the underlying rocks which are basalts extruded over a long period of time. Most investigations and authors assign this time to the Miocene Epoch (6 to 16 million years ago). The stratigraphic nomenclature[1] for the Columbia River Basalt Group is shown on page V-2.

B.2 Structural Changes

Initially the basalt flows (strata) were considered to be relatively horizontal until disturbed by very large tectonic forces.

These large forces disrupted the basalt flows into the present land forms as we see them within the province. They are the Yakima Basin, Pasco Basin, Walla Walla Basin, Umatilla Basin, John Day Basin, Grande Ronde Basin, and Lewiston-Clarkston Basin.

The uplands are the Blue Mountains, Palouse Plateau, Horse Heaven Hills, Columbia Hills and the in-between areas. These physiographic features have been modified somewhat by erosion and deposition, but most are as they were at the end of the structural movement.

The "Groundwater Control Areas" and the principal drainages in the Umatilla Basin are shown on the map on page V-3. This map shows the individual areas that have been declared Critical Groundwater Areas (CGAs). In these CGAs several of the wells in the Columbia River Basalt Group are limited in the amount or have to cease pumpage altogether.

1 Figure 2, Pages G6 and G7. Revisions in Stratigraphic Nomenclature of the Columbia River Basalt Group. Geological Survey Bulletin 1457-G. 1979. By: D.A. Swanson, T.L.Wright, P.R. Cooper and R.D. Bentley.

2 Page 113, Umatilla Basin Report, Oregon Water Resources Department. August 1988

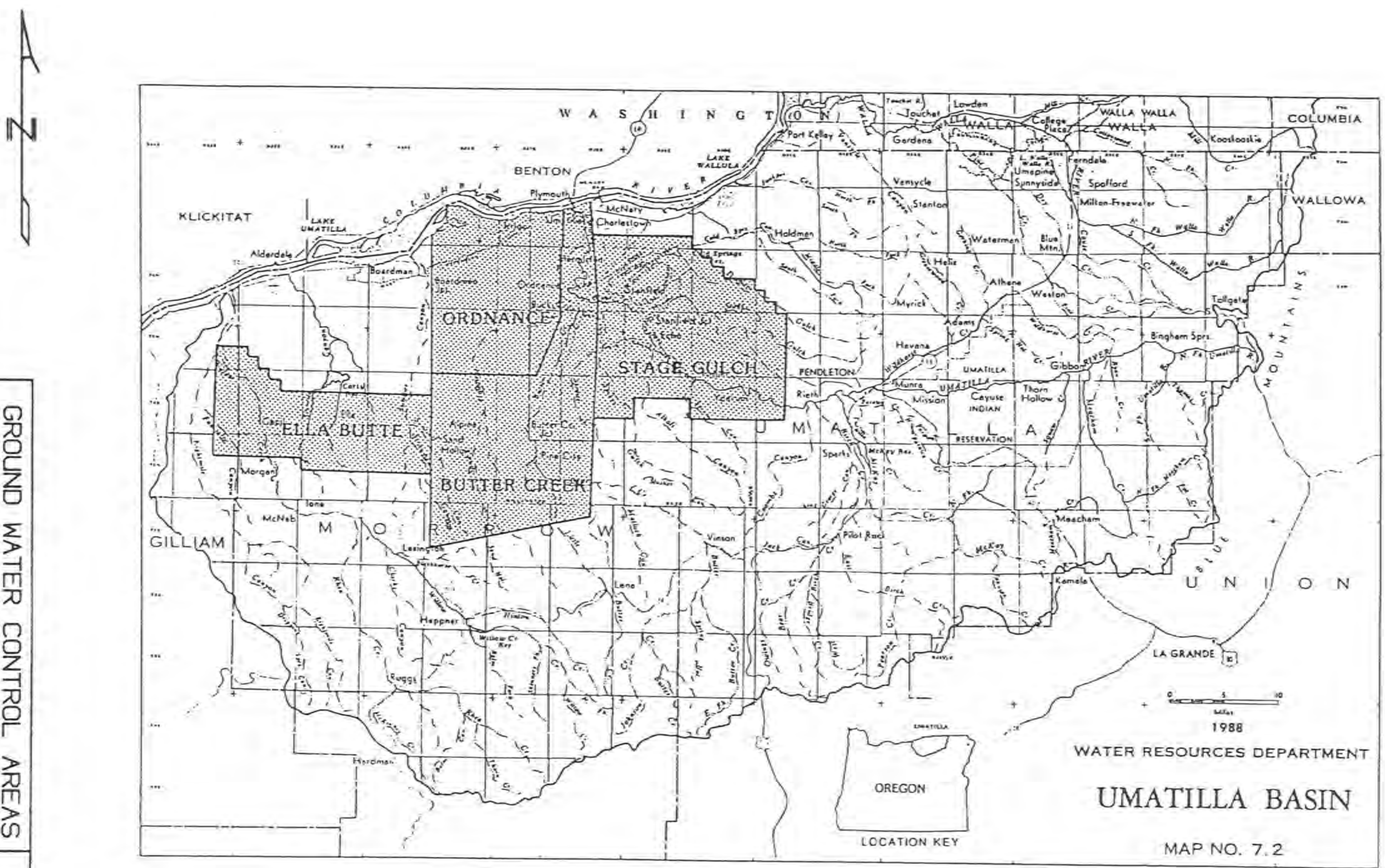
Series		Group	Subgroup	Formation	Member	K-Ar age (m. y.)	Magnetic polarity	Chemical type[1] Dominant	Chemical type[1] Subordinate
MIOCENE	Upper Miocene	Columbia River Basalt Group	Yakima Basalt Subgroup	Saddle Mountains Basalt	Lower Monumental Member	6[2]	N	31	
					Erosional unconformity				
					Ice Harbor Member				
					Basalt of Goose Island	8.5[2]	N	30	
					Basalt of Martindale	8.5[2]	R	29	
					Basalt of Basin City	8.5[2]	N	28	
					Erosional unconformity				
					Buford Member		R	27	
					Elephant Mountain Member	10.5[2]	N, T	26	
	Middle Miocene				Erosional unconformity				
					Pomona Member	12[2]	R	25	
					Erosional unconformity				
					Esquatzel Member		N	24	
					Erosional unconformity				
					Weissenfels Ridge Member				
					Basalt of Slippery Creek		N	22	
					Basalt of Lewiston Orchards		N	23	18
					Asotin Member		N	21	
					Local erosional unconformity				
					Wilbur Creek Member		N	20	
					Umatilla Member		N	19	
					Local erosional unconformity				
				Wanapum Basalt	Priest Rapids Member		R_3	18	17
					Roza Member		R_3 T	16	
					Frenchman Springs Member		N	15	
					Eckler Mountain Member				
					Basalt of Shumaker Creek		N_2	14	
					Basalt of Dodge		N_2	13	
					Basalt of Robinette Mountain		N_2	12	
	Lower Miocene			Grande Ronde Basalt		14-16.5[3]	N_2		
					(Basalt of Dayville, Basalt of Monument Mountain, Basalt of Twickenham)[5]		R_2	9,10	
				Picture Gorge Basalt[4] -?-?-		(14.6-15.8)[5, 3]	N_1	(6, 7)[5]	8, 11
							R_1		
				Imnaha Basalt[4]			R_1, T, N_0, R_0 ?	2, 4	1, 3, 5

[1] See table 2 for key to chemical types.
[2] Data from McKee and others (1977) [3] Data mostly from Watkins and Baksi (1974)
[4] The Imnaha and Picture Gorge Basalts are nowhere known to be in contact. Interpretation of preliminary magnetostratigraphic data suggests that the Imnaha is everywhere older than the Picture Gorge. See text.
[5] Information in parentheses refers to Picture Gorge Basalt

Proposed terminology for the Columbia River Basalt Group. N is normal magnetic polarity; R, reversed; and T, transitional. Polarity intervals are numbered sequentially, oldest to youngest, for the Imnaha through Wanapum Basalts, as we believe no major intervals are missing. Polarity intervals are not numbered in the Saddle Mountains Basalt, as one or more major intervals are probably missing owing to long periods of time between eruptions. For the Ice Harbor Member, probably no major intervals are missing, as potassium-argon ages for flows of the three magnetostratigraphic units are similar. Interbedded sedimentary deposits not shown.

STRATIGRAPHIC NOMENCLATURE FOR THE COLUMBIA RIVER BASALT GROUP

GROUND WATER CONTROL AREAS



B.3 Sequence of Change

Most investigators assign the time of disturbance to late Miocene, early Pliocene (six million years ago), extending into middle to late Pliocene time.

An early event in this tectonic process was the mountain building of the Blue Mountains. The Blue Mountains are located in both Oregon and Washington and extend in a northeast-southwest direction from Arbuckle Mountain south of Heppner, Oregon to the Lewiston-Clarkston Basin in Washington. This is a distance of approximately 140 miles. This arching of the basalt strata reached elevations between 5,000 to 6,000 feet above mean sea level (msl). The crest of the Blue Mountain Anticline is moderately broad, measured in miles and the flanks have slopes of one to five degrees, with occasional steep areas above ten degrees.

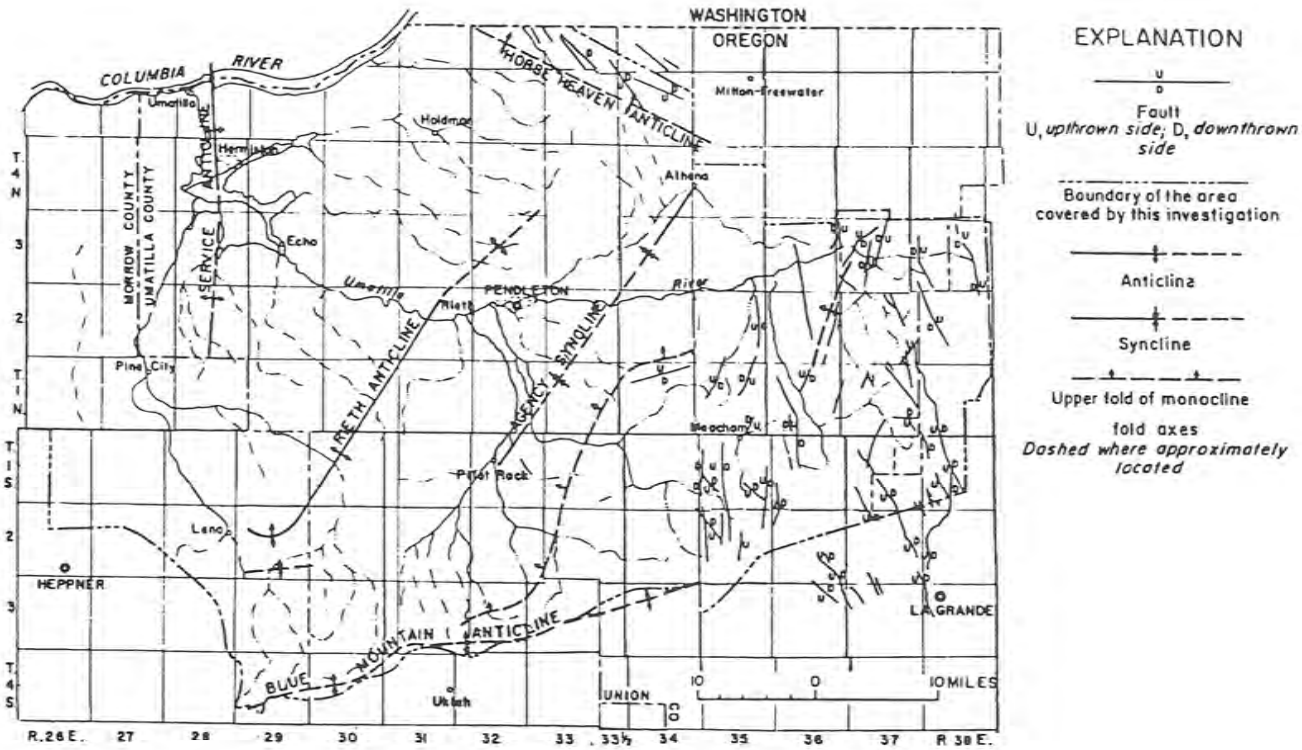
A Geologic Map[1] of the area is shown on page V-5. The direction of the dip of the strata is at right angles (normal) to the axis of the Blue Mountain Anticline. Since the anticlinal axis is sinuous (undulating) the dip of strata changes in direction. However, a general statement can be made: that the general direction of dip of the west flank is to the northwest.

Subsequent to the uplifting of the Blue Mountains, a second application of compressional forces were applied across the west central area of the Columbia Plateau. These subsequent forces produced the Horse Heaven Anticline, Reith Anticline, Service Anticline, and the Shutler Butte Anticline (not shown on the map on page V-5). These geologic features are transverse across the lowlands and basins and trend parallel to, or abut against the Blue Mountains. These subsequent features have been dated as late Pliocene to Pleistocene (1 to 6 million years ago). These geologic time dates are derived from the dating of the sediments trapped by these features.

The importance of these subsequent geologic features to the geology and ground water is the modifying effect, that these features have had upon the dip slopes that resulted from the Blue Mountain Anticline. The Shutler Butte anticline closed the western end of the Umatilla Basin by raising the basalt strata to elevations of 900-1,000 feet msl. The dip slopes from this structure are east or northeast and can be easily viewed in the Columbia River south canyon wall. The Horse Heaven Anticline divided the Umatilla Basin from the Walla Walla and Pasco Basins and extends 60 or more miles in a northwest-southeast direction. This structure rises the strata to an elevation of 2,000+ feet msl. In between these structures, are the Reith Anticline and Service Butte Anticline, which further divide the Umatilla Basin, but to a much smaller degree. The effect is to segment or compartmentalize the basin and locally disrupt the basalt strata.

[1] Figure 13, page 28. Geology and Groundwater of the Umatilla Basin Oregon. Geological Water Supply Paper 1620. 1964. By: G.M. Hogenson.

MAP OF. THE UMATILLA RIVER BASIN. OREGON.
SHOWING THE LOCATIONS OF MAJOR STRUCTURAL
FEATURES OF THE COLUMBIA RIVER BASALT



V-5

C. UMATILLA BASIN

The Umatilla Basin and in particular the Upper Umatilla Subbasin in the McKay Creek and Birch Creek areas are the focus of this section. These basins and highlands areas are within the previously described Columbia Plateau Province.

Pendleton, Oregon is centered in Section 10, T2N, R32E.W.M. and has a ground elevation of 1,068 feet. The corporate boundary of the City takes in parts of Sections 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 15 and 16 in T2N, R35E.W.M. and also parts of Sections 31 and 32 in T3N, R32E.W.M. The municipal airport (runways and buildings) are located in Sections 31 and 32 with a ground elevation of 1,490 feet. Sherwood Heights occupies the southwest part of the City in Section 16 with a general elevation of 1,150 feet. The former Community Memorial Hospital occupies part of Section 15 with a general ground elevation of 1,300 feet. In general, the City is spread out across the valley bottom, and up on the valley side walls. The Umatilla River flows through the City with River Mile 50 downstream and 57 upstream.

Interstate Highway I-84 crosses through the City, between Sherwood Heights and the main city center, and more or less along the City's south boundary. Highway I-84 has three exits to serve the City.

C.1 Rock Structures

The structural features of the underlying Columbia River basalts are shown on the Geologic Map on page V-5. This shows the Blue Mountains Anticline, Reith Anticline, Service Anticline, Horse Heavens Anticline, and the Agency Syncline. Pendleton is located 6 to 7 miles west of the axis of the Agency Syncline. In this area the Agency Syncline is several miles wide with the southeast flank rising as the toe section of the Blue Mountains, and the northwest flank rising to the crest of the Reith Anticline. The Umatilla River occupies a part of the valley floor. Alluvium fills the valley bottom to depths of 10 to 30 feet. The U.S.G.S. Water Supply Paper 1620, Plate 1, shows dips in the structures varying from one to three degrees.

C.2 Stratigraphy

The underlying basalt strata has been penetrated (drilled) to depths of 800 to 1,500 feet in the immediate area of Pendleton for municipal and irrigation water supplies. A study of the deep and shallower basalt well logs of record in the area indicates that the aquifers are in a confined condition resulting from the structure of the basalt rock formations. The wells that penetrate the rock basalt sections to depths of hundreds of feet have varying specific capacities (yields in gpm/ft of drawdown).

D. BASE MAPPING OF SELECTED WATER WELLS IN THE PENDLETON AREA

From a review of the well logs of record, wells of interest and those considered to be in the same geologic setting were selected for mapping. The base map shown as Plate No. 4, page V-8 is the compilation of U.S.G.S. quadrangle sheets (Pendleton, McKay Reservoir, Mission and Table Rock). The map has a base line drawn on it with 0+00 starting at McKay Creek, Elevation 1,820' msl, in Section 1, T1S, R33E.W.M. and extending in a North 36° West direction for a distance of 90,000 feet (17.04 miles). The end station at 900+00 has an elevation of 1450+/- feet and terminates in Section 32, Township 3 North, Range 32 East of the Willamette Meridian. The location of the City's existing and proposed wells are shown on this map in their proper location and ground surface elevation.

The base bearing alignment line shown on the map depicts the bearing of the structure of the basalt rock strata as could best be determined for the area (normal or at right angles to the axis of the Blue Mountain Anticline). The bearing of the maximum dip of strata changes in direction with changes in the direction of the Blue Mountains Anticline, but such changes occur slowly over distance. Shown on this plan map are the approximate locations of the axis of the Agency Syncline and the axis of the Reith Anticline. The geologic data shown on this map is taken from the:

> "Reconnaissance Geologic Map of the Pendleton Quadrangle, Oregon and Washington" by George W. Walker, dated 1973.
>
> Also identified as "Miscellaneous Geologic Investigation Map I-727" published by U.S.G.S. This paper likewise shows the mapped location of the McKay beds of basaltic gravels and uses the symbol Ts as Tertiary sedimentary rocks.

In addition to the geologic structure and sedimentary deposition data, well locations of the selected wells of record were obtained from the Oregon Water Resources Department and have been plotted on the base map. The record logs of these water wells are plotted by section, township and range to the least subdivision given on the well logs within the Section. The ground surface elevation for some of the wells was determined by their the plotted location on the base map's contour elevations. The plotted location of each well also determined and the distance from the well to the base bearing alignment line shown on the base map. This data contains the possibility of a degree of error due to the original location identification in the record of the logs, but it is not considered to be significant.

E. GEOLOGIC CROSS SECTION (PROFILE) COMPANION TO THE BASE MAP ABOVE

The Geologic Cross Section (profile) drawing, Plate 5, on page V-9, has been prepared along the base bearing line alignment shown on the above Base Map above. The underlying basalt flows and aquifers depicted on this drawing are based on information in the record logs of the respective wells. The vertical scale has been increased by a ratio of 10 times larger than the base line scale. The ground line shown on this drawing is taken from the contours of the plan map on Plate 4, page V-8.

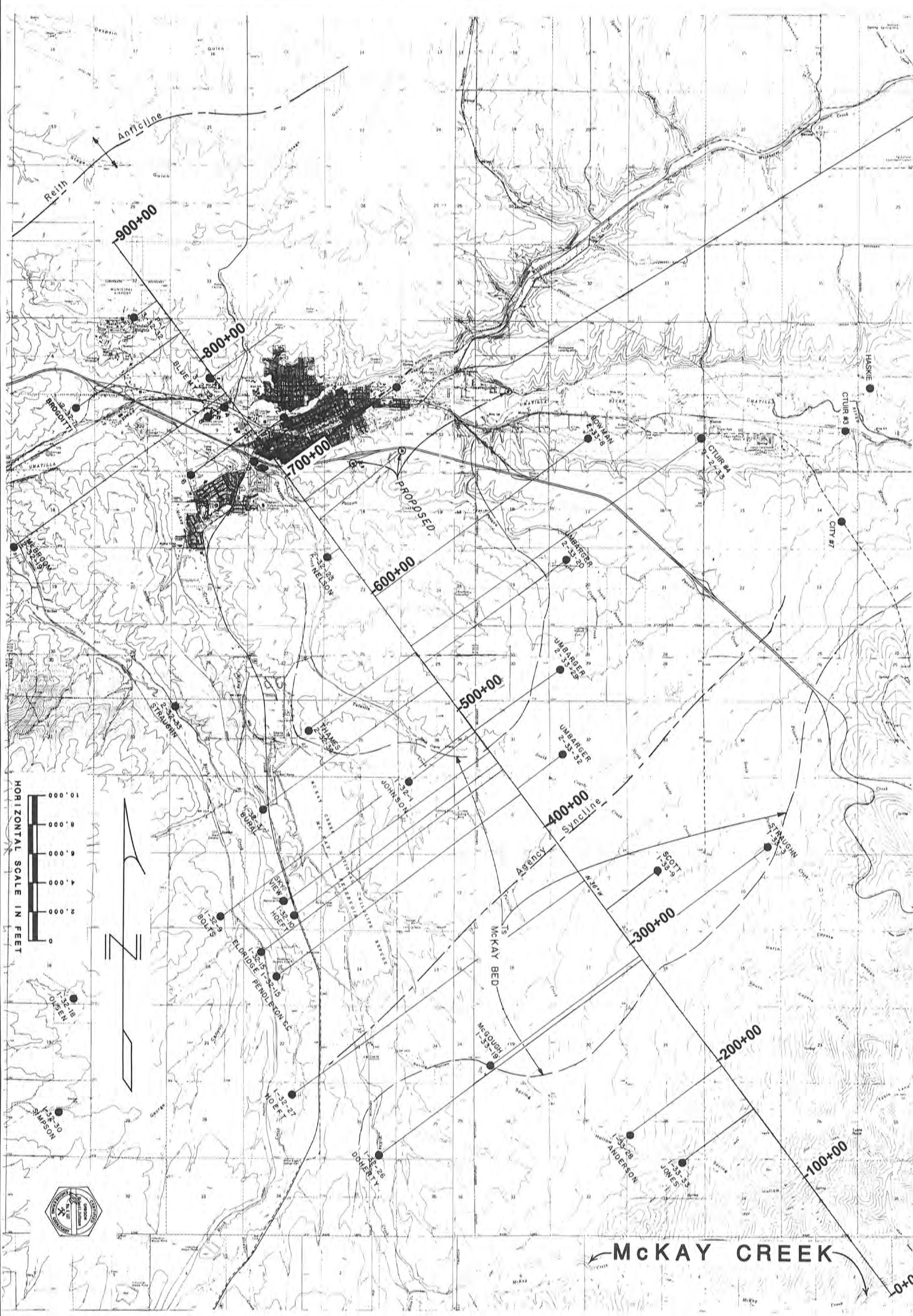
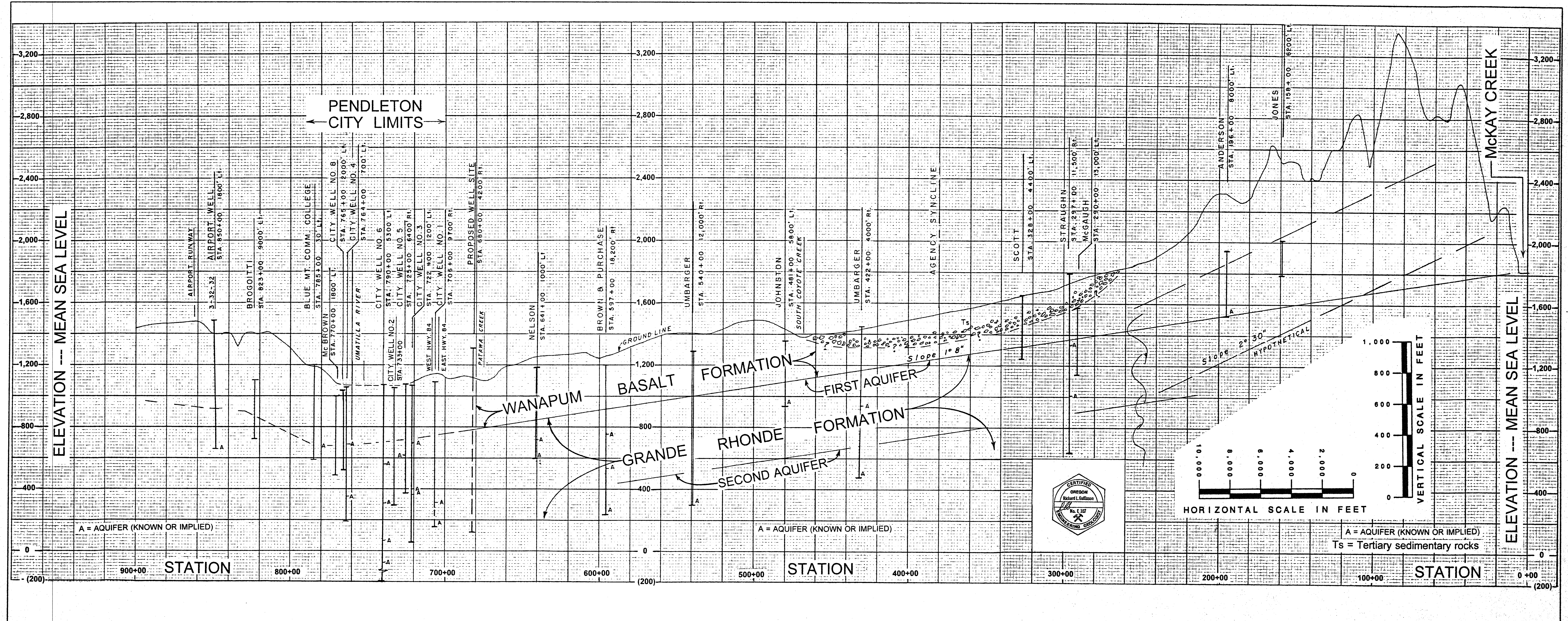


PLATE #4
GEOLOGIC SURFACE BASE MAP



GEOLOGIC CROSS SECTION (With well locations) PLATE #5 V-9

It is the consensus of most of the authors of recent geologic investigations that the upper most formation is the Wanapum Formation. See page V-2 for the stratigraphic sequence of the Columbia River Basalt Group. The Grande Ronde Formation lies under the Wanapum Formation. In many areas, these formations are separated by an interbed of silts and sands, called the Vantage Interbed. There is not any known evidence of the Vantage Interbed separating the Grande Ronde formation and the Wanapum formation within the study area.

On the Base Map, Plate 4, page V-8 the water well logs of record selected for analysis are shown with the identifying owner's name, station and offset, at the appropriate ground elevation. Other wells of general interest are shown without the station and offset shown. Using the average elevation of the principal aquifer (Wanapum to Grande Ronde Formation) this contact drops approximately 1,100 feet from McKay Creek to Pendleton City water wells. The principle contact in the City's wells is at a depth of 350 to 380 feet below the ground surface with an elevation of 700+ feet msl. The horizontal distance taken from McKay Creek to City Well No. 1 is 71,000 feet. Therefore, the tangent function is vertical distance divided by horizontal distance and varies from 0° 55 minutes to 1° 8 minutes (+/- 18'/1,000'), which is the contact as drawn on this Geologic Cross Section drawing.

F. AREA PRECIPITATION

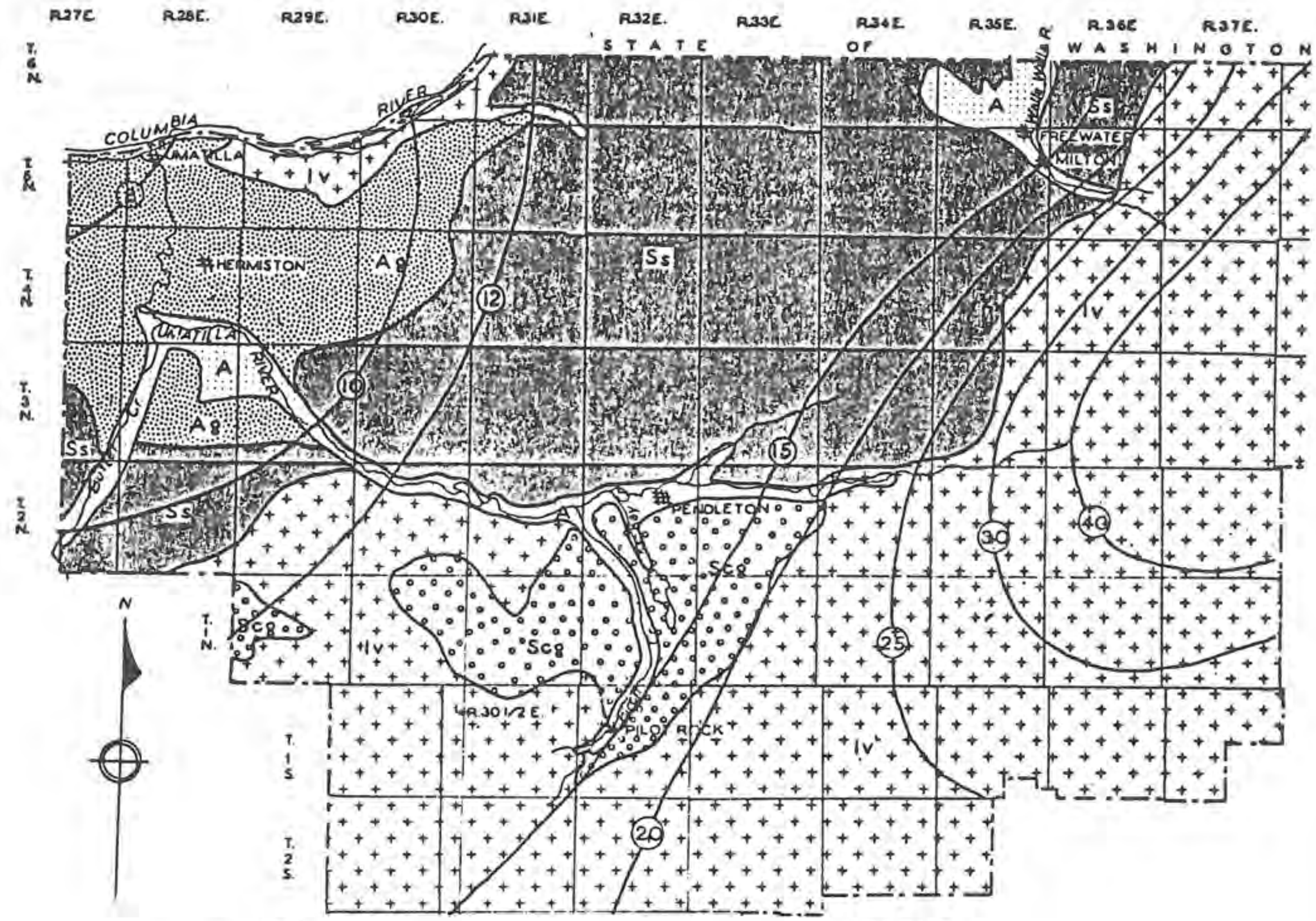
Within the study area the average annual precipitation in inches is shown on the Geologic Map and Precipitation Belts[1] on page V-11. This map shows the average rainfall to be 14 inches in the Pendleton area and 40 inches and more in the higher elevations. The precipitation occurs principally in the October to March period as rain in the lower elevations and as rain and snow in the higher elevations. In the high elevations the snow normally stays on the ground until late spring.

G. HYDROGRAPH OF THE NORTH FORK OF McKAY CREEK NEAR PILOT ROCK

This hydrograph of the "North Fork of McKay Creek near Pilot Rock"[2] station, for the period of October 1989 to September 1990, shows that the stream discharge (flows) varied from a low of 0.74 cfs in September to a high of 331 cfs in April (with one flow estimated at 524 cfs). These flows of record correlate well with the rainfall and snow pack for that period of time.

The hydrograph station measures the stream flow draining an area of 48.6 square miles. The elevation of this station is 1,870 msl, and located in the NE 1/4 corner of the SE 1/4 corner of Section 1, Township 1 South , Range 33 E.W.M. The average annual discharge at this station is 31,000 acre feet per year (10.1 billion gallons per year).

1 Figure 2, Land-Water Inventory of Umatilla County by the U.S. Soil Conservation Service.
2 USGS Water Resources Data for Oregon, Station 14022200



SCALE

0 3 6 12 miles

LEGEND

A	ALLUVIUM. RECENT GRAVELS, SANDS AND SILTS.
Ag	PLEISTOCENE TERRACE SANDS AND GRAVELS. GENERALLY UNCONSOLIDATED.
Ss	POORLY CONSOLIDATED SEDIMENTS UNDIFFERENTIATED LOESSIAL AND GLACIAL. 50'± THICK.
Scg	MODERATELY WELL CEMENTED GRAVELS OVERLYING LAVA.
Iv	UNDIFFERENTIATED COLUMBIA RIVER LAVAS AND CONSOLIDATED TUFFS. INCLUDES SMALL EXPOSURES OF GRANITIC AND SEDIMENTARY ROCKS.
(8)	AVERAGE ANNUAL PRECIPITATION IN INCHES.

GEOLOGIC MAP AND PRECIPITATION BELTS

H. NATURAL RECHARGE OF THE BASALT AQUIFERS

To recharge wells with water, the aquifers they tap, have to be exposed to a source of water at the higher elevations such as McKay Creek (Plate 5 on page V-9, - 1,800' to 2,400' msl). There is approximately 1,600 feet of basalt rock depicted in the section, normal to the rock structure. This is the drainage of McKay Creek where the end sections of the strata are exposed. The stream course of McKay Creek generally cuts across this strata from surface elevations of 1,800' to 2,400' msl and feeds water directly into the flow contact areas. Once the water has entered the aquifer it is confined and flows under the force of gravity. Water wells that penetrate the aquifers at lower elevations are moderate to high producers of water. These are the conditions encountered in the Pendleton area and upgradient of Pendleton.

By contrast the upper elevations of 2,400' to 3,000' msl, as shown by the wells of record, are small producers of water, because of the difficulty of the entrance conditions for the precipitation.

I. WANAPUM BASALT FORMATION

The Wanapum Basalt formation is the first, or the upper most, strata of lava flows in the study area. When this aquifer is penetrated and drilled through in the Pendleton area, the static water level rises approximately 200 feet above the aquifer to an elevation of 900+ feet msl. The aquifer has a thickness of 15 to 30 feet as shown by the City's well logs. The yield of this single aquifer was only able to be measured in Well No. 8 as the other City wells penetrated additional deeper aquifers.

The test data on the log record of Well No. 8 shows a yield of 940 gallons per minute with a drawdown of 4 feet. This is a Specific Capacity (SC) of **235 gpm/ foot of drawdown**. The current static water level in City Well No. 8 was measured on October 5, 1993 by using the air line and determined to be 193'. The surface elevation is 1,027' msl and by subtracting the depth measurement of 193', the static water level is determined to be at an elevation of 834' msl.

In February 1993 Well No. 8 was pumped at 1179 gpm and the water table dropped from a depth of 191' to 229', for a lowering of 36'. This is a Specific Capacity of only **32.7 gpm/foot of drawdown** which is significantly less than the 235 gpm/foot of the above yield test.

J. GRANDE RONDE FORMATION

The Grande Ronde formation lies under the Wanapum Formation and has an approximate elevation of 200' to 300' msl in the Pendleton area. The difficulty of more accurately establishing the elevation is the lack of good description of the subsurface materials and recorded changes in the static water level in the well logs. The second primary aquifer in the study area is contained within the Grande Ronde Formation.

The log of record for Well No. 1 states that the well was drilled to a depth of 935' and subsequently caved in and was only cleaned out to depth 774'.

The log of record for Well No. 2 indicates encountering red basalt at a depth range from 670' to 722' (Elevation 331' to 383' msl). This red basalt material indicates a basalt flow contact.

In both Well Nos. 1 and 2, the static water level (SWL) did not show a change at these well depths when the second aquifer was penetrated. This is probably because the SWL in the second aquifer is approximately the same or slightly less than the first aquifer. Initially both of these wells had SWL's within five feet of each other (Well No. 1 - Elevation 909' msl and Well No. 2 - Elevation 914' msl).

The log of Well No. 3 does show a static water level change after penetrating 8 feet of soft red basalt and brown clay at depth of 665' to 673' (elevation 371' to 397' msl). The static water level rose from depth 155' to 153'. This somewhat substantiates the pressure head of the lower (2nd) aquifer as being in the order of 500 feet.

The log of Well No. 4 shows the same conditions found in the log of Well No. 3. A brown porous basalt is logged as being encountered at depths of 680' to 691' (Elevation 356' to 367' msl) but the SWL remained the same.

In the log of Well No. 5, there is no evidence either from materials or static water levels to substantiate anything.

The log record of Well No. 6 indicates encountering porous black basalt from depths of 726' to 754' (Elevation 324' to 342' msl), which is in general conformance with the other wells above. The log records material changes at depth 993' to 1,004', 1,142' to 1,165', and 1,404' to 1,413'. Since this is the deepest well in the Pendleton area, the log does indicate there may be a potential for water bearing materials at depths greater than 1,000 feet.

In summary, the second aquifer in the Grande Ronde Formation is less defined than the first aquifer in the Wanapum Formation. However, there is sufficient evidence to approximate it's position in the subsurface profile drawing on Plate 5. The yield from the 2nd aquifer is not known, and can only be estimated to contribute approximately fifty percent of the yield of the City's wells.

K. STATIC WATER LEVEL CHANGES IN PENDLETON'S WELLS

The City's well logs indicate that from the late 1940s to the early 1950s, the SWL elevations ranged from a low of 909' to 918' msl. Currently the SWL elevations are approximately 830' to 840' msl, showing a drop of 78 to 79 feet in the last 40 to 45 years. The record shows a steady decline in the early years of 1950 to 1970 of approximately one foot per year. From the years of 1970 to 1990 the records indicate an increase in the decline of two to three feet per year.

Annual records of the water table have been available since 1958 and the decline in the water table since 1958 is shown on graphs in Chapter III on pages III-7 and III-8. The increasing amount of water annually withdrawn from the underlying basalt aquifers in prior years is the primary cause for the lowering of the water table. It can be further stated that additional withdrawals from the subsurface basalt aquifers in the Pendleton area will result in a corresponding acceleration of the lowering of the water table in the basalt aquifers.

Obviously, the danger exists that a significant decline in the yields of the City's wells will occur when the pumping level of the wells reaches below the depth of the first aquifer. An example of this is Well No. 5 (Stillman) shown below based on 1993 data.

Ground Elevation:	1,070' msl
Static water level depth:	246', (834' msl)
Pumping Drawdown level:	287' (783' msl)
Yield:	1,918 gpm
Log record shows soft brown cinders at:	300' to 310' (770' to 760' msl)

This indicates a significant reduction in yield may occur at Well No. 5 in the order of four or five years.

L. SUMMARY

The present water supply system is the same as described in the 1979 Water Study with a few modifications. Well No. 8 was added to the City's well supply system in 1988 and the well supply was diminished by the loss of any significant use of Well No. 1 (Byers). The available options for the future use of Well No. 1 are discussed in Chapter IV of this report. Well No. 1 has been utilized intermittently and has generally been non-productive since December 1990.

The declining static water level in the well's water tables is a function of the amount required to be pumped from the wells to satisfy the City's water demand. The greater the amount of the withdrawals, the greater the decline in the elevation of the underlying water table.

To mitigate this condition requires a greater yield from the City's springs or the development of one or more of the sources from the Umatilla River that the City has a permit and\or water rights for. To obtain a greater yield from the City's springs will require a substantial rehabilitation and/or reconstruction of the spring's collectors and may require pumping of the collected water at the spring site.

[1] Water Study for the City of Pendleton, Oregon. September 1979. Wallulis and Associates, Inc.

CHAPTER VI -- WATER CONSERVATION

A. CONSERVATION PLAN, A STATUTORY REQUIREMENT

The State of Oregon requires all cities and major water districts to have a water conservation plan, but at the start of this report had not adopted rules and regulations setting forth specific requirements of a State approvable Conservation Plan. Several draft plans, have in the past, been put forth by the Oregon Water Resources Department (OWRD) and disseminated for public comment.

One of the specific tasks of this Water Master Plan was to develop an acceptable approved Conservation Plan, or a conditionally approved plan. Draft plans have been previously submitted to the OWRD and reviewed and re-submitted. While in the process of preparing this Water Master Plan, the Oregon Water Resources Commission has adopted administrative rules. These rules require municipal water suppliers to submit for the OWRD's approval a "Water Management and Conservation Plan" whenever they process a request for a new permit and/or any change in existing permits and/or rights. This chapter provides an overview of the current administrative rules and provides the responses requested by the OWRD from their last review.

The rules require the conservation element of a Plan to provide for the curtailment of water in a minimum of three stages as follows:

- Mild alert (voluntary) general request for reduction of usage,
- Increasing to serious (selective specific rationing - alternate days of irrigation), and
- Critical (broad based and restrictive rationing without any irrigation allowed).

Some of the possible causes that can trigger a need to curtail water usage are:

- A local or area wide drought, and/or
- Contamination of a major water source,
- Loss of one or more water sources, e.g. wells,
- Failure (rupture/contamination) of a major water supply line,
- Loss of major pumping stations,
- Inoperativeness of a major water treatment facility.
- A general deficiency in any of the above during a peak demand period/season.
- Major fire conflagration consuming large areas or facilities.

Measures that can be incorporated into a Conservation Plan that may eliminate or mitigate the need for issuing mandates curtailing water usage are:

- Identifying areas where waste can be eliminated,
- Reduce unaccountable water (water produced versus metered to customers/users),
- Monitor water usage by type and class of customer for reasonableness,
- Integration with subbasin conservation plans, if any,
- Usage of water conservation appurtenances, shower heads, water closets, etc.,
- Encouragement of low water use landscaping,
- Implementation of a leak detection program (regular meter testing),

B. CONSERVATION OPTIONS AND STRATEGIES

There are a variety of options that the City may wish to employ to encourage a reduction in the amount of water consumption. These may include one or more of the following:

- Gaining voluntary through educational efforts
- Use of inducements e.g. subsidize purchase of low water use fixtures
- Adoption of punitive rate structures such as increasing rate block structures
- Increasing the cost of water
- Reducing the pressure provided to the customer
- Promulgating regulations on fixtures and irrigation practices, etc.

The actions that may aid in achieving a successful broad based conservation plan are:

- Investing in: Informational pamphlets, advertising in the news media,
- Providing personnel time to speak to schools and other publics, and
- Informational mailings, etc. included in the water billings.

There is an initial inertia from years of habit in the general use of water that must be overcome. A successful program will require continuous reinforcement of the conservation principles and objectives for many years.

B. CONSERVATION OPTIONS AND STRATEGIES (Cont.)

Water utilities are very capital intensive and have fixed operational costs. Any reduction in the quantity of water sold because of conservation must be offset by a corresponding increase in the water rates. It is important to point out to the users of the system that the increase in the water rates will be offset by saving to the individual user in other ways such as:

- Lower cost for heating of water for showers,
- Defer or eliminate the cost of expanding the physical plant (distribution system) to service future growth and/or commercial and industrial expansion,
- Reduces the size and capital cost of water treatment facilities, and
- Reduces the operational costs of the treatment facility e.g. power, chlorination, and
- Reduces the amount of wastewater that has to be treated.

B.1 INSIDE STRUCTURE OPTIONS FOR RESIDENTIAL AND COMMERCIAL

B.1.a Inducements and Promotional Efforts

Some water utilities have offered rebates for: retrofitting or replacement of fixtures, or free appurtenances to encourage users to make changes to their existing facilities. Some utilities conduct technical information programs instructing customers on how to implement the most effective conservation elements.

The most successful programs follow up at the customers site to see if the conservation measures have been installed. This is especially true in instances where the utility has provided free or subsidized the cost of:

- Reduced flow shower heads, low flow faucets, and faucet aerators,
- Toilet tank water volume displacement devices
- Test kits (tablets) for leakage in toilet tanks,
- Flow restrictors, and
- Replacement of older toilets with new ultra low flow toilets (1.6 gal./flush)
- Replacement of inefficient dishwashers and washing machines with efficient units.

B. CONSERVATION OPTIONS AND STRATEGIES (Cont.)

B.1 INSIDE STRUCTURE OPTIONS FOR RESIDENTIAL AND COMMERCIAL (Cont.)

B.1.b Promulgation of Regulations Mandating

- Installing pressure regulators to limit pressures to the customer to 70 psi or less depending on the piping and any peculiar needs of the customer that may warrant higher pressures.

- Prohibit the use of garbage disposal units.

- Install low flow shower heads.

- Install toilet tank displacement devices (bags) in older toilets.

- Install low flow faucets.

B.2 EXTERNAL OUTSIDE STRUCTURE OPTIONS - RESIDENTIAL & COMMERCIAL

B.2.a Inducements and Promotional Efforts

- Offer cash rebates for reducing the size of irrigated areas and use of plants that require minimal water.

- Distribute literature, pamphlets, brochures, guides, and technical assistance programs for users, including advice on landscaping maintenance.

- Actively promote the use of efficient irrigation equipment such as: drip systems, automatic controllers, and moisture sensors.

- Construct demonstration landscaping on City owned property.

- Promote the use of mulches and soil improvements where necessary.

B.2.b Promulgation of Regulations Mandating

- For new developments regulate yard sizes, and types of turf and landscaping plants (native and drought resistant).

- Limit the hours of irrigation from evening to the following morning.

- Limit or prohibit the use of water to wash down driveways and sidewalks. Require the use of brooms and dust pans as an alternate means.

- Prohibit the use of decorative fountains and ponds.

B. CONSERVATION OPTIONS AND STRATEGIES (Cont.)

B.2 EXTERNAL OUTSIDE STRUCTURE OPTIONS - RESIDENTIAL & COMMERCIAL (Cont.)

B.2.b Promulgation of Regulations Mandating (Cont.)

- Limit the size of turf areas by a certain future date.
- Prohibit car washing except at commercial car wash facilities, or require hoses to be equipped with shut-off devices at the end of hoses to minimize the waste of water during washing.

B.3 INDUSTRIAL WATER CONSERVATION MEASURES

Each industrial facility should be analyzed for it's particular needs. Some of the following options may or not apply to every industrial facility.

- Reuse and recycling of water. Several of the newer commercial car washing facilities reuse and recycle wash water.
- Promote the use of efficient water cooling system with reuse where feasible.
- Recommend and initiate an ongoing water auditing program to determine where water usage may be reduced and to identify leaks, if they exist. Installing additional meters internally to improve the auditing program of each process and/or usage.
- Landscaping recommendations as set forth in C.2 above.

B.4 EFFECTIVENESS OF CONSERVATION PROGRAMS

Based on experience of other water suppliers, an educational program alone will generally result in a reduction in water usage of 2 to 5 % during normal climatic conditions. Urgent requests during droughts or other periods of emergency will gain much more public support. There is at some point an economic balance as to the cost of investing in additional physical plant versus the costs of inducements to achieve a significant reduction in water usage. This balance point will vary with each community.

Approximately half (50%) of all the residential water demand in the State of Oregon, is utilized in the summer months for irrigation of yards. It has been estimated that 20 to 40% of the yards are over irrigated. Over irrigation costs results in an unnecessary expense to the customer and over watering may result in turf disease and other turf maladies. This wasteful practice places a burden on the community to provide additional physical plant capacity. The capital and operational cost of the physical plant is an expense all customers have to bear. State wide watering guides are available from the Oregon Water Resources Department (OWRD).

B.4 EFFECTIVENESS OF CONSERVATION PROGRAMS

An overwhelming majority of residents of the City maintain green yards in the summer months. The City stands out as an oasis of green in the summer months after the surrounding farm crops have ripened, turned brown and subsequently harvested. The green yards certainly add to the aesthetic beauty of the City and improve the ambient temperature around the homes. Any landscaping element of a conservation program should recognize the value of preserving the beauty of the community while achieving the desired conservation.

There are several sources of information on conservation options available to the City. Some of these sources are:

- The Oregon Water Resources Department
- Oregon State University Extension Service
- The American Water Works Association
- United States Environmental Protection Agency
- Washington State Department of Ecology
- California Department of Water Resources

C. MONITORING THE SUCCESS OF THE CONSERVATION PLAN

The City recently upgraded the computer equipment for recording water usage and for water and wastewater billings. A new Supervisory Control and Data Acquisition (SCADA) system was installed in the fall of 1993 for the operation of the City's water system. These two systems provide the City with the basic equipment needed to monitor the success of a conservation program. These systems are relatively new and software programs are still being developed, it will be some time before they will be able to reach their full potential in the conserving of water.

The hard data will need to be objectively reviewed for the impact of the annual variations in climatic conditions (running of taps in extremely cold winters and/or more irrigation in unusually hot summers). Pipeline breaks or other unusual events that may occur, should likewise be evaluated for it's impact on the conservation program.

With some additional programming, the computerized water billings data can be presented in a concise format (charts and graphs). Such information can be easily evaluated by the Public Works Director a monthly, annual, and longer periods of time. Armed with such readily discernible information, remedial actions could be implemented in a timely fashion to improve the conservation program. This information can also be utilized as a "report card" to the general public on the relative success of the conservation program.

C. MONITORING THE SUCCESS OF THE CONSERVATION PLAN (Cont.)

Conservation of water can definitely be a cost effective program for the City to vigorously pursue. The implementation of a successful conservation plan will:

- Increase the number of customers the City can service with the amount of water available through the City's existing water rights and permits,

- Reduce the size and cost of the treatment plant that will be required to fully utilize the use of the City's spring sources water rights and Umatilla River water rights/permits, and

- Defer or eliminate the need to increase the capacity of the distribution system.

One of the first efforts the City should undertake is to demonstrate a leadership role by implementing conservation efforts in all of the City's Departments and abandon the policy of providing **freewater** to all entities. **Freewater** can easily become very costly water to the City without some incentive to conserve. As has been proven historically over and over again, payment for water based on metered use has led to conservation.

A variation of payment for water may be the establishment of a reasonable amount for public benefit without payment, and payment for water usage above a stipulated amount. A policy of this type does require monitoring for wasteful practices, firm corrective actions, and appropriate adjustments made to the amount of water for which no payment is required.

To maximize the customers responsiveness to the implementation of a conservation plan it is mandatory that the City "**walks the talk**". It is important that there should be no visible surplus of water running off of any of the City's landscaped properties or other visual wasteful practices. If such wasteful practices are viewed by the public, the conservation plan promoted by the City, will be considered to be hypocritical and disregarded.

For a conservation plan to be effective, it has to be reinforced periodically at key times of the year. Reinforcing times are recommended at the start of the spring and summer irrigation season, and during the winter when faucets are left running to prevent the freezing of pipes. The only way to track the effectiveness of a conservation plan is to continuously monitor the consumption of the various classes and sub-classes.

Climate as a variable, has the single largest impact because of irrigation demand in the summers (extremely hot to mild) and during very cold winters when taps are left running to prevent pipe freezing on the amount of water consumed during any year.

C. MONITORING THE SUCCESS OF THE CONSERVATION PLAN (Cont.)

Graphing of water production and consumption can quickly provide an overview for management purposes and comparisons for periods of previous consumption. A suggested format for dividing the water production and consumption into major classifications and sub-classes for graphing follows:

C.1 WATER PRODUCTION (Separate Graphs)

City's springs

City's wells individually and aggregate

Combined total of springs and wells

C.2 CITY'S FACILITIES (Separate Graphs)

City Parks individually and aggregate

City Cemetery

City buildings, wastewater plant, and other sites, individually and aggregate

Combined total of the above

C.3 RESIDENTIAL CLASSIFICATIONS (Separate Graphs)

Single Family Residential with average usage per unit and aggregate

Duplexes with average usage per unit and aggregate

Multi-family with average usage per unit and aggregate

Planned Residential Developments with average usage per unit and aggregate

Mobile Home Parks with average usage per unit and aggregate

Combined total of the above

C. MONITORING THE SUCCESS OF THE CONSERVATION PLAN (Cont.)

C.4 COMMERCIAL RESIDENTIAL: HOTELS, MOTELS, RV PARKS (Separate Graphs)

Hotels with average usage per unit and aggregate

Motels with average usage per unit and aggregate

RV Parks with average usage per unit and aggregate

Combined total of the above

C.5 INSTITUTIONAL AND INDUSTRIAL CUSTOMERS (Separate Graphs)

Schools/Colleges with populations served individually and aggregate

Prison with population served

Hospitals, Rest Homes, and other care facilities, with populations served individually and aggregate

Indian Agency

Flour mill, bakery mill, trailer plant, etc. individually and aggregate

Combined total of the above

C.6 COMMERCIAL CUSTOMERS (Separate Graphs)

Restaurants, individually and aggregate

Shopping centers, individually and aggregate

Food Markets, individually and aggregate

All other commercial customers, with average usage per unit and aggregate

C.7 UNACCOUNTED FOR WATER (Separate Graph)

Graph showing the difference of the amount of water produced less all other major classifications

C.8 COMPOSITE GRAPH

A graph with seven lines incorporating all of the above major classifications. This is within the capabilities of the Lotus spreadsheet and should be for others also.

D. APPROVAL OF PENDLETON'S CONSERVATION PLAN

Pendleton's conservation element in this chapter varies considerably from the previously **conditionally** approved conservation plans by the OWRD. The OWRD monitored the City's draft conservation plan as it was evolving and consented to all of the conceptual changes.

At the last conference with Mr. Jack Donahue, OWRD's Conservation Program Representative, now retired, he advised that the City's last submitted draft would receive approval provided that the following unresolved issues are addressed. The following statements are made in response to the issues raised by Mr. Donahue and should place this chapter in an approvable form.

D.1 DESCRIPTION OF THE SYSTEM

The description of the system is included in this Master Plan.

D.2 THE CITY'S CURRENT CONSERVATION MEASURES

D.2.a. The water meter readers check for leaks in the meter boxes each time the meters are read.

D.2.b. The City's SCADA system was installed in place fall of 1993 and is currently monitoring the total water production. The Scada system will permit for the first time the monitoring amount of water returned to the river as an overflow from the South Hill Reservoir(s).

D.2.c The City meters all water users including all the City's Departments.

D.2.d The City reads meters monthly during the summer, bi-monthly in the spring and fall, and not during the winter months.

D.3 ANNUAL AUDIT

The City has recently installed a new computer system for recording water usage by various classifications. The new system is currently being programmed to provide the foundational information for an annual audit. Supplemental data such as water used for fighting fires and washing streets will be estimated.

D.4 WATER REUSE OPPORTUNITIES

The wastewater treatment plant is too far geographically from the central part of the City for the implementation of a cost effective reuse opportunity.

D. APPROVAL OF PENDLETON'S CONSERVATION PLAN (Cont.)

D.5 WHEN CONSERVATION MEASURES WILL BE IMPLEMENTED

It is recommended that implementation of an informational conservation program be initiated within 30 days of the City Councils' adoption of the updated Water Master Plan (final draft).

D.6 METER MAINTENANCE PROGRAM

The City Water Department maintains a testing and repair shop to periodically test all meters in the system. Meters showing abnormal readings are brought into the shop for testing. The meters are either repaired and reinstalled or replaced depending on the results of the meter test and inspection of worn parts.

D.7 NO EVALUATION OF CONSERVATION MEASURES

The above Section C addresses this issue.

D.8 LIST A DESCRIPTION OF PAST SHORTAGES

Depending on the definition of shortages, 1992 and 1994 were years when public institutions with large turf and landscaped areas were requested to reduce or curtail the amount of water usage for irrigation.

D.9 PREDETERMINED "TRIGGER" FOR IMPLEMENTING CONSERVATION MEASURES

A recommended trigger would be when the water demand has equalled 90% to 92% of production capacity for several days (10 days minimum) and there is reason to expect an increase in the system demand because of climate or other factors.

D.10 THERE IS NO LONG RANGE WATER SUPPLY ELEMENT

This report adequately addresses this issue for various population growth scenarios.

D. APPROVAL OF PENDLETON'S CONSERVATION PLAN (Cont.)

D.11 PROPOSED DATE FOR UPDATING OF THE PLAN AND SUBMITTING TO OWRD

The Water Management and Conservation Plan may be updated at one or more of the following events and will not exceed 10 years from the adoption of this document.

- Updating of the City's Comprehensive Plan
- Compliance with other federal and/or state agency mandated planning
- To address growth in one or more sectors of the City
- General unanticipated growth of the City

E. CITY'S CURRENT CONSERVATION AND CURTAILMENT PLAN - ORDINANCE

A complete copy of the current Conservation and Curtailment Plan (Ordinance), adopted January 3, 1995 is replicated on pages VI-13 to VI-18.

ORDINANCE NO. 3514

AN ORDINANCE ESTABLISHING REGULATIONS FOR THE ALLOCATION OF WATER RESOURCES TO BE EFFECTIVE WHENEVER THE PENDLETON CITY COUNCIL FINDS THERE IS A WATER SHORTAGE EMERGENCY; AND PROVIDING PENALTIES FOR VIOLATIONS THEREOF.

WHEREAS, the City of Pendleton is a water supplier, licensed by the Oregon State Health Division, Drinking Water Section; and

WHEREAS, the City desires to preserve the capability of the existing water sources to continue to meet the water demands of all customers of the City's water utility; and

WHEREAS, the City desires to increase the amount of water available from the present water sources for future growth of customers; and

WHEREAS, the City's Water Department (by metering of all permanent system users and the implementation of a permanent audit system accounting for un-metered water – e.g. water tanks on street flushers/fire trucks, estimates of fire usage, hydrant flushing, etc.) can account for a minimum of ninety (90%) percent of all water produced; and

WHEREAS, the City has installed a Supervisory, Control and Data Acquisition (SCADA) remote telemetry system for all elements of the City's water system; and

WHEREAS, the City's primary goal is to increase the amount of water available from existing water sources for future growth, through the implementation and encouragement of conservation measures, and thereby avoid the need for developing significant quantities of additional water sources that may require extensive treatment to meet the standards of the Federal Safe Drinking Water Act; and

WHEREAS, the City's secondary goal is to provide water for continued growth for all types of customers. The City Council has determined that it is timely and prudent to implement the policies herein that will result in a more efficient use of current water supplies; and

WHEREAS, it is the City Council's goal that the implementation of this Water Conservation Plan will result in a ten (10%) percent reduction in the total annual water demand and summer peak demands (as corrected for factors impacting demand e.g. population changes, weather, fire demands, etc.). Achieving this goal would, in effect, increase the capacity of the water system; and

WHEREAS, the potential for a drought, which may be coupled with other contributory factors, could further reduce the amount of available water; thus, the City Council enacts this Ordinance to: (1) adopt a Water Conservation Plan; (2) encourage water conservation; (3) provide for voluntary rationing during periods of mild water shortages; and (4) require the curtailment of the use of water during more severe water shortages as defined herein; and

WHEREAS, after the adoption of this Ordinance, the City Council will continue to review the progress of this Water Conservation Plan and direct the City Manager to implement necessary changes; and

WHEREAS, water rates will be evaluated as a part of the 1995 Water Master Plan and periodically thereafter; and

WHEREAS, certified businesses in the Pendleton Enterprise Zone that have a contract with the City with a special water rate structure, as authorized by State Administrative Rules, shall have those rates honored as specified in the agreement with the City.

NOW, THEREFORE, THE CITY OF PENDLETON ORDAINS AS FOLLOWS:

SECTION 1. **DEFINITIONS.** As used in this Ordinance, the following terms shall have the meaning given herein:

"City"	The City of Pendleton, Oregon
"City Manager"	The City Manager of the City of Pendleton or the manager's designee.
"Customer"	Any person using water supplied by the City.
"Person"	Any person, firm, entity, partnership, association, corporation, company, or organization of any kind.
"Water"	Water from the City, unless expressly provided otherwise or required by contract.

SECTION 2. **APPLICATION.** The provisions of this Ordinance apply to all customers using water provided by the City.

SECTION 3. **EDUCATION AND INFORMATION.** The City will inform the public of ways to conserve water and why conservation is important by:

A. Distribution of educational materials to all customers once per year until the City determines there is no longer a need to do so.

B. Submittal of conservation articles to the local newspaper and the local radio stations at times corresponding to the distribution mentioned above and more often if conditions warrant.

C. Providing new customers with conservation information when they apply for initial water service. The City will maintain a supply of printed materials available through private and public sources.

D. Encourage existing water users to replace their inefficient plumbing fixtures with new, low flow fixtures or to use retrofit kits. The typical retrofit kits will consist of; toilet tank insert(s), low-flow showerhead(s), faucet flow restrictor(s), toilet leak detection dye tablet(s) and an information guide. Information on other types of retrofits and other related conservation tips will be provided to water customers.

SECTION 4. **METERING.** The Water Department will continue the policy of metering all water service connections (customers, parks, public owned buildings, temporary construction, etc.) and production. The City will continue to test all meters which appear to have abnormal water usage.

SECTION 5. **WATER CONSERVATION DURING SUMMER IRRIGATION.** The public information program will include suggestions on landscaping and irrigation procedures which will reduce water use. The City will investigate and may promulgate subdivision and development regulations which would encourage developers to plant only low water using plants and grasses. Printed information on lawn irrigation, application rates, and types of drought resistant plants compatible with the area climate will be pursued.

SECTION 6. **LEAK DETECTION AND REPAIR.** The City will start a water audit and leak detection and repair program whenever the unaccounted for water exceeds ten (10%) percent of the water used by the system. The City will:

A. Check customer meters and plumbing which have high usage;

B. Monitor the water distribution system to identify leaks;

C. Monitor water system supply master meter(s) to identify abnormal conditions that could indicate a leakage or erroneous recordings;

D. Institute a program to field check sections of the water distribution system by testing customer meters and listening for leaks during low-use periods; and

E. Make needed repairs.

SECTION 7. **PROMOTION OF CONSERVATION.** This Water Conservation Program will be promoted by:

A. City staff will encourage builders to install plumbing fixtures that are water efficient, and the efficient use of water saving landscaping when they apply for a new water service.

B. Reviewing the conservation effect of the current water rate structure. If after review of water usage, it is deemed necessary, a new rate structure will be adopted which will encourage replacement of old inefficient plumbing fixtures and support more efficient lawn and garden watering.

C. Develop policy and implement measures to control and/or eliminate all free water accounts. Pendleton presently provides water free of charge to various non-profit organizations and agencies amounting to approximately 100 million gallons annually. Free water accounts presently have little or no incentive to conserve water.

SECTION 8. **WHOLESALE CUSTOMERS.** The City currently has no wholesale customers. If the City sells water to another water supplier in the future, the supply agreement will require that supplier to adopt a similar water conservation plan.

SECTION 9. **VOLUNTARY WATER USE CURTAILMENT.** Prior to enforcing a mandatory curtailment of water consumption during a water shortage the City shall:

A. On a finding that there are factors and circumstances present that will result in water demands exceeding the capacity of the City's water sources (ninety [90%] percent of system capacity or above normal lowering of the water levels in wells), the City shall:

(1) Advise customers of the current water situation, and projected deficiencies of the current system to meet demands without a voluntary reduction in the amount of water consumed, and

(2) Identify the percentage of voluntary reduction that is required to avoid a shortfall in the capability of the existing source(s) to avoid the need to implement the mandatory cutbacks provided by this Ordinance.

(3) Communicate the need for voluntary reduction through:

a. Monthly utility billings,

b. Local media – newspapers, radio, television, and

c. Printed materials posted in public places.

Included in the above announcements will be suggestions on how to accomplish the voluntary reductions.

If the voluntary reduction program is successful, the City will continue with the above steps until the voluntary reductions are no longer necessary.

B. If the voluntary reduction program is unsuccessful, the City Manager will implement the appropriate curtailment sections of this Ordinance.

SECTION 10. WATER CURTAILMENT PURPOSE AND INTENT. Whenever the City Council finds:

A. That a water shortage emergency condition prevails in the area served by the City, or

B. That the ordinary demands and requirements of water consumers cannot be satisfied without depleting the water supply of the City to the extent that there would be insufficient water for human consumption, sanitation, and fire protection; the City Council shall, by motion, impose a First Level of Curtailment or a Second Level of Curtailment as provided by this Ordinance.

SECTION 11. FIRST LEVEL OF CURTAILMENT.

A. Nonessential Residential Uses. During a first level of curtailment the following uses of water for residential purposes are prohibited:

(1) The use of water to wash all types of motorized vehicles (for land, air, and water) except at commercial fixed washing facilities existing prior to the enactment of this Ordinance or those that recycle or reuse the water.

(2) The use of water to wash down all types of permanent (horizontal or vertical) exterior hard surfaced areas.

(3) The use of water to fill, refill or add to any indoor or outdoor private swimming pool or jacuzzi pool except for neighborhood fire control (when deemed necessary by the City Manager), except where the pools have recycling water systems and evaporative covers, or where the use of the pool is required by a medical doctor's prescription.

(4) The additional use of water in a fountain or pond for aesthetic or scenic purposes.

B. Nonessential Commercial, Institutional or Industrial Use. During a first level of curtailment the following commercial or industrial water uses are prohibited:

(1) The use of water to serve a customer in a restaurant unless requested by the customer.

(2) The use of water for scenic and recreational ponds and lakes.

(3) The use of water from hydrants for construction purposes, fire drills, or any purpose other than fire fighting.

(4) The use of irrigation water for schools, parks, cemeteries, recreation areas, golf courses, community food gardens, residential gardens, and similar recreation or memorial type facilities in excess of seventy-five (75%) percent of the normal historical amount consumed.

(5) The use of domestic water for schools, nursery facilities, restaurants, shopping centers, gasoline service stations, health and swim clubs, and all other commercial uses in excess of ninety (90%) percent of the normal historical amount consumed.

(6) The use of water for manufacturing, food processing, cooling or cleaning of equipment in excess of ninety (90%) percent of the normal historical amount consumed.

(7) The use of water for agricultural irrigation in excess of seventy-five (75%) percent of the normal historical amount consumed.

(8) The use of water for dust control.

C. Gutter Flooding. No person or customer shall cause or permit water to run to waste in any gutter or drain.

D. Discontinuance of Service. The City may, after one warning by certified mail or in person, disconnect the water service of any person when the City Manager determines that the person has failed to comply with any provisions of this Ordinance. Disconnected service shall be restored only upon:

(1) Payment of the turn off and on charge, as specified by the City's general rate structure, and any other costs incurred by the City in the discontinuance and restoration of the service; and

(2) The giving of suitable assurances to the City that the action causing the discontinuance will not be repeated.

In addition to the foregoing, the City may, prior to restoration of service, install a flow-restrictive device on the customer's service.

E. Variances. The City Manager may grant temporary variances for prospective uses of water otherwise prohibited after determining that due to unusual circumstances that failure to grant such variance would cause an emergency condition affecting health, welfare, sanitation, or fire protection of the applicant or the public.

F. Appeal. The City Manager's action to discontinue service or apply conditions regarding the restoration of service may be appealed to the City Council. If the aggrieved person files notice with the City Manager within five days of notice of the action or the proposed action, the action will be stayed pending a decision on the appeal.

No such variance shall be retroactive or otherwise justify any violation of this Ordinance occurring prior to issuance of the temporary variance.

SECTION 12. SECOND LEVEL OF CURTAILMENT. In addition to the restrictions in Section 11, the following curtailments may be enforced during a second level of curtailment:

A. 1 or 2 residential units - Daily usage allotment:

(1)	one permanent resident	80 gallons
(2)	two permanent residents	110 gallons
(3)	three permanent residents	140 gallons
(4)	each additional permanent resident	30 gallons

B. Multi-residential units (three or more units) - Daily usage allotment for each unit shall be 130 gallons per day.

Each customer in whose name water is supplied to a residence, or residences or apartments or other dwelling units, shall upon request of the City Manager advise the City, under penalty of perjury, of the number of permanent residents using water supplied to the residence, residences, apartments, or other dwelling units.

If the customer fails to advise the City Manager, each residence, apartment or dwelling unit shall be permitted the water allocation herein provided for one permanent resident.

C. Other Nonessential Uses. All other uses of water not expressly set forth in this Ordinance in excess of seventy-five (75%) percent of the normal historical amount consumed.

D. Determination of Amount of Prior Water Consumption. The normal historical amount of water consumed shall be determined by the City utilizing historical records of the same time periods. Where no such records exist, the amount shall be the average use of similar existing services as determined by the City from it's records.

SECTION 13. PENALTIES. Violations of any provision of this Ordinance may be punished by fines not to exceed:

First violation $100.00
Second violation within 6-month period $250.00
Third and subsequent violations in three years $500.00

Offenses under this Section shall be tried in the Municipal Court as a violation and not as a crime.

SECTION 14. ORDINANCE CONTROLLING. The provisions of this Ordinance shall prevail and control in the event of any inconsistency between this Ordinance and any other rules or regulations of the City.

SECTION 15. **SEVERABILITY CLAUSE.** The invalidity or illegality of any provision of this Ordinance shall not affect the remainder of this Ordinance.

PASSED by the City Council and approved by the Mayor, January 3, 1995.

APPROVED: s/ Robert E. Ramig
Mayor

Attest: s/Judi A. Zoske
City Recorder

Approved as to form:

s/Peter H. Wells
Peter H. Wells
City Attorney

CHAPTER VII -- IMPROVEMENTS

A. NECESSITY FOR IMPROVEMENTS

The principal factors that necessitate the need for improvements to the water system have been identified and discussed in the prior chapters of this report. These factors in brief are:

- The loss of use of City Well #1 (2.58 mg/day = 941.7 mg/year) because of the declining water table and a 12" casing in the borehole preventing the lowering of the existing pumping equipment,

- The changing requirements mandated by the Federal Safe Drinking Water Act administered by the U.S. E.P.A. on the allowable amount of turbidity in water sources. As the turbidity limit has been lowered, the amount of water from the City's springs considered to be safe for drinking water has been dramatically reduced. To maximize the use of this source will require treatment by conventional filtration or membrane filtration,

- The increase in population of 14,328 in 1978 to 15,395 in 1992. The historical maximum annual average consumption was 344.73 gallon/person/day (hot summer irrigation) in 1986 (see page II-6). This increase in population equates to an additional annual demand of 134,257,000 gallons per year. During the hot summers, there is reduction in the yield of water available from the springs, compounding the problem.

  Providing water demands for additional population growth and future industrial needs increases the magnitude of the improvements required, and

- The gravity transmission line from the springs has a limited carrying capacity of 5.25 mgd (69.5%) of the City's existing water permits/rights of 7.56 mgd. This constriction prevents the delivery of 2.31 mgd or 843.2 million gallons per year presumed to be available if the springs are fully developed.

Sections A through I of this chapter are based on the limited current knowledge on the:

- Legal status and viability of the City's existing water rights and permits for the springs and the Umatilla River. There is some question as to the quantitative amounts available and the time that the water may be available.

- The ability of developing new wells with yields of 3,000 gpm. The City has had limited success in the developing of wells of large capacity, and none at 3,000 gpm. Well development costs vary considerably depending on formations encountered (rock, caving stratas, need for liners, screens, etc.).

Section J on page VII - 48 discusses these and other presently undeterminable considerations. These considerations may have very significant impact on the assumptions made in this chapter.

B. QUANTIFYING THE EXTENT OF IMPROVEMENTS REQUIRED

B.1 HISTORIC MAXIMUM MONTHLY DEMAND

Without the knowledge of any impending special water demand, the best method for projecting future water demand is based on the historic per capita consumption during the maximum year of record. As stated above, this was 344.73 gallons per capita per day on an annual basis in 1986.

B.2 DESIGN POPULATION

The attainment of reaching the design population of 20,000 persons is as set forth in Chapter II on page II-2 (based on the graph band of high, moderate and low growth rates). The selection of a 20,000 person population design provides for adequate facilities for future time periods as follows:

- UPPER BAND The projected high rate of population for the year 2000,
- MEDIUM BAND The projected medium rate of population for the year 2010, and
- LOWER BAND The projected low rate of population for the year 2020.

A conservative rate of growth is recommended because of the high capital costs of the proposed improvements, and the potential of an Artificial Recharge and Recovery (ARR) project to provide long term storage to meet summer high demand periods for one or several successive years.

B.3 AVERAGE ANNUAL DAILY DEMAND FOR A POPULATION OF 20,000 PERSONS

Based on the above data, the **average** annual and daily demands are:

Average daily demand = 344.73 gal. per capita per day x 20,000 persons or **6,894,600 gal./day**

Average annual demand = 6,894,600 gal. per day x 365 days or **2,516,529,000 gal./year**

B.4 AVERAGE DAY DEMAND DURING THE MAXIMUM MONTH FOR 20,000 PERSONS

A maximum water demand month of 314.225 MG occurred in August 1986 when the population was 14,445 persons. From this data, the following is developed:

- Average day demand for maximum month: 314.225 MG/31 = 10.136 MGD.
- Per capita demand average day max. month: 10.136 MGD/14,445= 701.72 gal.
- Average day max. month for 20,000 persons: 20,000 x 701.72 = 14,034 MGD.

B.5 MAXIMUM DAY DEMAND DURING THE MAXIMUM MONTH FOR 20,000 PERSONS

No records of high daily or hourly (summer) peaking demands are available. The newly installed SCADA system will provide this data in the future. Actual records of the maximum days and hours during the hotter summer climate years of 1986 and 1992 would have provided usage patterns on which to base future demands. Lacking this information, it will be necessary to estimate how much higher the maximum day demand was in the summer of 1986 than the average day demand.

Based on the experience of other cities, the maximum day in the maximum month ranges from an increased demand from 7% to 30%. July and August are the months that generally place the highest demand on the water system. The highest demand month in Pendleton is generally preceded in the previous month by a fairly high water demand, which tends to establish an irrigation pattern prior to the maximum month. It is not unusual in Pendleton, for several days in succession, to reach temperatures almost as hot as the hottest summer day. For the basis of this study, we will assume that the maximum day will be 20% more than the average day of the maximum month. The maximum day during the maximum month for a population of 20,000 persons is therefor estimated to be:

Maximum day in maximum month: 14.034 MGD x 1.2 = 16.841 MGD

B.6 MANMADE RESERVOIRS CAPACITY FOR PROVIDE PEAKING DEMANDS

The City's reservoirs are capable of meeting the peaking demands of a single day, but incapable of meeting a series of sustained hot summer days. To construct conventional storage facilities for several successive hot summer days could create problems such as: maintaining a sufficient chlorine residual (disinfectant) over a long storage period; or an initial dosage so high that the chlorine residual at the consumer's tap would be offensive to some customers. Another undesirable alternative that could offset additional reservoir capacity and longer storage periods, would be to reduce the operating height in the reservoirs. This alternative would reduce the water pressure below acceptable levels to several customers. It is imperative, therefor, that the water supply source(s) be adequate to address the demand imparted by a succession of several hot summer days in the hottest years of record.

B.7 PRUDENT SIZING OF WATER PRODUCTION CAPACITY FOR MAXIMUM DEMAND

There are basically two approaches normally applied to designing adequate water production capacity to assure that there is sufficient water to meet anticipated water demand plus provide for a reserve capacity. These are:

- From the fire underwriting approach, it is desirable to have adequate capacity at all times with the largest single source of supply out of service. In Pendleton's case, this would be the City's springs. There was an occurrence in the past where a derailment of a train spilled a substance that found it's way into the City's springs. An accidental rupture of gravity supply line, could also happen in the future. This chapter is premised on developing the springs up to the full amount of their present water rights of 7.56 MGD (11.7 cfs).

B.7 PRUDENT SIZING OF WATER PRODUCTION CAPACITY FOR MAX. DEMAND (Cont.)

- Where multiple sources are available, the general recommended criteria is that only 75% of all sources should be considered as firm supply to meet peaking demands. This allows 25% of source capacity for: avoiding short cycling periods and/or failure of electrical motors; mechanical failure; electrical outage; unscheduled maintenance; malfunction of controls; accidental rupture of supply and transmission lines; and a host of other possibilities. The additional reserve capacity using this approach is: 16.84128 MGD/3 = 5.613760 MGD.

Because of the City's size and the ability to achieve a quick response in the case of an emergency, the latter is recommended for design of the source capacity. The design capacity of all water sources for a population of 20,000 person becomes:

Maximum day during the maximum month:	16.84128 MGD
Reserve Capacity:	5.61376 MGD
Design Capacity:	22.45504 MGD

From B.3 above, the average annual day demand for a population of 20,000 persons is only 6,894,600 gallons. The above design capacity of 22.45504 MGD is 3.26 times the average annual day demand.

A successful Artificial Recharge Recovery (ARR) project could meet this additional demand, provided: that the City has sufficient well production capacity accessing the underground basalt aquifers (reservoir), and that a reasonable amount of the water injected is recoverable.

B.8 ADDITIONAL SOURCE REQUIREMENTS W/O SPRING IMPROVEMENTS OR ARR

This section considers the alternatives of: not improving the yield of the springs, electing not to implement a successful ARR program, improving undeveloped permitted wells, increase the yield of existing wells that are not producing up to the amount of their permits, and the development of unused surface water rights and permits. The different options are as follows:

- Continued use of the existing City's wells and allow the water table in the underlying aquifers to continue to decline. In the event that a Critical Groundwater Area (CGA) is declared, the City may possess enough senior water rights to require others to reduce pumpage enough to stabilize the deep well water table.

- Add new well water sources that are already permitted but undeveloped. This can be expected to accelerate the decline in the underground water table of the deep wells.

- Develop water sources from existing permits and water rights on the Umatilla River. Of these, the two oldest ones total 1.61 MGD (2.5 cfs) and are probably senior enough to be assure year around availability. The quantity and periods of availability (times of the year) of the other two more junior ones are not known.

B.8 ADDITIONAL SOURCE REQUIREMENTS W/O SPRING IMPROVEMENTS OR ARR

- Construction of one or more dams on the Umatilla River.

Table VII - 1 on page VII - 6, extrapolates the 1986 water year demands from a population of 14,445 to 20,000 persons. Yield from the City's spring sources shown in the table are assumed to be the same as recorded in 1986. The primary purpose of the Table is to illustrate the amount of water required from other sources if there is not any additional yield developed at the City's springs.

In 1986 the amount of usable potable water from the City's springs was 858.96 million gallons (MG). There were other years when the amount of potable water from the springs was considerably less, e.g.

1992 - 553.08 MG	1989 - 730.01 MG	1987 - 593.38 MG
1985 - 519.46 MG	1984 - 632.79 MG	1983 - 671.27 MG

If any one of the above lower annual yields from the springs had been used in Table VII - 1, there would have been a corresponding increase in the amount of water required to be developed from **other** sources. Such a combination of a high annual demand and low spring production may occur in future years, but can not be justified on the basis of historic records.

Table VII - 1 shows that for the maximum month of August, **other** sources will be required to provide 346.265 MG (average daily rate of 11.17 MGD) to supplement the spring sources. Therefore, the amount of additional source development and treatment required for the maximum day (with reserve capacity) is:

Total Additional Source Required: 11.17 MGD x 1.2 x 4/3 = 17.87 MGD

The only means of providing the majority of this much demand would be the withdrawal of water from the underlying aquifers (reservoir). This alternative is portrayed on a chart on page VII - 7. In viewing this chart, it is important to realize that the chart portrays projected water demands for the <u>average day</u> during each month. For the maximum day for any month would require adding 20% for the maximum day plus an additional 33% for a reserve source capacity.

The information in this sub-section demonstrates indispensability of maximizing the yield from the City's spring sources.

If the City's springs were developed to their legal water rights and an implemented ARR project would prove to be successful, this sub-section would become a moot issue.

TABLE VII-1

PENDLETON'S MONTHLY WATER DEMANDS FOR 20,000 PERSONS IN MILLIONS OF GALLONS PER MONTH

WITHOUT IMPROVEMENTS AT SPRINGS (IMPACT ON DEEP WELL SOURCES)

MONTH	SPRINGS GRAVITY	* OTHER	TOTAL	% SPRINGS	% * OTHER
JAN.	63.629	71.293	134.922	47.16	52.84
FEB.	16.851	87.293	104.144	16.18	83.82
MAR.	0.000	120.480	120.480	0.00	100.00
APR.	54.955	84.412	139.367	39.43	60.57
MAY	134.600	106.625	241.225	55.80	44.20
JUNE	96.062	273.065	369.127	26.02	73.98
JULY	103.300	250.390	353.690	29.21	70.79
AUG.	88.800	346.265	435.065	20.41	79.59
SEPT.	62.200	139.327	201.527	30.86	69.14
OCT.	73.209	70.563	143.772	50.92	49.08
NOV.	103.700	44.909	148.609	69.78	30.22
DEC.	61.654	62.947	124.601	49.48	50.52
YR. TOTAL	858.960	1,657.569	2,516.529	34.13	65.87
MAX. MO.	134.600	346.265	435.065		
MIN. MO.	0.000	44.909	104.144		

* OTHER INCLUDES DEEP WELL SOURCES

SUPPLY WATER	FROM	ABOVE SOURCES
MAX. MO.	69.78	100.00
MIN. MO.	0.00	30.22

AVERAGE DAY--- MAXIMUM AND MINIMUM MONTHS:

Max. month	4.487	11.170
Min. month	0.000	1.449

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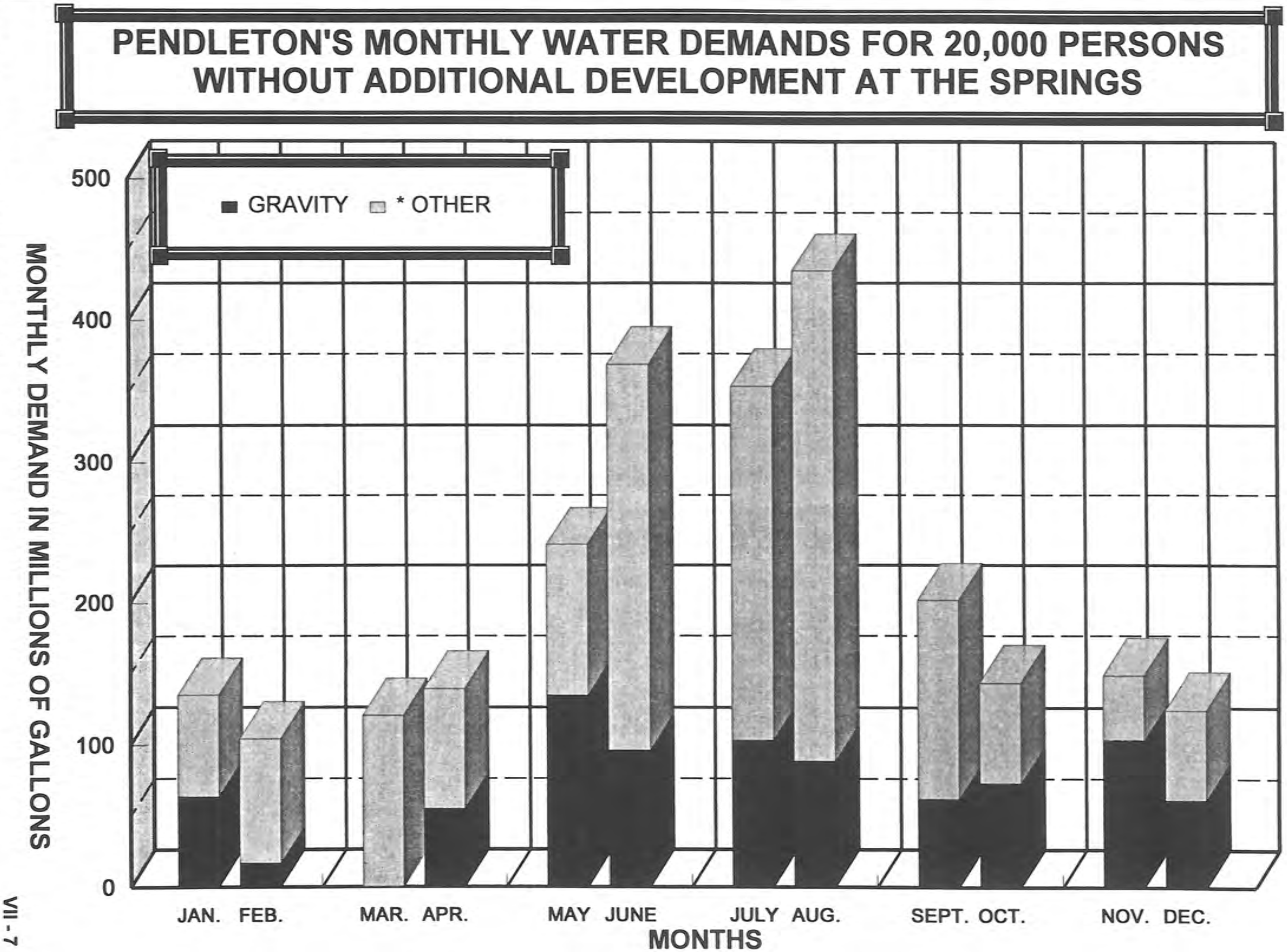

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B.9 MINIMUM SOURCE DEVELOPMENT REQUIRED FOR A SUCCESSFUL ARR PROJECT

To determine the amount of water to be stored and recovered from the basalt aquifers (reservoir), we need to establish how the demand varies throughout the maximum water demand design year. To accomplish this, we are again, as in the prior section, utilizing the 1986 water demand year with the same extrapolated population of 20,000 persons. This section is also based on the premise that the City's spring sources will be fully developed to 7.56 MGD. The data in Table VII - 2, on page VII - 9 was developed based on this criteria.

The graph on page VII - 10 is based on the data in Table VII - 2, which is premised on 65.66% of the water artificially injected being recovered to meet the additional demands imposed by summer irrigation. This assumes that the recovery rate of the injected water would be somewhat comparable with the ARR project at Salem, Oregon (64.24% page III - 21, 5th ¶).

The OWRD permit for the City of Hermiston's ARR project, limits artificial recharge to starting on October 15th to June 15th of the following year. Based on a phone conference call with Fred Lissner, Manager of the Groundwater Section of the Oregon Water Resources Department (OWRD), the condition placed on the Hermiston ARR project may not be required of Pendleton. However, it should be noted what the impact would be if the condition of limiting artificial injection each year from October 15th to the following June 15th, was applied to the Pendleton ARR project. The data generated in Table VII - 2 would have to be amended as follows:

Amount available for recharge:	714.323 MG
less 50% of the available recharge in October:	45.316 MG
Revised amount available for recharge:	669.007 MG
Amount of recharge water required for summer demand:	469.057 MG

% recharge recovery = 469.057 MG/669.007 MG = 70.11%

Because of the pattern of high to low daily demands of water consumption, there will be times during the day when the water demand is considerably less than the water source capabilities. Data in Table VII - 2 is based on artificial recharge from the spring sources occurring whenever the demand periods are less than the production capacity (7.56 MGD) capacity of the springs. **The ability to store quantities of surplus water from the springs on a year around basis whenever it is available, materially improves the effectiveness of an ARR program. Even during years with hot summer months, there will be whole days and parts of days when the demand rate is less than 7.56 MGD.** If recharge is not permitted during these periods of low water demand, the computed amount of water available for recharge must be correspondingly reduced. Lacking data on the historical patterns of daily use (less than springs production capacity) prevents accurate projections on the actual impact of not being able to recharge days during these days.

TABLE VII-2

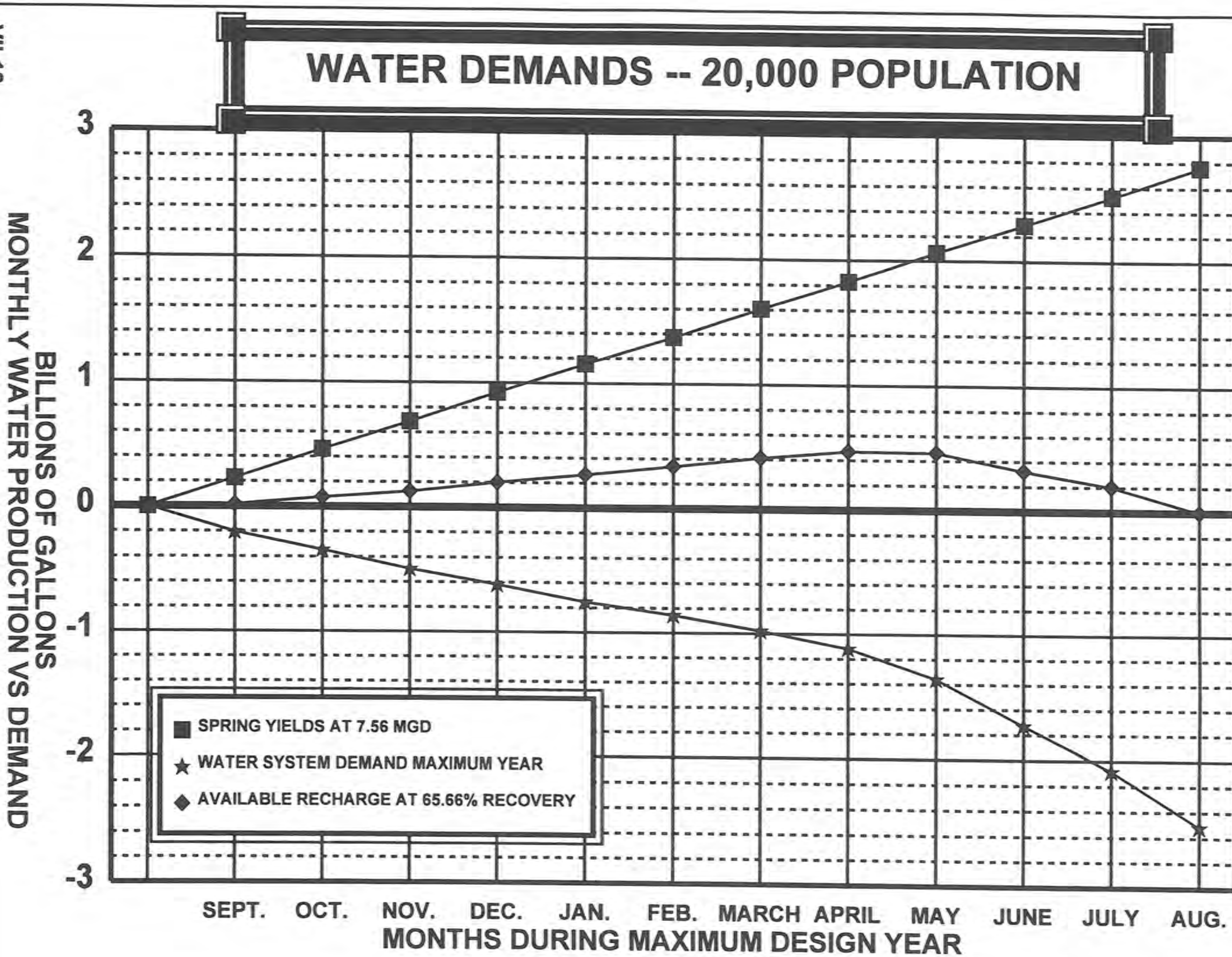
PENDLETON'S MONTHLY WATER DEMANDS FOR 20,000 PERSONS
IN MILLIONS OF GALLONS PER MONTH

SPRING SOURCES IMPROVED TO 7.56 MGD PLUS ARTIFICIAL RECHARGE & RECOVERY

MONTH	SPRINGS YIELD	MONTHLY DEMAND	AVAILABLE FOR RECHARGE	REQUIRED RECOVERY FROM RECHARGE
JANUARY	234.403	134.922	99.481	0.000
FEBRUARY	213.609	104.144	109.465	0.000
MARCH	234.403	120.480	113.923	0.000
APRIL	226.841	139.367	87.474	0.000
MAY	234.403	241.225	0.000	6.822
JUNE	226.841	369.127	0.000	142.286
JULY	234.403	353.690	0.000	119.287
AUGUST	234.403	435.065	0.000	200.662
SEPTEMBER	226.841	201.527	25.314	0.000
OCTOBER	234.403	143.772	90.631	0.000
NOVEMBER	226.841	148.609	78.232	0.000
DECEMBER	234.403	124.601	109.802	0.000
YR. TOTAL	2,761.795	2,516.529	714.323	469.057
MAX. MO.		435.065	113.923	200.662
MIN. MO.		104.144	0.000	0.000

RECOVERY % OF ARTIFICIAL RECHARGE REQUIRED TO EQUALIZE ANNUAL DEMAND:

AMOUNT AVAILABLE FOR RECHARGE:	714.323
AMOUNT REQUIRED FROM RECHARGE:	469.057
NET AMOUNT AVAILABLE EACH YEAR FOR RECHARGE:	245.266
PERCENT RECOVERY REQUIRED:	**65.66%**



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B.10 SUPPLEMENTAL SOURCE DEVELOPMENT RECOMMENDED FOR AN ARR PROJECT

The recommended source development includes the full development of the City's springs (11.7 cfs) and the 1885 and 1890 Umatilla River permits for 2.0 and 0.5 cfs respectively, for a combined total of 14.2 cfs (9.177 MGD). This option provides for at least a small redundancy in water sources. Additional redundancy may be possible if the Point Of Diversion (POD) of one or some of the existing spring supply's POD can be relocated to within the City Limits. The option of relocating the POD is discussed in more detail in the following Chapters.

The amount of water recoverable from an artificial recharge is unknown and will be most successful if injected in well(s) upgradient from the City's other wells. There is some question as to which well has the highest water table because the limited periods of rest from pumping for all of the City's wells. It is also possible that flows are occurring from upper to lower aquifers and/or pumping from private wells could mask the true slope of what would otherwise be an un-stressed hydraulic gradient (direction of flow that would normally occur in the aquifers).

The additional 2.5 cfs (1.616 MGD) of the Umatilla River source will provide a higher degree of assurance that there will be an adequate amount of water injected and locally stored ("banked") into the basalt aquifers (reservoir) to meet and/or exceed the irrigation demand burden placed on the water system in the summer months. Table VII - 3 on page VII -12 indicates that only a recovery of 27.293% of the artificially injected water is required to meet the water demands of the maximum future design year. If we assume the same recovery of artificially injected water of 66.116% as developed in Table VII - 2 page VII - 9, the amount available to be "banked" in the basaltic aquifers is:

Available for recharge from Table VII - 3:	1,148.986 MG
Quantity of water recoverable @ 66.12%:	759.660 MG
Water required from "bank" for max. design year:	313.592 MG
Surplus recharge water "banked" in aquifer:	446.068 MG

The graph on page VII - 13, graphically depicts the data in Table VII - 3 and the above computations. The upper line is predicated upon a continuous combined water yield from the springs and the Umatilla River of 9.177 MGD versus the water demands during the maximum design year. The middle line represents the accumulative difference between the monthly water yields and demands peaking at 759.66 MG in May. At the end of the maximum design year, the middle line shows the surplus of 446.068 MG of artificial recharge water "banked".

During years of low annual and average annual water demands, the amount of water available to be "banked" in the basalt aquifers increase and lower the required percentage (%) of water required for meeting the water demands in those years. With a high rate of recovery, it may not be economically justifiable, to treat all of the available water and "bank" it in the basalt aquifers. How much to "bank" that will be cost effective can only be determined after a reasonable recovery percentage is known.

Prior to being able to withdraw artificially injected water from an underground aquifer, it must be demonstrated to the OWRD that there has been water "banked" (stored) in the underground aquifer.

TABLE VII-3

PENDLETON'S MONTHLY WATER DEMANDS FOR 20,000 PERSONS IN MILLIONS OF GALLONS PER MONTH

WITH SPRING & RIVER SOURCES IMPROVED TO YIELD 9.177 MGD, PLUS ARR

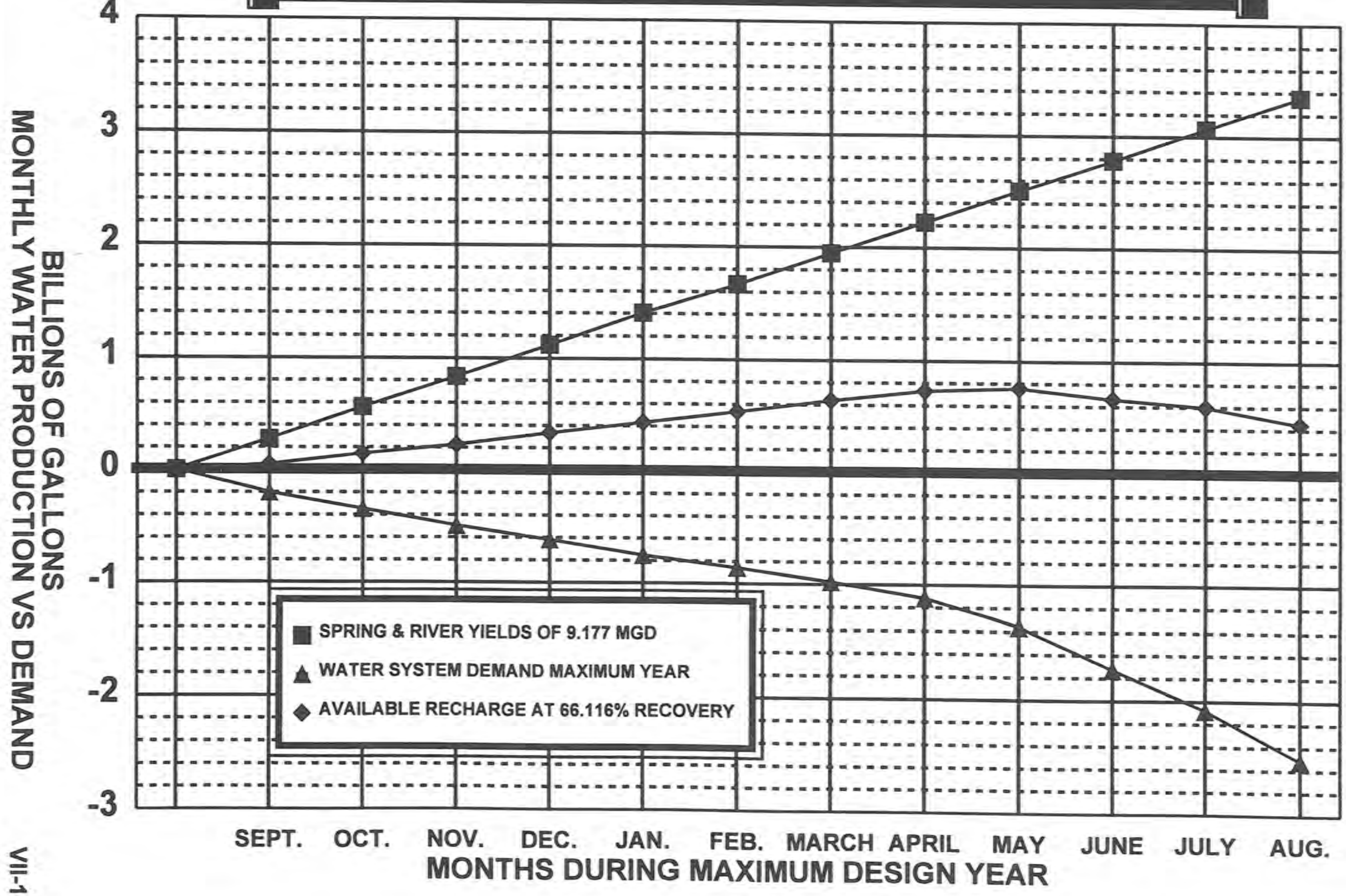
MONTH	SPRINGS AND RIVER YIELD	MONTHLY DEMAND	AVAILABLE FOR RECHARGE	REQUIRED RECOVERY FROM RECHARGE
JANUARY	284.489	134.922	149.567	0.000
FEBRUARY	259.252	104.144	155.108	0.000
MARCH	284.489	120.480	164.009	0.000
APRIL	275.312	139.367	135.945	0.000
MAY	284.489	241.225	43.264	0.000
JUNE	275.312	369.127	0.000	93.815
JULY	284.489	353.690	0.000	69.201
AUGUST	284.489	435.065	0.000	150.576
SEPTEMBER	275.312	201.527	73.785	0.000
OCTOBER	284.489	143.772	140.717	0.000
NOVEMBER	275.312	148.609	126.703	0.000
DECEMBER	284.489	124.601	159.888	0.000
YR. TOTAL	3,351.923	2,516.529	1,148.986	313.592
MAX. MO.		435.065	164.009	150.576
MIN. MO.		104.144	0.000	0.000

RECOVERY % OF ARTIFICIAL RECHARGE REQUIRED TO EQUALIZE ANNUAL DEMAND:

AMOUNT AVAILABLE FOR RECHARGE:	1,148.986
AMOUNT REQUIRED FROM RECHARGE:	313.592
NET AMOUNT AVAILABLE EACH YEAR FOR RECHARGE:	835.394

PERCENT RECOVERY REQUIRED: 27.29%

WATER DEMANDS -- 20,000 POPULATION



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B. QUANTIFYING THE EXTENT OF IMPROVEMENTS REQUIRED (Cont.)

B.11 LOSS OF SOURCE WATER IN THE TREATMENT PROCESS

The previous subsections of this section were based on the full development of the yield of the springs and Umatilla River to the full amount of their existing permits and/or water rights. It is important to recognize that with each different type of treatment process, there is a certain percentage of the influent (source) water that will be lost in the treatment process and some in the distribution system. Losses in the treatment processes being evaluated include:

- Reject water for membrane filters,
- Filter ripening (initial partial plugging/sealing of the upper layer of the filter and backwashing for rapid sand filter types, and
- Filter ripening (creating a biofilm on the filter surface called schmutzdecke) for the slow sand filter. Recirculation of this water is proposed resulting in practically zero loss.

The degree of turbidity in the source water is one of the indicators of the amount of water that will be lost in each of the above treatment processes.

From the turbidity data collected by the SCADA system, we have developed Table VII - 4 on page VII - 15. During some periods there is an absence of data because of the software programming was still in the development stage during the installation period, and/or when the spring sources were partially or completely shutdown. For example, on January 20, 1994, it is apparent that one of the springs with higher turbidity was completely shut off for five days lowering the spring's turbidity from slightly over 7 Nephelometric Turbidity Units (NTU) to slightly over 3 NTU. The remaining springs were then shut off for a period of 13 days without any data being collected. Shutting down of the more turbid springs is a standard management procedure to maximize the use of the spring sources. Unfortunately, this practice does distort the data and avoids recording some of the higher turbidities.

High turbidity can eliminate some treatment options, or require pretreatment to lower the turbidity. Data in the Table VII - 4 shows, that for 90% and 80% of the year the turbidity is 10 (NTU) and 5 (NTU) or less, respectively. These relatively low turbidities are significant when the future complete development of the spring's existing permits and water rights is contemplated. The table does confirm that the months with the lowest turbidity are the months with the lowest yield. This is the only year of record and may or may not be representative of past or future years, but is certainly encouraging.

There is a lack of turbidity data available for other locations on the Umatilla River upstream of the City. However, it is important to note that it will be preferable to select a river intake site upstream of Wildhorse Creek. Wildhorse Creek is aptly named for the erratic and highly turbid streams of water laden with silt.

TABLE VII-4

TURBITY MEASUREMENTS OF CITY'S SPRING SOURCES

FOR YEAR OF APRIL,1993 TO MARCH 1994 INCLUSIVE

TURBIDITIES ARE IN PPM IN THE HEADINGS, AND DAYS IN THE COLUMNS

TURBIDITIES SHOWN ARE DAILY AVERAGES

TURBIDITY IN HEADINGS ARE BASED ON AN ACCURACY OF 0.10 PPM

MONTH	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	OVER 9 OR INDEFINITE	TOTAL NUMBER OF DAYS
APR.			5	7	14	3				1	30
MAY		11	10	2	8						31
JUNE	3	26								1	30
JULY	26	3	2								31
AUG.	24	7									31
SEPT.	15	15									30
OCT.		31									31
NOV.		30									30
DEC.		25	6								31
JAN.			1	1		1	4	12		12	31
FEB.			9	5	5					9	28
MAR.						9	7	7	5	3	31
TOTAL DAYS	68	148	33	15	27	13	11	19	5	26	365
% OF YEAR	18.6%	40.5%	9.0%	4.1%	7.4%	3.6%	3.0%	5.2%	1.4%	7.1%	100.0%

PERCENT OF YEAR TURBIDITY LESS THAN 5.0 NTU = 79.73%

NOTE: THERE WERE ONLY THREE DAYS OF RECORD WHEN THE TURBIDITY WAS BETWEEN 9 & 10 PPM. ON DAYS IN THE INDEFINITE COLUMN ARE FIVE DAYS WHEN THE WATER FROM ONE OF THE MORE TURBID SPRINGS WAS TURNED OFF, AND ON THE REMAINING 18 DAYS THE TURBIDITY WAS NOT RECORDED.

B.12 SEASONAL AND SHORT TERM STORAGE

At or near a selected treatment plant site, it is proposed to construct an 90 million gallon (MG) surface storage reservoir. Water from the river intake on the Umatilla River will be pumped to this 90 MG reservoir along with any water being transmitted from the City's springs. The multi-purposes of this 90 MG reservoir are:

- Augmentation of Umatilla River flows during periods when the river upstream of Pendleton is frozen. This will maximize the production capacity of the selected form of treatment.

- Bridging times when the City would forgo taking water from the Umatilla River to assist in critical fish passage.

- Reduce the turbidity of the river and/or spring sources through long term storage. The settling out of solids that would be otherwise in suspension will extend the periods of filtration runs, and produce a better quality finished water.

- Act as an equalizing reservoir during the summer months to optimize production of treatment facility when the river and spring sources are incapable of providing enough water to fully utilize the treatment plant's capacity.

An ideal site for this 90 MG reservoir would have level ground with a rock (hard) free depth of 30' feet or more. To illustrate the amount of land that may be required the following dimensions are offered.

Design criteria:

Reservoir to have a minimum of 3' of freeboard,.

An average annual loss of 4' from evaporation/precipitation, plus the loss through the liner.

Based on the above criteria, the physical size possibilities for a reservoir depth of 25' are:

820' x 820'   700' x 950'   500' x 1,340'

With allowance for perimeter dikes, a geometric shape dictated by topography, and the size of the ownership parcels, it may require acquiring anywhere from 40 to 80 acres of land to obtain a functional tract.

C. OWRD RULES ON "BANKING" WITHDRAWAL OF RECHARGED WATER

An ARR project requires a permit for injection and a permit for withdrawal. The OWRD's Administrative Rules, Chapter 690, Division 11 pertaining to ARR as published on January 1994 are quoted in full below. There is currently a House Bill being considered by the State Legislature that may streamline the present rules, if passed as proposed.

C.1 PERMIT TO ARTIFICIALLY RECHARGE BASALT AQUIFERS

"Groundwater Recharge Applications - Supplemental Information Requirements; Permit Conditions

690-11-042 **(1)** Permit required. The appropriation of water from any source for the purpose of recharging a groundwater reservoir requires a permit. Likewise, any beneficial use of artificially recharged groundwater in any such groundwater reservoir requires a secondary groundwater permit.

(2) Pre-application conference. Due to the complexities and costs associated with recharge projects and recharge permitting, the Department requires a pre-application conference.

(3) Supplemental information for permit application. In addition to data required on permit applications under OAR 690-11-020 to 690-11-030, the applicant shall submit additional information to assist the Commission in determining the public interest on the proposed project. An application shall be accepted by the Department for filing only if it contains all required data. Upon request, the Department may assist other agencies in developing their responses to permit applications. The following attachments are necessary:

(a) Minimum perennial stream flow or instream water right. If a stream is proposed recharge source, the applicant shall provide a copy of the document which establishes that the supplying stream has a minimum perennial stream flow or instream water right for the protection of aquatic fish life. If none is established, the applicant shall attach a copy of a waiver of this prerequisite from the Oregon Department of Fish and Wildlife;

(b) Water Quality Permit. The applicant shall attach a copy of the necessary water quality permits from Oregon Department of Environmental Quality, show that the application for necessary permits has been filed, or show that permits are not necessary;

(c) Purpose of recharge. The applicant shall describe the ultimate use or value of the groundwater recharge;

(d) Annual storage. The applicant shall describe the volume of water, or range of volumes expected to be stored annually by artificial recharge. The applicant shall describe anticipated losses between the point of diversion and the place of recharge;

(e) Financial capability. If the proposed recharge diversion is for five cfs or more, the applicant shall display proof of financial capability to construct and operate the proposed project. Unless otherwise approved by the Director, the capability shall be supported by written statements from a lending institution;"

C.1 PERMIT TO ARTIFICIALLY RECHARGE BASALT AQUIFERS (Cont.)

"(f) Hydrogeologic feasibility report. The applicant shall demonstrate that the proposed recharge project is hydrologically feasible. The report should include an assessment of ground-water conditions in the reservoir and anticipated changes due to the proposed recharge project. This report shall be sealed and signed by a professional(s) registered or allowed, under Oregon law to practice in this area of geology;

(g) Project Description Report. The applicant shall provide plans for recharge project construction, operation and costs. The report shall outline proposed monitoring plans for flows, water levels in wells and groundwater quality. If surface water is a proposed source of recharge, the report shall indicate when surplus surface waters are generally available. The report shall be sealed and signed by a professional(s) registered or allowed, under Oregon law to practice civil engineering and this area of geology;

(h) Additional information. The Director may require the applicant to submit additional information to assist the Commission in its public interest determination.

(4) Recharge permit processing. Prior to referring an application to the Commission for a public interest determination, the Director shall work with the applicant and may work with any person or agency to prepare a draft permit, In particular, the Director shall seek assistance from the State Department of Environmental Quality to develop a water quality monitoring program and standards.

(5) Permit Conditions. Any permit shall address the following items:

(a) Maximum rate and volume. A permit shall specify a maximum diversion rate and a maximum annual diversion volume:

(b) Meters. The recharge permit shall require both the metering of recharge water from the source(s) and metering of water at the place(s) of recharge. Any subsequent secondary groundwater permit shall require metering of stored recharge water withdrawals;

(c) Records, Inspections. The permit shall require the permittee to keep accurate and current records of metered values, water levels and other pertinent information. The permit shall allow the Director to inspect records or works covered by the permit upon reasonable notice and at any reasonable time;

(d) Estimated data. When metered or measured data are missing in whole or in part, the Director may make estimates from available data. The Director's estimates shall be reasonable and, where there is a range of uncertainty, be conservatively low on water delivered to the place of recharge and conservatively high on withdrawals of stored recharge water;"

C.1 PERMIT TO ARTIFICIALLY RECHARGE BASALT AQUIFERS (Cont.)

"(e) Water levels. The response of water levels in wells shall provide the principal basis on which to judge the effectiveness of recharge under the permit and the availability of stored recharge water:

(A) Monitoring program. The permit shall specify a water level monitoring program for selected times and wells; and

(B) Key wells, target levels. The permit shall designate several key wells in the monitoring program. The permit shall establish upper and lower target water levels for each well. Actual water levels on and annual assessment date shall be compared to the target levels for the purpose of prescribing allowable use of stored recharge water.

(f) Determination of stored recharge water. The permit shall specify the formula to determine the availability of artificially recharged groundwater for appropriation. The formula shall result from one of the following:

(A) Negotiation. The applicant and the Department may negotiate a formula which relies principally on water levels in wells, metered quantities of recharge, secondary permit withdrawals, and hydrogeologic conditions in the area. At permit issuance, stored recharge water may be credited at up to 85 percent of water metered to the place of recharge. Withdrawals of stored recharge water shall be debited at 100 percent of metered values. Calculations of stored recharge water shall be based only on recharge over the last five years;

(B) Definitive groundwater investigation. The applicant may present a definitive groundwater investigation as a method to determine stored recharge water. The Director must be satisfied that use of such information accurately describes the quantity and location of water available for withdrawal as a result of the recharge. That quantity must be in excess of the groundwater which would be available if artificial recharge were not practiced. If no agreement is reached by negotiation, the applicant must determine stored recharge water by a definitive groundwater investigation.

(g) Storage account. The Department shall record its final determinations on stored recharge water in a storage account. The permit shall specify a method by which the permittee may obtain information on that account;

(h) Annual report. The permittee shall submit an annual report to both the Department and any secondary permittee. That report shall include the range of recharge rates and total quantities during the year at both the diversion point and the place of recharge. In addition, the report shall include a general operations review, the permittee's estimate of the storage account and the results of other water quantity and quality programs which are required in the permit;"

C.1 PERMIT TO ARTIFICIALLY RECHARGE BASALT AQUIFERS (Cont.)

"(i) Allowable use of stored recharge water. See rules governing secondary groundwater in OAR 690-11-044;

(j) Permit assignment. A permit condition shall require a potential assignee to prove, to the Director's satisfaction, the financial capability to construct uncompleted portions of and operate the project, if such proof was required for the application;

(k) Condition changes. If, under actual operation of the recharge project, the Director notifies the permittee that the Director has reason to believe there are adverse groundwater quantity or quality effects, the permittee shall cease recharge activities. No further diversion shall be made until measures to prevent, correct or monitor those adverse effects have been agreed to and implemented;

(l) Technical Oversight. If the recharge diversion is for five cfs or more, the permit may require the permittee to have the construction and operation of the proposed project overseen by a professional(s) registered or allowed, under Oregon law, to practice civil engineering.

(m) Other conditions, the permit may contain other conditions which the Commission believes are necessary.

(6) Recharge certificate. Annual reports as required in the permit shall be an element of proof of appropriation to the satisfaction of the Department prior to issuance of a confirming water right certificate. Operational conditions of the permit shall become conditions of the certificate."

C.2 PERMIT FOR WITHDRAWING RECHARGED WATER FROM BASALT AQUIFERS

"Secondary Groundwater Permits for Use of Artificially Recharged Waters; Supplemental Information Requirements; Limitations; Conditions

690-11-044 (1) Permit required. The appropriation of artificially recharged groundwater for any beneficial use requires a secondary groundwater permit.

(2) Supplemental information for permit application. In addition to data required for permit applications under OAR 690-11-020, the applicant shall submit certain additional information. The following attachments are necessary:

(a) Identify source. The applicant shall identify an artificially recharged groundwater reservoir as a supply of water;

(b) Written consent. The applicant shall include the written consent of the holder of the recharge permit or certificate;"

C.2 PERMIT FOR WITHDRAWING RECHARGED WATER FROM BASALT AQUIFERS (Cont.)

"(c) Source proof. The applicant shall submit proof that the proposed use will actually be from the recharged reservoir. Documentation may include water level similarities to the recharged reservoir, geologic and geographic similarities, hydraulic information, and other pertinent data; and

(d) Recharge understanding. The applicant shall attach a copy of the currently valid recharge certificate or permit and a statement that the applicant understands its content and the conditions of that recharge.

(3) Limitations on secondary groundwater permit approval. During the first 5 years of recharge, the Department shall limit cumulative secondary permits to no more than 85 percent of the projects permitted annual recharge volume. Subsequent recharge permits may exceed 85 percent based on recharge performance as determined by the Department.

(4) Secondary groundwater permit conditions. A secondary groundwater permit shall address the following items:

(a) Maximum rate and volume. A permit shall specify a maximum diversion rate and annual diversion volume;

(b) Meters. The permit shall require the permittee to meter all withdrawals so as to provide data as a debit against the storage account;

(c) Water levels. The permit shall require permittee to measure water levels on a specified basis;

(d) Estimated data. The permit shall specify that when metered or measured data are missing in whole or in part, the Director may make estimates from available data. The Director's estimates shall be reasonable and, where a range of uncertainty exists, be conservatively high on withdrawal of stored water;

(e) Records, inspections. The permit shall require the permittee to keep accurate and current records of withdrawals and water levels. The Director may inspect any records or works covered by the permit upon reasonable notice and at any reasonable time;

(f) Annual report. The permittee shall be required to submit an annual report to the Director and holder of the recharge right. The report shall note withdrawals, dated water levels and other data pertinent to the storage account;

(g) Allowable use of stored recharge water. The permit shall indicate that availability shall be determined on the basis of secondary groundwater right priority and the allowable use of the stored recharge water. The allowable use of stored recharge water falls into three categories. For the ease of reference, these categories are named as the following color zones:"

C.2 PERMIT FOR WITHDRAWING RECHARGED WATER FROM BASALT AQUIFERS (Cont.)

"(A) Green zone. If water levels at key wells are above the upper target level, use is allowed up to the maximum of the storage account or maximum duty, whichever is lower. These wells and targets are noted in the recharge permit;

(B) Yellow zone. If water levels at key wells are between the upper and lower target levels, use is allowed up to 85 percent of the recharge volume for the preceding 12 months; and

(C) Red zone. If water levels at key wells are below the lower target level, no use of stored recharge water is allowed.

(h) Condition changes. If the Director has reason to believe that the well(s) is not withdrawing artificially recharged groundwater or there are other substantial groundwater concerns, the permittee shall cease withdrawal upon notice from the Director. No further withdrawal shall be made until measures to prevent, correct or monitor the situation have been agreed to and implemented; and

(i) Other conditions. The permit may contain other conditions that the Director specifies.

(5) Secondary groundwater Certificate. Annual reports as required in the permit shall be an element of proof of appropriation to the satisfaction of the Department prior to issuance of a confirming water right certificate. Operational conditions of the permit shall become conditions of the certificate."

D. WATER TREATMENT OPTIONS

There has been an increasing emphasis for water suppliers to minimize the use of chemicals in their treatment processes that create trihalomethanes. Trihalomethanes are carcinogenic compounds created by chlorine interacting with organic matter which can survive the treatment process. If it is not possible to reduce trihalomethanes to the regulated limits with the existing water source, suppliers are advised to investigate changing to a better source water, and/or purchasing water from another supplier.

Post Disinfection Products (PDB) that result from the treatment process are another matter of concern and regulation. Disinfectants-Disinfection By-Products (D-DBP) will be a regulation that will require suppliers to disinfect water sources that are surface sources and/or groundwater sources under the direct influence of surface water. There is apparently some realization at the US EPA, that at some point the addition of a disinfectant in the treatment process, will be counter productive by excessively raising the level of PDB's delivered to the customer. At the AWWA conference meeting at Spokane in May 1994, an EPA speaker, a toxicologist from EPA Region IX, stated that we have perhaps reached a balance point, where an increase in the use of a disinfectant (primarily but not necessarily chlorine), will result in a corresponding and undesirable increase in the post disinfection byproducts (PDB) in the water distribution system.

Chemical additives generally used in the water treatment process that do not create trihalomethanes are suspected of causing primary and secondary deleterious health effects. The EPA speaker from Region IX at the May 1994 AWWA conference in Spokane, Washington stated that there are probably several secondary health problems from chemical compounds that are in the finished treated water, but lack documentation because the medical field and laboratories have not been directed to indicate causative factors which would lead to a more accurate "body count".

There has been some indication that the U.S. Congress will relax in the re-authorized "Safe Drinking Water Act" some of the more stringent and prohibitive costly requirements on smaller suppliers of water. There are on the other hand ongoing research that continues to identify real health hazards that must be removed from the water delivered for human consumption.

Giardia, Yersinia, Cryptosporidium, etc. were causing serious illness and death for years before they were identified. A cryptosporidiosis outbreak two years ago in Milwaukee, Wisconsin sickened 400,000 residents and more than a 100 persons died. Giardia and Cryptosporidium range in size from 2 to 8 microns (µm). One of the presentations at the 1993 NW Regional AWWA conference stated that recent studies reaffirm that a conventional rapid sand treatment plant must incorporate flocculation and sedimentation to effectively filter out both of these microorganisms.

To remove of cryptosporidium, an organism practically immune to disinfection, it must occur no later then during the filtration stage. To date there is no known effective treatment for this organism. Each infected individual can only rely on their own immune system. Individuals with a normal immune system recover over a period of time. An Enhanced Surface Water Treatment Rule (ESWTR) is proposed for adoption this year. It is proposed that this rule will set the Maximum Contaminant Level **Goal** (MCLG) for cryptosporidium of zero. A **goal** of zero is the standard for carcinogenic compounds/elements that can cause cancer in humans and similarly for other life threatening diseases for which there is no known cure. Currently being considered in the ESWTR is a clause that would stipulate: "All systems that filter must achieve at least 99 percent (2 log) removal of *Cryptosporidium* between the source and the first customer".

The approximate average per capita potable consumption for drinking and cooking is less then a gallon per day of water through the customers meter. Pendleton's average consumption over the last 19 years has been 307.5 gallons per capita per day. Therefore approximately 0.3% of the water produced is needed for actual potable use. The other 99.7% is used for washing dishes, clothes, showers, cars, flushing toilets, mopping, irrigation, fighting fires, street flushing and for industry that may also need potable water for a significant portion of their use. With such a small minority of the water use driving the cost of the overwhelming majority of water use, a question comes to mind. At what point will additional regulations make it more cost effective to:

- Provide a separate distribution system of smaller pipes to provide customers with a potable water for drinking and cooking, plus a Basic Water Supply (BWS) that meets current standards for potable water. Customers would be advised to utilize the upgraded potable treated water for drinking and cooking, and the use of the BWS for all other uses. The BWS would not present an unacceptable health hazard if a limited amount was unintentionally consumed as drinking water.

- Have customers install their own Reverse Osmosis (RO) units for drinking and cooking water. The RO units would be serviced by the City, or by a City approved and licensed contractor. Customers would be again advised that limited accidental drinking of the BWS would not present an unacceptable health hazard.

The era of an inexpensive and plentiful potable water supply in most areas is rapidly becoming history. Dual water distribution systems, such as one for limited potable consumption combined with a second for general water use, may be the viable option in the future. Another alternative may be retrofitting and installing point of use (POU) treatment systems at each water service with the continued use of a single distribution system.

D.1 MEMBRANE FILTRATION

There are two basic types of membrane filtration that are utilized to improve the quality of water for domestic and other uses. One type is pressure driven and the other is voltage driven. The voltage driven type is known as electrodialysis which transfers ions across the membrane. The pressure driven transfers a portion of the influent water across the membrane. The influent water that passes through the membrane is called permeate and the rejected water is called concentrate. Electrodialysis removes ion species only, whereas the pressure driven removes all inorganics, most organic species, silica and suspended solids.

The pressure driven type of membrane was selected for evaluation as a part of this study and are commonly classified as either reverse osmosis, nanofiltration, ultrafiltration and microfiltration. The pore sizes of these different classifications are as follows:

- Reverse Osmosis: 0.0005 to 0.002 microns
- Nanofiltration: 0.001 to 0.01 microns
- Ultrafiltration 0.01 to 0.1 micron
- Microfiltration 0.1 to 1.0 micron

There has been a consistent improvement and use of membrane filtration by water suppliers in the last 20 years. The southern states, and Florida in particular, are some of the more prominent users of this technology. The types of waters that have been treated are warm ocean water and brackish well water. There are not any known operational municipal membrane filtration plants using a colder surface or spring water source in the northern climates. The technology does have the following desirable attributes:

D. WATER TREATMENT OPTIONS (Cont.)

D.1 MEMBRANE FILTRATION (Cont.)

- Relies on mechanical screening of impurities without the addition of any chemicals.
- Compact process that can house a 10 MGD facility in 100' x 150' structure.
- Easily expandable by the use of incremental modules.
- Simple operation requiring minimum attention and level of skilled personnel.

Other attributes that makes the consideration of membrane filtration impractical for the City of Pendleton are:

- Membrane filtration requires a source water with a turbidity of 1.0 NTU or less. For Pendleton this would require the additional cost of pre-treating the spring supply.
- The capital investment for plants in the southern states with a warm source water is approximately 10% more than a conventional treatment facility.
- The effectiveness of the filtration process is temperature sensitive and rated at a water influent temperature of 77°F. The 49°F temperature of the City's springs reduces the effectiveness of the process by 50%. Restated, the capital cost of a treatment facility to treat Pendleton's springs would be approximately 2.2 times the cost of a conventional treatment facility plus the cost of pretreatment to lower the turbidity to less than 1.0 NTU.
- The amount of water rejected by the membrane can range from 20% to 50%, with the latter suggested as the recommended conservative approach for the spring supply. Pendleton is not in a position to waste 50% of the water it has permits and water rights for.
- The only available known alternative for disposition of the reject water for Pendleton would be spray irrigation. In other states the reject water is required to be blended with municipal or industrial wastewater before being applied to a field. The State of Oregon has not adopted any rules or policies on disposition of reject water from membrane filtration.

It would seem that the only practical application for membrane filtration in the northwest would be at points of use e.g. residential units, medical facilities, restaurants, etc. where the percentage of reject water is very small compared to the average daily per capita usage. In point of use applications such as new residential units, the cost of a reverse osmosis unit the approximate cost is $500 to $600 and somewhat more for retrofitting existing residential units. Point of use membrane filtration may provide a more cost effective alternative, than continuing to make major upgrading of treatment facilities in the future to meet new mandates, or the construction of treatment facilities and dual distribution systems.

D.2 RAPID SAND FILTRATION

The first rapid sand filtration treatment plant was constructed in Somerville, New Jersey in 1884. Rapid sand filtration, after turn of the century, became by far the popular form of water treatment. In the earlier years, settled and the filter backwash water with the accompanying solids were returned to the source stream without any treatment required.

The addition of chemicals in the treatment process, some of which remained in solution or created other complex compounds compromised the treated water quality, was not understood or documented until recent years. Current regulations on the operational practices and disposition of waste sludge have significantly raised the cost of this type of treatment.

The original rapid sand filtration water facility typically consisted of a treatment train in the following order:

- The introduction of a coagulant (typically aluminum sulphate) and a polymer (organic chemical) into the raw water to create a flocculent material.
- The introduction of ozone and/or chemicals to change/modify/or remove: pH, iron manganese, and other undesirable constituents that may be in the water.
- The gentle stirring of the coagulant by paddle wheels to maximize the formation of a flocculent material (floc).
- The settling of the floc in a sedimentation basin.
- The outflow from the sedimentation basin flowing to the top of a sand filter bed that is overlain on top of supporting gravels and collector piping. Periodically the filter will be backwashed with clean water to clean the sand filters. The water used in the backwashing is wasted to the sewer and/or stored in ponds for settlement and then applied to a field as irrigation water.
- Disinfection of the filter outflow by chlorination prior to being placed into a clear well where the water is held to provide adequate contact time for the chlorine to interact with the water.

Over the years there have been adaptations and/or variations to the rapid sand filtration process which may include one or more of the following:

- Mixed media filter beds with materials of different specific gravity.
- The use of tube settlers (small inclined rectangular tubes) in the sedimentation basin to improve the effectiveness of the settling of the floc.
- The use of granular activated carbon following or in lieu of other types of filters.

D.2 RAPID SAND FILTRATION (Cont.)

- The use of deeper than standard depth filters of different types of materials.

- The use of upflow sedimentation basins where the water passes through a plastic type media slightly heavier than water. Periodically this media is vigorously backwashed with air and water and wasted similar to the backwashing of the filters that follow the sedimentation basins.

The rapid sand filtration, or currently more aptly classified as **rapid rate filtration** (normal range of 2 to 5 gal./sq. ft./min.). Rapid rate filtration processes includes all the variations of rapid sand filtration and generally have the following desirable attributes:

- Capable of treating high levels of turbidity, excellent color removal and taste improvement for normal waters.

- Will to some extent remove iron and manganese.

- A modest sized structure to house the treatment facility.

Some of the undesirable attributes of the rapid sand filter process are:

- Relatively high operation costs for personnel, chemicals, materials, and power. Highly technical personnel are required to operate the facility (including an on-site laboratory). Continuous monitoring is necessary to make adjustments to chemical dosages and mechanical devices in response to raw water quality and flows.

- Requires the construction of lagoons (ponds) to hold and settle out the settled floc and other solids, plus the backwash and solids from the filters.

- In Pendleton's case, this would necessitate applying the settled effluent from the lagoons to a field for disposal. Additional land would have to be acquired for this purpose. Since chemicals are used in the treatment process, a permit from the DEQ will be required. The permit may stipulate that pre-treatment of the sludge is needed before being applied to the land.

- A study by the U.S. Public Health Service[1] in 1930 documented that the average modern rapid sand water treatment facility has limits on it's ability to remove bacteria as follows:

  For plants with post chlorination, the E. coli index of the raw water should not exceed 5,000 per 100 cc.

  For plants with pre and post chlorination, the E. coli index of the raw water should not exceed 20,000 per cc.

1 "The Efficiency of Water Purification Processes", Public Health Bulletin 193, 1930

D.3 SLOW SAND FILTRATION (Cont.)

- Requires less power than other types of treatment.
- Requires less skilled personnel to effectively operate the facility.
- Has a greater efficiency in the removal of bacteria than the rapid sand filter. Based on it's exceptional ability to remove giardia, it is credited with being equally capable in the removal of cryptosporidium.
- Lower operational costs than other types of treatment.
- Less water is required for establishing successive filter runs than the rapid sand filtration process. Normally 0.5% or less, and with the proposed recirculation of water from the filters after cleaning back to the filters, it is expected to be considerably less than 0.5%.

The slow sand filter process has the following undesirable attributes:

- The slow sand filter requires considerably more surface area to effectively treat the water than other processes. The suggested rate of filtration range by the Ten State Standards is from 43.2 to 144 gal./sq. ft./ day (0.03 to 0.10 gal./sq. ft./min).
- Will require either an on-site facility to clean the sand periodically removed from the surface for reuse, or dispose of it on a field. The removed material consists of only natural products and will not require any permit for disposal.
- More land area is required for this physical treatment facility than any other type. It does not, however, require additional land for irrigation disposal.

In recent years there has been a resurgence in the popularity of the slow sand filtration process. Oregon entities listed below in the last few years have selected and operate slow sand filtration facilities.

Astoria
Detroit

Corbett
Hillsboro

Joseph
Oak Lodge Water District

Kernville, Gleneden, Lincoln Beach
Panther Creek, Lincoln County

Cape Lookout State Park
Westfir (+/- 8 years old)

Oswald State Park
Wickiup Water District (+/- 5 years old)

Slow sand treatment facilities at Stayton and Salem, Oregon have been operation for several years.

D. WATER TREATMENT OPTIONS (Cont.)

D.3 SLOW SAND FILTRATION (Cont.)

The Salem, Oregon facility is located 17+/- miles up river from the City on the banks of the North Santiam River. This facility has been in service for approximately 60 years, and has two existing slow sand filters with an estimated capacity of 84 MGD. Salem's 1993 Water System Master Plan[1] proposes the construction of a third filter to provide a minimum production capacity of 84 MGD when one of the three filters is out of service for cleaning. In addition, the two existing filters are proposed to be reconstructed to current construction standards.

Oregon entities that have pilot studies underway for the construction of slow sand treatment facilities are:

Banks	Brownville
Camp Myrtlewood, Coos County	Camp Tapawingo, Polk County
Cannon Beach	Falls City, Polk County
Idanha, Marion County	Lyons Mehama Water District
Manzanita	Nehalem
Sumpter	Youngs River Lewis & Clark Water Dist.
Rockwood Water District	

In London, England, their sand filtration facility was first placed in service in 1839, and has been continuously expanded since then. The Thames Water Authority of London continues to currently use this process and services a population of 11 million people[2].

E. RECOMMENDED TREATMENT OPTION FOR PILOT TESTING

Based on the evaluation of the alternatives in the previous sections, the slow sand filter treatment is recommended for one year pilot testing, in accordance with the Oregon Health Divisions requirements. Based on the turbidity information, it appears that this type of treatment may provide the City with:

- A treatment facility low in capital and operational costs,
- Simple to operate, requiring less skilled technical personnel,
- Highly reliable and effective method for removal of Giardia and Cryptosporidium,
- Chemical free (except for post treatment disinfection) reducing the risk of creating of trihalomethanes in the distribution system (Post Disinfection Products - PDB).

1 City of Salem, The Water System Master Plan, Final Draft, 11/24/93, CH2M Hill

2 Evaluating Modifications to Slow Sand Filters, M. Robin Collins, T. Taylor Eighmy and James P. Malley Jr., Journal AWWA, September 1991.

- Free of sludge disposal problems (chemically free),
- Compared to others treatment types, uses the lowest amount of finished product water in the treatment process (conservation) and power, and
- Without the need for chemicals (except for post treatment disinfection) reduces hazards and risks to the City's operational personnel and ultimate customers.

It is also anticipated that the turbidity from the springs may be substantially reduced when the collector pipes are imbedded in selected gravels to pre-screen the water.

E.1 DESIGN CRITERIA FOR A SLOW SAND FILTER AND APPURTENANCES

The following design criteria is offered without the benefit of pilot testing and may require substantial revision after the completion of the pilot testing. This section includes both the City's springs and the Umatilla River as sources for treatment.

There is only a limited amount of data available on the turbidity of the Umatilla River and this data is from the vicinity of the City's springs. This data indicated that there were periods where the turbidity of the river was higher than the springs and periods when the reverse was true. There is no data available for the turbidity of the Umatilla River within the City limits where the probable Point Of Diversion (POD) will be for the City's two oldest river permits/rights. The river source may have to be turned off during extended periods of high turbidity.

Flow to be treated:

Spring sources:	7.561 MGD	or	5,251 gpm
Umatilla River:	1.616 MGD	or	1,122 gpm
Total:	9.177 MGD	or	6,373 gpm

Filtration facility criteria:

Type: Earthen pond/dike structures with plastic type linings.

Top of Dike width:	10.0 ft.
Dike slopes (ratio)	3:1
Pond/cell configuration:	Square
Number of ponds/cells:	4 configured as a square

Vertical dimensions inside ponds/cells:

Freeboard (above standing water:	3.0 ft.
Height of free standing water:	5.0 ft.
Depth of sand filtering media:	4.0 ft.
Gravel support layer w/collector piping	1.5 ft.
Total vertical height inside pond:	13.5 ft.

E.1 DESIGN CRITERIA FOR A SLOW SAND FILTER AND APPURTENANCES (Cont.)

Filtration Rate through sand filters set at 65 gallons/square foot/day

Compute area requirements of ponds/cells:

Total filter area (bottom of filter) required:

Area = 9,177,000 million gallons per day/65 gallons per square foot per day
= 145,185 square feet, or 3.24 acres

Number in operation at all times: 3

Area per filter (bottom) = 145,185 square feet/3
= 47,062 square feet, or 1.08 acres

Additional cell required for maintenance when a cell is down for cleaning.

Compute the horizontal dimensions of the bottom (square) of each filter:

Area = 47,062 square feet

Dimensions = $(47{,}062)^{1/2}$
= 217' x 217'

Compute pond dimensions to the centerline of the top of the dikes:

Additional dimensional length:

[(12' height x 3) + 5' half dike width] x 2 = 82'

Centerline dimensions at top of dikes:

217' + 82' by 217' + 82' = 299' by 299'
say= 300' by 300'

Sizing of influent and effluent pipes for filters:

Flow to/out of each filter = 9,177,000 gallons per day/3 filters
= 3,059,000 gallons per day
= 3,059,000 gallons per day/1440 minutes per day
= 2,124 gpm or 4.73 cfs

Try 16" diameter pipe w/cross sectional area of 1.396 square feet:

V (water velocity) = Q (flow rate)/A (cross sectional area)
V = 4.73 cfs/1.396 sq. ft.
V = 3.39 ft./sec. "OK"

Sizing of effluent pipe for flow from three filters:

Flow out of three filters = 9,177,000 gallons per day
= 9,177,000 gallons per day/1440 minutes per day
= 6,373 gpm or 14.2 cfs

Try 30" diameter pipe w/cross sectional area of 4.91 square feet:

V (water velocity) = Q (flow rate)/A (cross sectional area)
V = 14.2 cfs/4.91 sq. ft.
V = 2.89 ft./sec. "OK"

A sedimentation basis is provided for a place to settle fine sands flushed out of the filter bed during the initial filling and after each cleaning. With turbidity and particle counters to monitor the status of the effluent from the filters, effluent with a relatively low turbidity, could be recirculated directly to the headworks without having to pass through the sedimentation basin.

The sedimentation basin can also serve as a place to deposit wash water and waste material from the on-site cleaning of the filter sand. One publication[1] states that a machine has been specially designed, called the "Ejector Washer". It washes and replaces the sand without requiring the sand to be taken out of the filter bed. This older publication does not list the name of the manufacturer or the facility at which it was used. It would take additional research to find out more about the practicality of this or other similar devices. In any event there would be a need for some place to deposit the dirty water for settling and removal of the deposits. The proposed design criteria for the sedimentation basin is as follows:

Set detention period for 2 hours with recirculation back to headworks of the filter.

Find volume of water in basin:

Flow rate per cell = 9,177,000 gallons per day/ 3 cells
= 3,059,000 gallons per day

For 2 hour period = 3,059,000 gallons/12
= 254,917 gallons

Volume in cubic feet = 254,917 gallons/ 7.48 gallons per cubic foot
= 34,080 cubic feet

[1] Water Supply and Sewerage, page 303, by Ernest W. Steel, C.E., published by McGraw-Hill Book Co., 1947

E. RECOMMENDED TREATMENT OPTION FOR PILOT TESTING (Cont.)

E.1 DESIGN CRITERIA FOR A SLOW SAND FILTER AND APPURTENANCES (Cont.)

Set liquid depth at 4 feet, configuration of the pond to be square, and find the area @ mid-depth.

Area at mid depth (2') of water = 34,080 cubic feet/4 feet
= 8,520 square feet

Dimensions = $(8,520)^{1/2}$
= 92.3' x 92.3'

Set freeboard at 3 feet and top of dike width at 10 feet, find pond dimensions:

Pond dimensions to centerline of dikes = [(5' x 3) + 5' half dike width] x 2 + 92.3'
= 132.3' x 132.3'
Say = 135' x 135'

Check velocity across the cross section of the pond:

Cross sectional area = (92.3' + 2.7') x 4' = 380 square feet

Flow rate from above = 2,124 gpm or 4.73 cfs

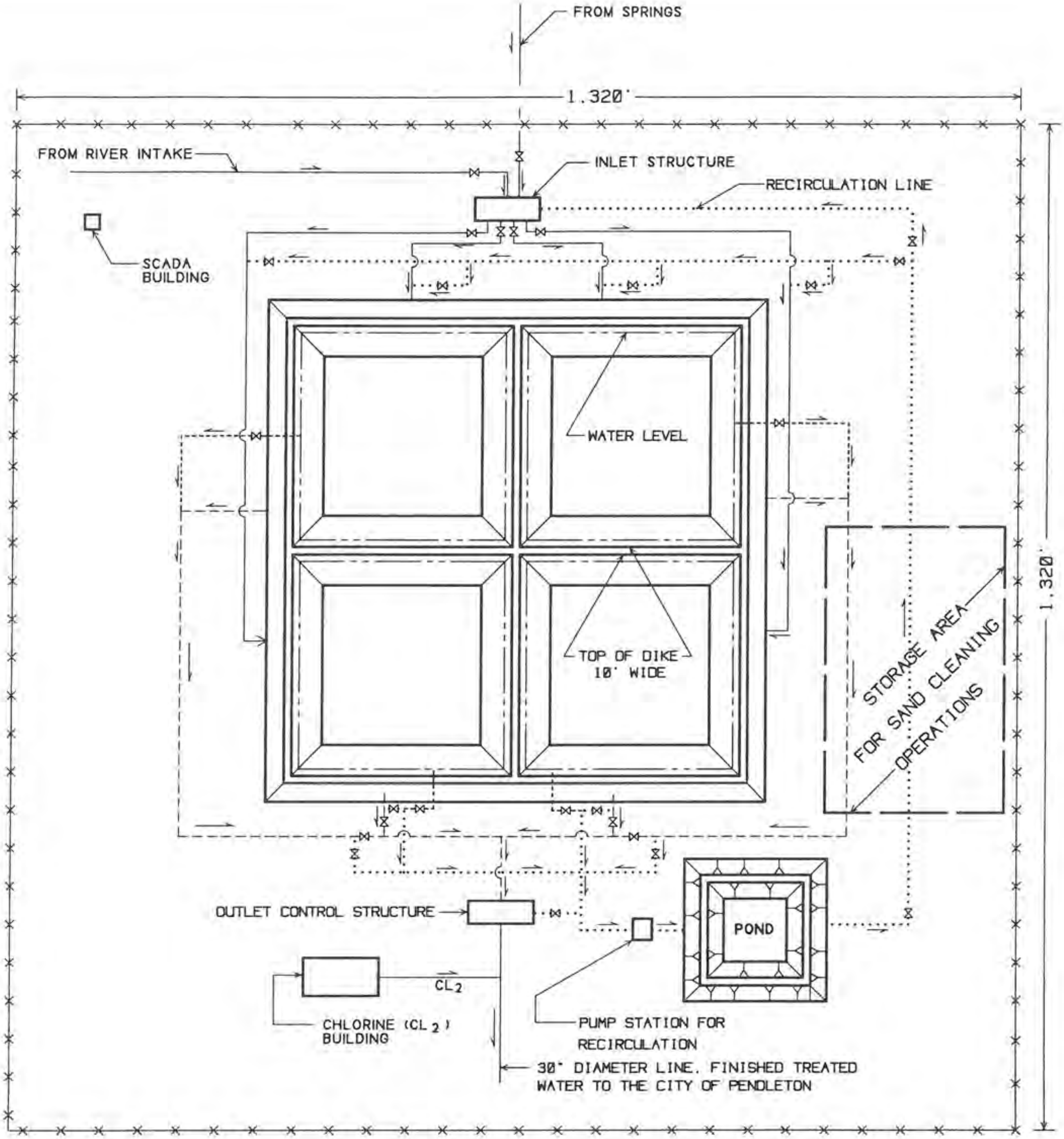
Velocity = Q/A or 4.73 cfs/380 square feet
= 0.125 ft./sec. or 9"/minute

Typical layouts for a site plan, filtration cells and the sedimentation pond are shown on pages VII - 36, VII - 37 and VII - 38 respectively.

E.2 TREATMENT PLANT SITING CONSIDERATIONS

The material in this section is germane to any treatment process that requires post disinfection of the treated water.

The attack on the use of chlorine as a disinfectant in professional journals appears to be escalating and preparing the public for the severe restriction of it's use, if not an outright ban. The EPA speaker, a toxicologist from EPA Region IX, at the May 10 to 13 1994 AWWA Pacific Northwest Regional conference in Spokane, stated that we have perhaps reached a balance point, where an increase in the use of a disinfectant (primarily chlorine), will result in a corresponding and undesirable increase in the post disinfection byproducts (PDB) in the water distribution system.



FOUR INDIVIDUAL CELLS -- EARTHEN DIKES

LEGEND

INFLUENT PIPING TO FILTERS & FINISHED WATER ————————
EFFLUENT FROM UNDER FILTERS, FINISHED & DRAIN - - - - - - - - - -
FILTER SURFACE DRAINS NEAR TOP OF FILTER ------------------------
DRAIN TO PUMP, POND AND RECIRCULATION ....

SLOW SAND FILTER - 9.177 MGD

SCALE: 1" = 200'

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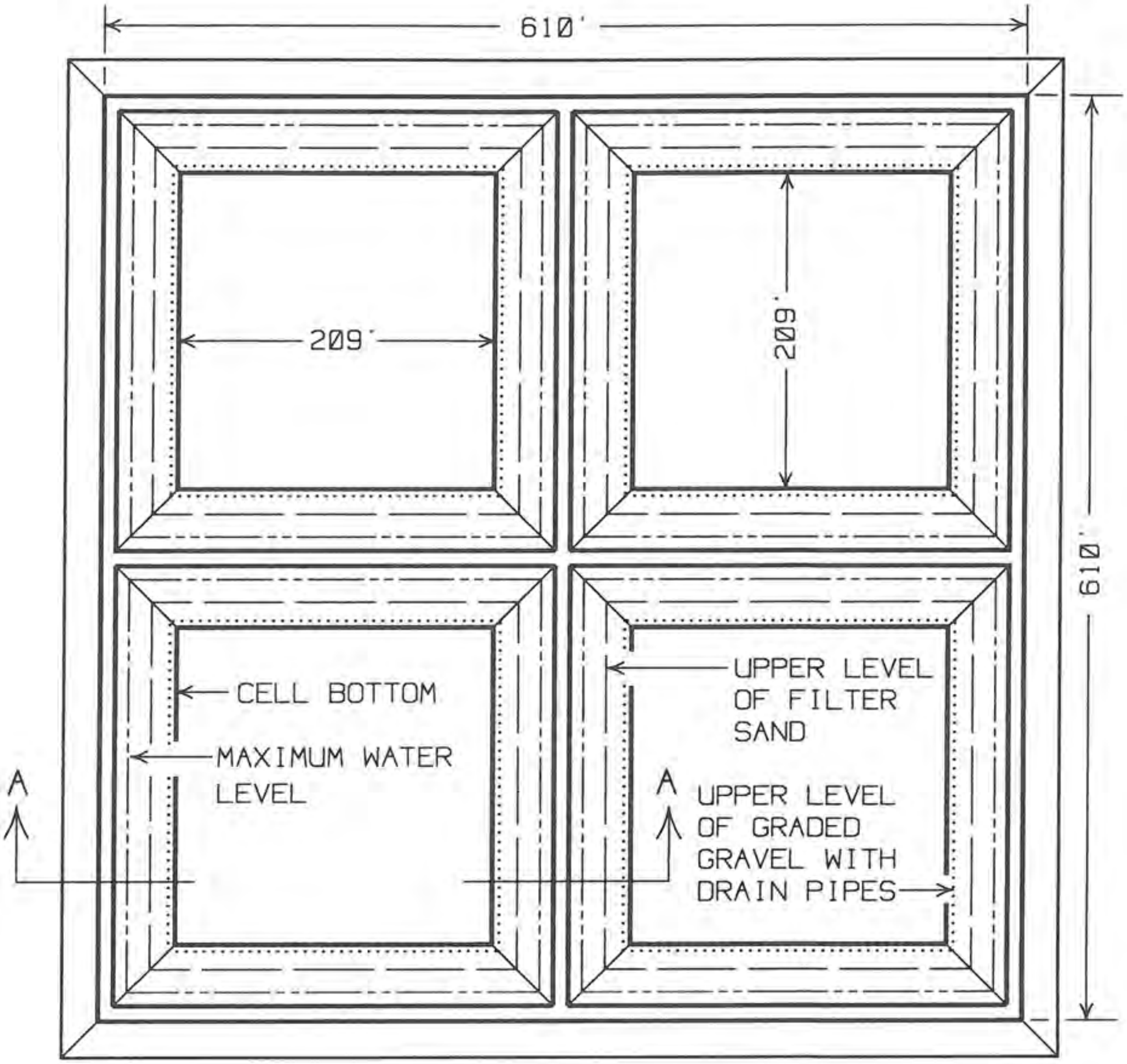
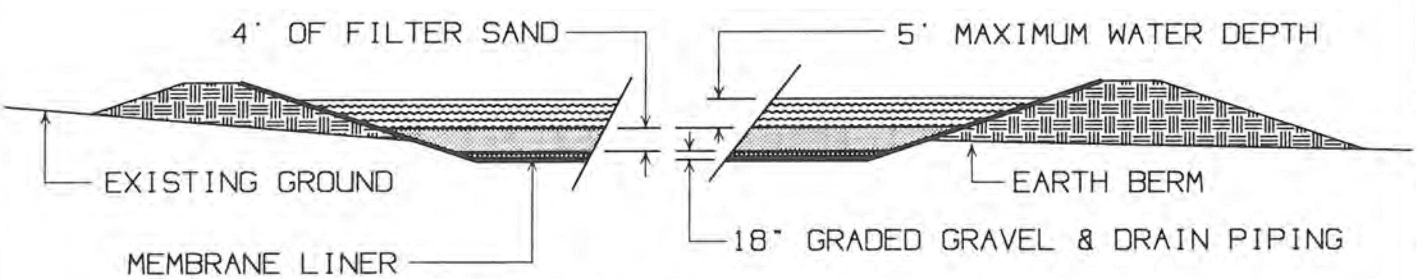


FOUR CELLS OF THE SLOW SAND FILTER

SCALE: 1" = 120'



SECTION A-A

NOT TO SCALE

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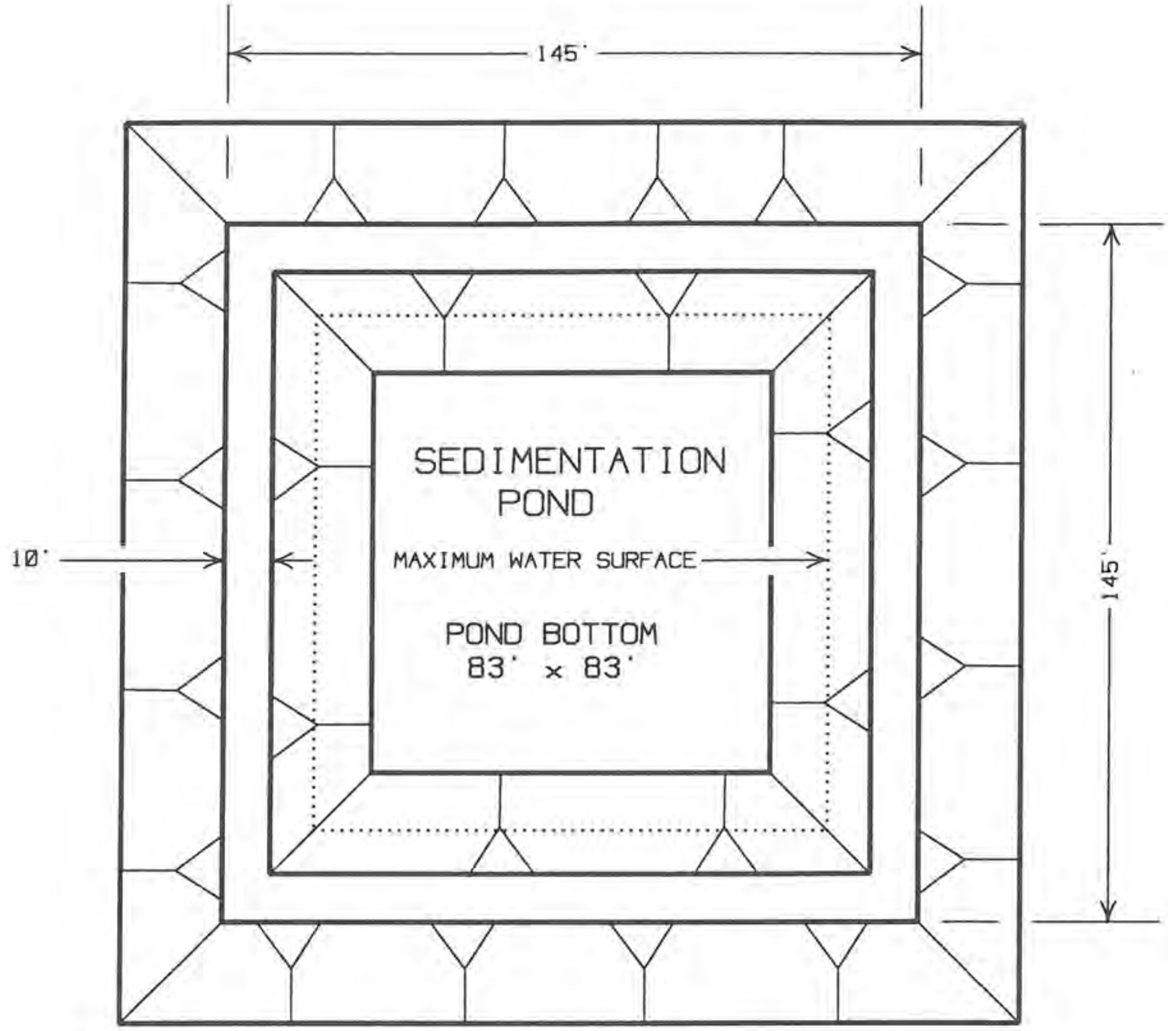
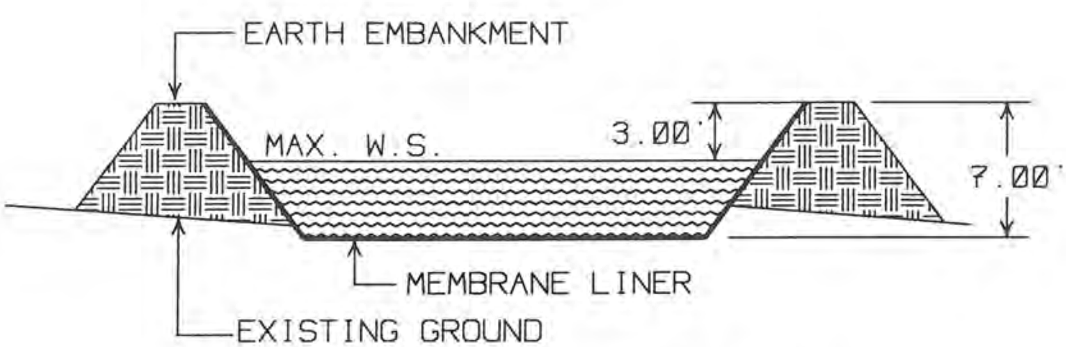


SEDIMENTATION POND

SCALE 1" = 40'



SECTIONAL VIEW

NOT TO SCALE VERTICALLY

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E. RECOMMENDED TREATMENT OPTION FOR PILOT TESTING (Cont.)

E.2 TREATMENT PLANT SITING CONSIDERATIONS (Cont.)

The following paper was presented at the 1993 NW AWWA Regional conference and is titled "Uniform Fire Code Requirements for Chlorine Treatment Facilities" by: Roger L. Coffey with R.W. Beck, Engineers. This paper is based on a 1991 revision to Article 80 Requirements of the Uniform Building Code (UFC), which is within Part VII - Special Subjects. The following excerpts quoted from the UFC are in quotations with regular type. Mr. Coffey's comments are in quotations with italic type. Some of the material has had **bold type** applied to it for emphasis.

Page 2. *"CHLORINE CHARACTERISTICS AND DEFINITIONS*

The following are characteristics, definitions, and classifications from the UFC, which relate to chlorine and that are significant with respect to design of facilities addressing UFC requirements.

- *Chlorine is a hazardous material, both in liquid and gaseous form, and is classified by the code as a toxic, oxidizing, and corrosive material.*
- *"The UFC classifies one-ton tanks as portable tanks, as per Article 9.*
- *The UFC classifies 150-pound tanks as containers per Section 80.102 (b).*
- ***IDLH** (Immediately Dangerous to Life and Health) is a concentration of airborne contaminants which represents the maximum level from which one could escape within 30 minutes without any escape-impairing symptoms or irreversible health effects. **The IDLH for chlorine is 30 parts per million.** The code requires that treatment systems reduce the discharge concentration of hazardous materials to at most, one-half IDLH levels at the point of discharge to the atmosphere. Therefor, for chlorine, the maximum discharge to the atmosphere is 15 parts per million.*
- ***PEL** (Permissible Exposure Limit) is the maximum permitted eight-hour time weighted concentration of an airborne contaminant. **The PEL for chlorine is 0.5 parts per million**. Systems installed to monitor leaks or the presence of contaminant must provide alarm at or below the PEL."*

E.2 TREATMENT PLANT SITING CONSIDERATIONS (Cont.)

The sections that the local Fire Chief has significant discretionary power in, and may be interpreted differently by successors to that position are:

Page 1, 3rd ¶. *"Most existing chlorine storage facilities do not meet the UFC Article 80 requirements. Per the 1991 UFC Article 1, Section 1.103(b);* ***at the discretion of the local Fire Chief****, Article 80 requirements can be applied to existing facilities if conditions constitute a distinct hazard to life and property."*

Page 3, 2nd ¶. *"There are many requirements included in the code that are* ***left for interpretation by the local Fire Chief****, as to what is appropriate and necessary for the specific facility. ....what is designed in one facility in a certain jurisdiction to meet specific requirements, may not be accepted for the same application in another jurisdiction."*

Page 3, 3rd ¶. *"A permit is also required when a material is classified as having more than one hazard category. Chlorine is both a toxic and a corrosive,* ***therefore a permit is also required by this paragraph****."*

Page 4, 1st ¶. Section 80.103 (b) - Hazardous Materials Management Plan (HMMP) **may be required by the Fire Chief**, as a part of a permit application. ....."

Page 4, 2nd ¶. "Section 80.103 (c) -. A Hazardous Materials Inventory Statement (HMIS) **may be required by the Fire Chief** per Appendix II-E. ...."

Page 6, 2nd ¶. "Section 80.301 (m) - Mechanical exhaust ventilation is to be provided in all storage areas. Specific ventilation requirements include:

- a ventilation rate of at least 1 cfm per square foot of floor area.
- continuous operation **unless exempted by the Fire Chief**.
- emergency ventilation system shutoff controls to be located at the outside doors to the storage areas."

"The UFC includes specific ventilation requirements for the chlorine storage areas. The ventilation requirements do not coincided with the ventilation requirements per the mechanical code, but attempt to establish a threshold ventilation for the room. The UFC also requires the ventilation to be continuous, ***unless exempted by the Fire Chief****. Continuous ventilation in an unattended facility is a waste of energy necessary to operate the ventilation system, as well as the energy required to heat the storage room."*

E.2 TREATMENT PLANT SITING CONSIDERATIONS (Cont.)

"A second requirement of the UFC is that all exhaust from the storage room ventilation system must be treated. This is a waste of energy and treatment material in operation of the treatment system. To meet the intent of the code, we located a gas detection unit in the exhaust duct system to monitor the concentration on chlorine. If chlorine is not present, or present below the ***PEL****, there is no need to route through the scrubber or the treatment system. This air can be exhausted directly to the atmosphere. However, if chlorine activates the gas detection alarm due to a concentration above the PEL, then the scrubber system activates dampers, which had permitted exhaust directly to atmosphere, close so that all exhaust goes through the scrubber."*

Page 7, 1st ¶. "Section 80.301 (p) - Unless exempted, storage area is to be equipped with automatic sprinkler system."

"This has been enforced on all installations we have been involved with. ***The UFC provides for an exemption by the Fire Chief.****"*

Page 8, 4th ¶. "Section 80.303 (a) - The gas detection system shall initiate a local alarm and transmit a signal to a constantly attended control station. The gas detection system shall be capable of monitoring the storage room at or below the **PEL**."

"What constitutes a constantly attended station has been an issue. ***A constantly attended site 24 hours per day was acceptable to the Fire Chief for one jurisdiction. A central monitoring station off-site which is staffed 24 hours per day was not acceptable to the Fire Chief for a different jurisdiction*** *and the Owner has to use an independent monitoring company to monitor this facility."*

OTHER CODE SECTIONS THAT ARE OF CONSIDERABLE SIGNIFICANCE ARE:

Page 5, 1st ¶. "Section 80.108 - Buildings used for storage or use of hazardous materials must be constructed in accordance with the UBC. Boundaries of a control area must be either the exterior wall, roof, or foundation, or an **occupancy separation with a one-hour fire rating.**"

Page 7, 2nd ¶. "Section 80.301 (u) - **A local fire alarm pull station is to be located outside each exterior door** of the storage room to activate a local alarm."

E. RECOMMENDED TREATMENT OPTION FOR PILOT TESTING (Cont.)

E.2 TREATMENT PLANT SITING CONSIDERATIONS (Cont.)

Page 7, 3rd ¶. "Section 80.301 (v) - When a manual alarm, emergency signal, detection, or automatic fire extinguishing systems are required, such systems shall initiate an audible and visual signal at **a constantly attended on-site location**."

Page 7, 8th ¶ continued to page 8.

"Section 80.303 (a) - INDOOR STORAGE ....

- Storage of cylinders shall be within a ventilated separate gas storage room. The exhaust system shall be designed to handle the accidental release of gas and shall be capable of diluting, absorbing, adsorbing, neutralizing, burning or otherwise processing the entire contents of the largest cylinder of gas stored. For portable tanks, the maximum flow rate of release shall be calculated based on assuming the total release from the tank within 240 minutes.

- A treatment system is described as a system capable of diluting, absorbing, adsorbing, neutralizing, burning or otherwise processing the entire contents of the largest cylinder of gas stored. Scrubber systems are not the only solution to the treatment issue. **A deluge system has also been an acceptable solution to certain jurisdictions.** Where a scrubber system neutralizes the chlorine with a caustic soda solution, the deluge system absorbs the chlorine and allows disposal of this solution. Both systems must be sized correctly to handle the design leak rate and the volume of the largest container or **in some cases, the volume of the manifold container system.**"

Page 8, 2nd ¶. "Section 80.303 (a)

- Emergency power shall be provided in lieu of standby power for exhaust ventilation, including treatment systems, gas-detection systems, and emergency alarm systems."

"***Emergency power differs significantly from standby power**. Emergency power systems are governed by Article 700 of the National Electric Code, and have much more stringent requirements on the starting time requirements of the power system. Another significant aspect of the emergency criteria is the determination of what is to be powered by the emergency power system, and what cannot be powered, Provisions must be included to separate the emergency features into a separate emergency panel. Other non-essential functions would be located in separate panels.*"

E.2 TREATMENT PLANT SITING CONSIDERATIONS (Cont.)

Attending the meeting was Ron Grage, Special Projects Director, for Regal Chlorinators, Incorporated. He handed out two similar brochures on the historic safety of utilizing chlorine gas 150 pound cylinders and 1 ton containers. The brochures point out:

- The inaccuracy of the media's reporting on how chlorine gas was released, by not emphasizing that the release of chlorine gas often originated from alternative forms chlorine compounds (calcium hypochlorite and sodium hypochlorite).

- Calcium hypochlorite comes in the form of a dry powder or tablet and can:

  Explode and cause catastrophic fires when a single match or cigarette is dropped into it.

  A dirty scoop or oily rag over the side of a drum can cause spontaneous combustion.

  Uncovered in a very warm humid room can fill the room with chlorine gas.

  Injuries caused by contact with eyes or damp skin.

  Explosions caused by dropping or striking sealed containers.

- Sodium hypochlorite comes in the form of a liquid and can:

  Cause fires when combustible materials soaked with it and rags have been allowed to stand.

  Cause fire when combustible materials soaked with it and exposed to heat or flame.

  Eye and skin damage caused by splashing.

The cost of Calcium Hypochlorite and Sodium Hypochlorite costs approximately 6.1 and 5.3 times as much as chlorine in a gaseous form to effect the same level of disinfection.

An attendee at the conference, stated that his City had adopted a policy to switch to sodium hypochlorite, and offered the following comments:

- The increased cost of providing additional building requirements (tank space)

- The need to replace holding tanks at frequent intervals because of it's corrosive-ness, and

E.2 TREATMENT PLANT SITING CONSIDERATIONS (Cont.)

- Based on experimenting with several different types of tank materials and combination of materials, he thought that about a five year life would probably be the most cost effective tank construction material.

Low dosage rates of chlorine will probably continue to be the disinfectant of choice. It seems prudent to recommend that:

- A treatment site be located away from populated areas.
- The prevailing wind will direct any leakage away from populated areas.
- Selection of a site (highly lighted) near traffic to minimize vandalism e.g. the north side of freeway I-84 and east of the central interchange (S.E. 3rd Street).
- Selection of a treatment process that will minimize the need for chlorination, other than as a post treatment disinfectant.

F. RECOMMENDED IMPROVEMENTS TO THE SPRINGS

As documented in the earlier chapters of this report, the City's springs offer the City the largest available combined renewable water source. To be able to fully utilize this source, it will require the City to treat the water for turbidity, and possible pathogenic organisms and viruses.

The City's records indicate that there are observation wells at some of the spring sites. The records do not indicate the depth to the basalt rock under the gravels. To obtain the maximum permitted allowable yield, may require the lowering of the collector piping at each of the springs. If this is the case, we recommend that a trench be dug down into the basalt rock low enough for embedding a collector pipe below the rock profile. The object being to capture all the water sheet draining along the top of the rock profile. The trench should provide ample space under, around and over the pipe for the placing of graded rock to pre-filter the water. The installation of properly graded rock should provide for adequate inflow and a material reduction in the turbidity. The reduction in turbidity at the springs will improve the efficiency and substantially reduce the treatment and operational costs.

There have been additions and alterations to the piping at the springs over the last 80 years. There is some question as to the exact routing and materials used in all cases. Some of the existing piping may be re-usable and worthwhile salvaging. To fully evaluate the extent of the improvements needed and related costs for improving the spring sources, we recommend the following sequence of events:

- From the record drawings, determine the location of the observation wells and conduct a field survey and search for them.

F. RECOMMENDED IMPROVEMENTS TO THE SPRINGS (Cont.)

- Televise all of the lines with the capability of tracking the camera at the surface for marking, surveying and mapping. Observe water flows, type of pipe (material, size, condition and perforations).

- Dig open pits where necessary to determine the underlying profile of the rock. Place observation wells in pits prior to/or during backfilling of the pit for future data collection.

- Evaluate data and prepare a plan to maximize the yield from the springs to a year around source of up to 7.56 MGD (11.7 cfs).

G. RECOMMENDED IMPROVEMENTS TO THE DEEP WELLS

The summer of 1992 placed a real stress on the City's water sources to meet customer demands. The lowering of the water table in the underlying basalt aquifers has resulted in the loss of use Well #1 (Byers Ave.) as a production well. A 12" diameter steel casing immediately below the pump's bowls is smaller in diameter than the pump's bowls. This prevents the lowering of the existing pump.

G.1 IMPROVEMENTS TO WELL #1 - BYERS WELL

In the short term, the City could install a smaller diameter, higher speed (rpm) set of pump bowls down into the 12" diameter casing/liner. To achieve substantially the same flow with a smaller set of pump bowls is possible, but would depend on the condition of the well borehole and liner. This option does have a risk of rock falling down from the unlined borehole permanently lodging the smaller pump to the casing.

To determine the maximum yield that can be obtained with a smaller set of pump bowls, a preliminary evaluation of the well should be made as follows:

- Televise and record observations on the full depth of the borehole with a color camera.

- Conduct a plumbness and alignment test on the well.

- Perform a geophysical borehole analysis to include:

  Spontaneous Potential (SP): SP log identifies the lithology of the geologic materials as well as locating the high and low permeable zones, except in wells with thick mafic basalts.

  Single Point Resistivity (SPR): SPR log provides a continuous record of apparent rock resistivity (density and porosity zones).

  Caliper log: Measures the diameter of the borehole.

G.1 IMPROVEMENTS TO WELL #1 - BYERS WELL (Cont.)

Fluid Temperature and Fluid Resistivity logs: Fluid temperature measures the temperature of the water (normal regional geothermal gradient is approximately 1° C/100').

Fluid resistivity can be utilized in evaluating the hydraulic regime of the borehole and varies with temperature. Logs must be corrected to a reference temperature before being used quantitatively.

Flowmeter: Measures and records vertical direction of flows within the well borehole.

Natural Gamma log: Useful in making stratigraphic correlations between boreholes and when trying to identify sands and clays.

The above information is useful in the selection of a smaller diameter set of pump bowls and a higher speed motor. In addition this information will give some indication about the feasibility of upgrading of this well again to a full production well by:

- Evaluating the practicality of removing the existing 12" diameter casing/liner,
- Enlarge the borehole diameter for installation of larger pump bowls, and
- Installing screens in the borehole collapsing sections to capture any water that may not be able to enter behind the existing casing/liner.

The Specific Capacity (SC), an indication of productiveness, should be verified after the smaller diameter pump bowls are installed. This well may be an excellent well for the construction of a combination recharge/production well and merit additional upgrading.

The restoring of this well with smaller pump bowls would provide a needed interim source until the full development of the spring source can be achieved.

G.2 IMPROVEMENTS TO WELL #6 - SHERWOOD WELL

There is some question about the productiveness (SC) of this well (see page IV-38). If the specific capacity is 14.6 instead of 5.4 gpm/ft. of drawdown, it could be capable of producing as much water as City Well #4. It is recommended that this well be tested and the yield verified.

If the test indicates that a favorable yield is available, then the following tests similar to City Well #1 are recommended as follows.

- Televise and record observations on the full depth of the borehole with a color camera.

G.2 IMPROVEMENTS TO WELL #6 - SHERWOOD WELL (Cont.)

- Conduct a plumbness and alignment test on the well.

- Perform a geophysical borehole analysis to include:

G.3 IMPROVEMENTS TO WELL #11 - McKAY WELL

This well has been utilized for years as a source of potable water for the City's Wastewater Treatment Plant. There is conflicting information on the potential yield of this well in the original well log and supplemental supporting information of record. This well should also be tested to ascertain the actual potential of this well serving as a major production well that may also be utilized as a recharge well.

An approximate method of determining the Specific Capacity (yield/ft. of drawdown) can be obtained by utilizing the existing pumping equipment. This can be accomplished by regulating the yield at various fixed rates and observing the water table levels.

H. WATER TRANSMISSION IMPROVEMENTS

H.1 DEVELOPMENT OF CITY'S SPRINGS EXISTING PERMIT/RIGHTS - 7.56 MGD

Based on observations of by Ralph Baumgartner, City Water Superintendent, to very limited portions the existing gravity line from the springs, the line is apparently in excellent condition. The majority of the line (probably over 99%) is buried and prevents extensive visual observations to evaluate the total evaluation of the line's conditions. If all of the line is in excellent condition, it would provide a mean of conveyance to the City, without the expense of pumping and merits continued use. If the gravity line is planned for continued use in the future, we recommend that the City consider televising the full length of the gravity line to evaluate its remaining useful life.

Two options are available, if the existing line proves to be in a condition to merit it's continued use. These options for transmitting the additional flow (7.56 MGD - 5.25 MGD = 2.31 MGD) are:

- Laying another water line parallel to the existing gravity line or

- Using the Umatilla River as a means of conveyance.

If it is determined that the Umatilla River between the springs and the City is a taking stream (loss to lower aquifers and/or evaporation), the latter option may not be a viable alternative.

H.1 DEVELOPMENT OF CITY'S SPRINGS EXISTING PERMIT/RIGHTS - 7.56 MGD (Cont.)

However, if the line appears to be in an advanced state of deterioration, then the options that should be evaluated are:

- Constructing a new line from the springs to the City capable of transmitting all the 7.56 MGD to the City. If Well #7 is to be continued as a viable source, the line capacity from Well #7 to the City would have to be increased an additional 0.6 MGD to 8.16 MGD, or

- Utilizing the Umatilla River as a means of conveyance.

As stated above, if the Umatilla River is deemed a taking stream, the latter option may not be a viable alternative.

H.2 TRANSMISSION OF THE TWO OLDEST RIVER WATER RIGHTS - 1.62 MGD

The City has two older Umatilla River water rights, with priority dates of 1885 and 1890, for 1.293 MGD and 0.323 MGD respectively. The 1885 water right map shows that the point of diversion, as near as can be determined, was located just upstream of the junction of Wildhorse Creek and the Umatilla River. This location was probably selected to avoid the highly turbid Wildhorse Creek.

Assuming the above to be the location to construct a river intake, the appropriate line sizing from the river intake for a 1.62 MGD transmission line would be as follows:

Assume a 12" diameter pipe size with a cross sectional area of 0.785 square feet:

Flow rate = 1.62 MGD or 1.62 MG/1,440 min day
= 1,125 gpm or (1,125 gpm) x (7.48 gal./cubic foot) x (60 seconds/min)
= 2.50 cfs

Velocity = 2.50 cfs/0.785 square feet
= 3.19 ft./sec. "OK"

If an additional 2.31 MGD flow at the springs is developed above the capacity of the existing gravity line, and this flow added to the above the 1.62 MGD from the river, the transmission line sizing from the river intake would have to be increased to 3.93 MGD. The line size would be as follows:

Assume an 18 diameter pipe size with a cross sectional area of 1.767 square feet:

H. WATER TRANSMISSION IMPROVEMENTS (Cont.)

H.2 TRANSMISSION OF THE TWO OLDEST RIVER WATER RIGHTS - 1.62 MGD (Cont.)

Flow rate = 3.93 MGD or 3.93 MG/1,440 min day
= 2,729 gpm or (2,729 gpm) x (7.48 gal./cubic foot) x (60 seconds/min)
= 6.08 cfs

Velocity = 6.08 cfs/1.767 square feet
= 3.44 ft./sec. "OK"

If the springs are developed to the permitted yield of 7.56 MGD flow, transmitted via the river and added to the 1.62 MGD river permits, the transmission line sizing from the river intake would have to be increased to transmit 9.18 MGD. The line sizing would then be as follows:

Assume a 30 diameter pipe size with a cross sectional area of 4.909 square feet:

Flow rate = 9.18 MGD or 9.18 MG/1,440 min day
= 6,375 gpm or (6,375 gpm) x (7.48 gal./cubic foot) x (60 seconds/min)
= 14.20 cfs

Velocity = 14.20 cfs/4.909 square feet
= 2.89 ft./sec. "OK"

A review of the above alternatives indicates what the impact would be, if the existing gravity line was abandoned, and all the water from the City's springs conveyed down the Umatilla River to a single river intake structure. Complete abandonment of the gravity line would also raise the issue of how to continue to utilize city Well #7 (Mission Well).

I. WATER STORAGE IMPROVEMENTS

The City recently completed the construction a new 1.15 MG reservoir to service the southwest area of the City plus a second 0.5 MG reservoir at the City's airport area. In addition the interior and exterior of the existing 0.5 MG reservoir at the airport was re-coated. The 2.0 MG South Hill Reservoir and the 1.0 MG North Hill Reservoir are scheduled for having plastic type fabric liners installed on their interiors this year.

There is an existing 0.3 MG concrete reservoir in the wheat field north of the City Limits which is in an advanced state of deterioration. This reservoir services the upper levels of the northern parts of the City. The maximum elevation of water stored in this reservoir provides for pressures of approximately 20 to 30 psi for customers near the northern City Limits. These customers have had to install individual booster pumping units for each of their residences to have sufficient pressure to utilize their appliances. A new 0.5 MG reservoir is recommended to replace the existing 0.3 MG reservoir. The new reservoir would be configured to provide for some additional pressure to the customers near the northern City Limits.

J. " WILD CARDS" IN THE IMPROVEMENT PLANNING

As mentioned in this and previous chapters, there are some questions as to the viability of the City's present water rights and permits. Discussions with the OWRD staff has often resulted in ambiguous or vague responses. Some of the "wild cards" that can significantly affect the premises made in these chapters are discussed in the balance of this section.

J.1 CLAIMS BY THE CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) claims jurisdiction over the water falling on, lying under, and flowing through the Umatilla Indian Reservation. The CTUIR's entitlement to water rights, based on the 1855 treaty, have not been determined as of this date. Any water right(s) granted the CTUIR with an 1855 priority date will have seniority over all of the City's water rights and permits.

Based on discussions with Reed Marbut, Water Rights Adjudication Administrator for the OWRD on Indian claims, indicated that the OWRD may start negotiations with the CTUIR to establish their water rights in 1997. The quantity of any right assigned to the CTUIR and/or any added quantity for stream flow for fish propagation, will have an impact on some or all of the City's water rights and permits.

J.2 CITY'S 1885 AND 1890 WATER RIGHT ON THE UMATILLA RIVER

The 1885 water right, D2604 for 2.0 cfs and the 1890 water right, D2582 for 0.5 cfs should predate several other water rights on the Umatilla River including the federal governments one for filling of the Cold Springs Reservoir. The City may be legally entitled to withdrawing the 2.5 cfs on a year around basis.

In recent years, there has been legislation and funding that permitted the transfer of water rights from the Umatilla River to the Columbia River to improve the minimum stream flows on the Umatilla River. This project is known as the "Umatilla Basin Project". Federal funding was approved to construct a pumping plant on the Columbia River. Water is pumped from the Columbia River into the Cold Springs Reservoir and the West Extension Irrigation Canal to replace water formerly obtained by gravity from the Umatilla River during minimum stream flows in the Umatilla River.

If the Umatilla Basin Project has merit, it would seem that the City should be able to have a similar amendment to their water rights made by the State Legislature. The purpose of this amendment would be to permit the City to withdraw additional amount of water during periods of surplus in the Umatilla River (above the minimum stream flows) in exchange for the amount the City may forgo to use their oldest water rights during critical low flow river periods. The value of the using City's oldest water rights to assist if fish propagation may merit an even more favorable exchange in the transfer of water rights.

J.3 CITY'S 1910 WATER PERMIT ON THE UMATILLA RIVER

The 1910 water permit, #458 for 8.0 cfs on the Umatilla River, is junior to several older rights and permits on the Umatilla River. However, the priority date of this permit is senior to the priority dates of the City's springs.

Being an undeveloped water source, it has never been subject to regulation by the watermaster's office. According to Tony Justus, Watermaster at the Pendleton office, the times and quantities of water available with this permit are unknown, but are expected to be subject to regulation during certain times of the year.

The point of diversion in this permit is at the North Fork of the Umatilla River. There is some question as to being able to legally utilize the river as a means of conveyance from the North Fork to the City without development of the permit first at the North Fork.

J.4 OWRD'S ABILITY TO REGULATE WATER RIGHTS AND PERMITS

Through the OWRD's Administrative Rules, a watermaster exercises considerable control over water rights and permits. From the OWRD's Administrative Rules Chapter 690, Division 250 - Water Distribution, the following is quoted.

"Futile Calls

690-250-020

(1) A call for distribution of surface water is futile when a junior appropriator has been denied the use of water and, in the judgement of the watermaster, an inadequate amount of water, or no water, reaches the senior appropriator or minimum flow point or reach or instream water right. Factors for consideration by the watermaster in making such a judgement may include, but are not limited to the following:

(a) Soil moisture conditions;
(b) Temperature;
(c) Evaporation rate;
(d) Moisture condition of the stream channel;
(e) Conveyance characteristics of the stream channel; or,
(f) Previous records that show conveyance characteristics of the stream

(2) Upon the judgement that water will not reach its destination, or that an inadequate amount of water will reach its destination, the watermaster may disregard the call of the senior downstream appropriator."

J.4 OWRD'S ABILITY TO REGULATE WATER RIGHTS AND PERMITS (Cont.)

" Regulation of Ground Water/Surface Water

690-250-120

(1) The watermaster shall respond to complaints based on a review of appropriate records and performance of necessary field inspections as judgement may require. The watermaster may request the assistance of a ground water geologist. The watermaster's response may be by oral or written communication to the ground water and surface appropriators involved in the complaint, or by personal visits by the watermaster or assistant watermaster.

(2) The watermaster shall distribute the surface water and ground water by relative priority within the affected area if ground water and surface water connection and substantial interference are determined. The watermaster may request the assistance of a ground water geologist during any phase of ground water/surface water distribution."

J.5 CITY'S SPRINGS

The City's springs have the following priority dates and an rates of flow:

Spring	Priority Date	Flow Rate - CFS	Flow Rate - MGD
Wenix	11/28/1910	4.0	2.585
Shaplish	5/20/1912	3.0	1.939
Three Simon	4/22/1929	2.7	1.745
Longhair	4/22/1929	2.0	1.293
	Totals	11.7	7.562

These springs have not been subject to "cut-backs" on their usage. Based on discussions with Tony Justus, Watermaster at the Pendleton office, the consideration of "cut-backs" on the spring's yields has been deferred until the jurisdiction over the water rights on the Umatilla Reservation have been resolved. There is considerable concern about the degree of viability of the City's springs as year around sources.

J.6 NORTH FORK OF THE UMATILLA RIVER BY LEGISLATIVE ACT, DATED 1941

The important part of this withdrawal by the State Legislature is that it is subject to water rights existing on March 8, 1941(see quotation [1] from the ORS below). This makes the water right junior to several older water rights and permits on the Umatilla River. The quantitative amount of water that may be accrue to the City's benefit is unknown.

J.6 NORTH FORK OF THE UMATILLA RIVER BY LEGISLATIVE ACT, DATED 1941 (Cont.)

The following is quoted from the Oregon Revised Statutes:

"538.450 Pendleton; right to waters of Umatilla River.

(1) Subject to water rights existing on March 8, 1941, there is granted to the City of Pendleton, Umatilla County, and its water commission, the exclusive right to use for public or municipal purposes or use, or for the general use and benefit of people within or without the city, all waters of the north fork of the Umatilla River, the springs at the head which form the stream, and its tributaries to the confluence of the north fork with the main stream of the Umatilla River in the northwest quarter of section 22, township 3 north of range 37 east of the Willamette Meridian, which north fork is a tributary of the Umatilla River situated in Umatilla County.

(2) The City of Pendleton, its water commission, any of the city's agents, agencies and officers, and others on its behalf, may appropriate all such waters for these purposes and uses, and application therefor may be made for the benefit and use of the city, as above set forth, either by the city in its own name, or by any of its agents, agencies or officers or by any other persons on its behalf.

(3) No person shall appropriate or be granted a permit to the use of any of such waters, except as provided in this section. But the City of Pendleton may, under this grant, divert such waters from their watershed and convey them to the city and elsewhere for use by it for public or municipal purposes or use or for the general use and benefit of people within or without the city. All such waters are withdrawn from future appropriation, except for use and benefit of the city as set forth in this section."

A legal opinion should be sought on whether this right could be construed to include storage rights for an Artificial Recharge and Recovery Project (ARR) and/or a surface impoundment of surplus waters during the winter months. If the right could be so construed, it would be senior to the water right for an ARR project by flooding over a sandy and gravelly formation over the underlying basalt a by the County Line Improvement District in the West end of the County.

J. " WILD CARDS" IN THE IMPROVEMENT PLANNING (Cont.)

J.7 DEVELOPMENT OF ADDITIONAL DEEP WELLS

J.7.a Permitted but undeveloped wells combined in a single permit

The City has permits for undeveloped wells with the following priority dates and flow rates:

Well No.	Priority Date		Flow Rate - CFS	Flow Rate - MGD
#6 (Sherwood)	10/10/1962		6.67	4.31
#9 (South Hill)	10/10/1962		6.67	4.31
#10 (Crispin)	10/10/1962		6.67	4.31
#12 (McCormack)	10/10/1962		6.67	4.31
		Sub Totals	20.00*	12.93*
#11 (McKay Creek)	4/04/1966		6.70	4.33
		Totals	26.70	17.26

*The single permit allows for a maximum yield of 2,993 gpm (4.31 MGD) at each well site, provided that the aggregate developed yield does not exceed 8,976 gpm (12.93 mgd).

The 26.7 CFS in the permitted but undeveloped wells equals 28,690 gallons per minute. None of the existing City wells have been able to produce 3,000+ gpm (4.3+ MGD), as provided for in the existing permits. The expectation that the development of additional wells will be larger producers than the existing City wells is highly speculative.

J.7.b Permitted Remaining Developable Capacity in Existing City Wells

There is in the City's well permits a remaining developable capacity as follows:

Well No.	Priority Date		Flow Rate - CFS	Flow Rate - MGD
#2 (Round-up)	10/10/1962		0.90	0.58
#4 (E. Or. Hospital)	10/10/1962		0.22	0.14
#5 (Stillman)	10/10/1962		0.17	0.11
#7 (Mission)	10/10/1962		5.74	3.71
#8 (Prison)	4/04/1966		4.25	2.75
		Totals	11.28	7.29

The total developable capacity in the existing producing wells is 5,061 gpm (7.29 MGD).

An attempt was made several years ago to improve the yield in Well #7 (Mission) without success. Improving the yield of the existing wells can be a very expensive endeavor without any assurance of success. At the extreme case, the City may be able to move the well point of diversion within a 500' radius and drill a replacement well in the hope that the borehole will penetrate more porus aquifers.

J. " WILD CARDS" IN THE IMPROVEMENT PLANNING (Cont.)

J.8 IMPROVEMENT "WILD CARDS" IMPACT ON ESTIMATED PROJECT COSTS

The advice and opinion from an attorney with expertise on the State's statutes, rules and regulations is recommended to get a better handle on the status of the City's water rights and permits. Such findings may not be absolutely conclusive, but they would certainly be helpful in narrowing the parameters on each of the: water rights, permits, and viability of the existing developed sources. Better cost projections can be made once there is some definitive information on the status of the City's water rights and permits, and the location of alternative treatment sites is known.

CHAPTER VIII

PROJECT DEVELOPMENTS COMMON TO TWO ALTERNATIVES

A. REPLACEMENT OF LOSS OF SUPPLY FROM WELL #1 (BYERS AVE.)

The lowering of the water table has already side lined the use of City Well #1 (S.E. Byers Ave.) as a viable water source. This well, a major supply well, formerly produced 2.58 MGD (1,792 gpm/4.0 cfs). When this well is pumped now, the water level falls below the pump suction. Immediately below the pump suction there is a reduction in the size of the borehole with a metal liner. This metal liner prevents the normal option of re-boring of the well and the further lowering of the pump bowls. The continued lowering of the water table will place all of the other City's deep wells at similar risk and endangers their long term viability as reliable water sources.

This Firm is recommending that the City implement an experimental Artificial Recharge and Recovery (ARR) program utilizing Well #1 (Byers Avenue). However, in the short term there is an immediate need to replace the loss of production from Well #1. The only practical solution is to develop one of the City's partially developed or undeveloped deep wells currently in permit status. This will for the short term, further aggravate the problem of the falling water table in the underlying Columbia River Basalts.

Based on limited testing by City forces, it appears that City Well #11 is a prime candidate to replace Well #1. The permit for this well is for 6.7 cfs(3,000 gpm/4.33 MGD). Prior to the performing a yield test, the well bore should be tested for:

- Diameter of casing and borehole for it's full depth.
- Plumbness and alignment.
- The borehole televised with a color camera.
- Temperature/depth readings.
- Aquifer flow/depth readings.

It is recommended that the largest practical pumping system be installed in this well, and the well be tested at the maximum sustainable pumping rate. The normal test period for a municipal well is for a continuous 48 hour duration. If the well test indicates that this well will not supply enough water to replace Well #1 (Byers Ave.), the City should explore the possibility of developing one of the other permitted, but undeveloped deep wells.

B. INITIATION OF AN EXPERIMENTAL ARR PROGRAM

The City will need to obtain OWRD approval to convert Well #1 (Byers Ave.) to an ARR well to determine the feasibility of the City implementing a permanent ARR program. This involves the removal of the existing pumping equipment, altering the piping, adding of injection flow controls, and modifications to the Supervisory Control and Data Acquisition (SCADA) system.

To preserve the future viability of the City's deep well sources, it is essential to alleviate the continuing decline in the water table. Meeting additional water demands from City growth and arresting the decline in the water table can be accomplished by:

- Implementing a successful ARR program,
- Removing the turbidity from the City's spring sources to make them acceptable for recharge (injection), and
- Utilization of existing but undeveloped deep well and surface water rights/permits.

There will be limited opportunities to utilize the City's springs sources for ARR until the turbidity has been lowered to acceptable limits. With extensive use of the deep wells in the winter months, the City may be able to inject a sufficient amount of water to make preliminary determinations about the potential success of an ARR program. If the turbidity remains high during the winter months, as it has in past years, meaningful injection may not occur until the turbidity is lowered from the City's spring supply by Slow Sand Filtration treatment.

There is current legislation sponsored by Representative Chuck Norris, which if passed, will dramatically streamline the permitting process for implementing an ARR program. The City and this Firm have been active participants in this important deliberative process.

C. RETAINING OF LEGAL COUNSEL SPECIALIZING IN OREGON WATER RIGHTS

There is in this report and prior reports, the recommendation that the City retain the services of legal counsel that specializes in Oregon Water Rights. There are issues to resolve for both alternatives considered in this report. Legal advice is needed on:

- Pros and cons of aggressively pursuing the maximum development of all of the City's water permits and water rights versus a cooperative approach with other entities,
- Entering into negotiations with other entities, as may be in the City's best interest, e.g. exchange of water rights (timing and quantities),
- Changes to the permits and/or water rights e.g. change in the point of diversion such as the Springs to the City via the Umatilla River (determine amount of quantitative loss in rights/permits because of evaporation and/or seepage),

C. RETAINING OF LEGAL COUNSEL SPECIALIZING IN OREGON WATER RIGHTS (Cont.)

- Preparing to address objections that may be raised by other entities that seem prone to attack any material development of water sources in the State, and

- Rendering advice on whether the City should be an advocate for the declaration of a critical groundwater for the Pendleton area.

The cost for these legal services can vary greatly depending on what a preliminary investigation may reveal. The degree of opposition by other entities will also materially affect the amount of legal fees the City will encumber. Costs for these legal services will probably be materially different for each of the two alternative plans proposed in this report. For this reason a budget for legal services is shown with each alternative plan.

D. OBTAINING AN ARR PERMIT

An integral part of the submittal to the OWRD, would be a request for a pre-application conference with the OWRD staff for an ARR permit. Pertinent OWRD rules for an ARR project were recited on pages VII-16 to VII-21 in the previous chapter. The purpose of the conference with the OWRD staff is to arrive at an agreement as to what additional data, analysis, and/or geological research is required to obtain a permit.

E. CONVERSION OF WELL #1 (BYERS AVE.) TO AN ARR WELL

Well #1, historically was one of the City's highest production wells 2.58 MGD (1,792 MGD/4.0 cfs). This well is now proposed to be only an injection well. Therefor it will not be a true ARR well, where water can be injected and withdrawn from the same borehole. If the water table raises sufficiently from the recharge program, it may later again be a major producing well, or abandoned and a new ARR well drilled along side of it in the future to take advantage of the existing permit.

Because of the high distribution system pressure at this Well (120 +/- psi), it will be necessary to seal the head of the well. It is very unlikely that the well is capable of accepting as much water as the distribution system can deliver. This resistance will result in a build up of pressure in the well during injection. Valving to control pressure in the system and the rate of injection will be required. The quantity to be injected will be controlled by the water levels in the City's reservoirs.

E. CONVERSION OF WELL #1 (BYERS AVE.) TO AN ARR WELL (Cont.)

Changes needed at the well for an experimental ARR project, includes: removal of existing pumping equipment, piping modifications, changing the well head (raising and sealing to the casing), metering, manual and automated control valving, and additions to the Supervisory Control and Data Acquisition (SCADA) system (hardware and software programming).

F. DEVELOPMENT OF CITY WELL #11 (McKAY CREEK/SEWAGE TREATMENT PLANT)

There is some conflicting information on Well #11 as to depth (334' or 339'), amount of casing installed (200' or 334') and yield (bailed dry vs. high yield). Well #11 is currently being used by the City's wastewater treatment plant. This well has satisfactorily supplied the wastewater treatment plant for several years and may have a reasonably high yield capability.

The City staff has conducted a preliminary test on the Specific Capacity (SC) of this well and the results are encouraging. This well should be tested the same as stated in Section A.

Estimated costs for development of Well #11 is premised on:

- Preliminary testing of existing well, including the removal and replacement of the existing pumping equipment.
- The removal of the existing 10" casing (8' deep) and reboring the well.
- The well's rock borehole being reasonably straight and plumb,
- There being no obstructions in the well,
- The well's specific capacity is in the range of 50 to 150 gpm/ft of drawdown, and
- Drilling of a completely new well if tests indicates problems with plumbness, alignment, obstructions, etc. in the existing well. If the City acquires the Brogoitti well, this well may be a good candidate for a second ARR well.
- The yield of 6.7 cfs (3,007 gpm or 4.33 MGD) as allowed for in the existing permit will be fully developed, or as a minimum, a yield of 2.58 MGD (1,792 MGD/4.0 cfs) to replace the loss of Well #1 (Byers Ave.).

F. DEVELOPMENT OF CITY WELL #11 (Cont.)

Estimated costs for development of Well #11 is premised on (Cont.):

- The depth of the well not to exceed 500 feet and includes the following:

  Preliminary testing shown above.

  Well drilling, casing, liners, screens, testing, and sterilization.

  Installation of the pumping system.

  Pump building, meter, electrical & mechanical.

  2,000' of 18" diameter water transmission line (rock trenching anticipated).

  Extension and inclusion into the SCADA system.

  Contingencies and engineering.

G. DEVELOPING OF CITY WELL #6 (SHERWOOD WELL)

Should the test results at Well #11 (Mckay Creek/Sewage Plant Well) indicate that a major producing well can not be reasonably anticipated at this location, Well #6 provides a second alternative. Well #6 has been drilled to a depth of 1,500' and serves as monitoring well. Prior to any yield testing, this well should be subjected to testing for plumbness, alignment, be televised, and have a geophysical borehole analysis conducted as set forth on pages VII-42 to VII-44.

This well was drilled in a very tight formation with a corresponding low Specific Capacity (yield in gpm/ft. of drawdown). Testing this well to the amount of it's permit, will result in a localized severe drawdown of the water table (from well log approx. 557' to a depth of 800+').

Test pumping this well will require specialized testing equipment such as a: very large diesel powered unit, deep pump settings with large diameter pump shafting, etc. A 48 hour uninterrupted test at this location will be very expensive. However, the 1,500' depth of this well, may be one of the few City wells capable of pumping at the permitted rate of 3,007 gpm, but at a very high pumping cost.

G. DEVELOPING OF CITY WELL #6 [SHERWOOD WELL] (Continued)

Prior to any serious consideration of developing this well, the cost of installing additional transmission lines to service the western extremities of the City to supply an equal quantity of water should be evaluated as an alternative. These additional transmission lines would also be very expensive and not provide any additional water for peaking demands. Therefor the improving of the well should be assigned an additional credit, because of the benefit of developing an additional source.

If this well is developed to it's full permitted capacity, it's primary role could be to serve as:

- A well for meeting high summer peaking demands (irrigation),
- Satisfying an industrial/commercial need in the western section of the City, and
- An additional well to access the artificially injected water ("banked") into the underlying basalt aquifers.

The other alternative to consider, would be to not fully develop the well to the 3,007 gpm allowed by the permit. The City's umbrella permit over this well (#6), also includes the South Hill Well (#9), Crispin Well (#10) and the McCormack Well (#12).

The umbrella permit provides that these four wells may collectively yield up to 12.925 MGD (8,976 gpm/20.0 cfs), with no individual well to exceed 3,007 gpm (6.7 cfs). The other three wells have not been developed and some of the aggregate amount could be utilized at the other permitted well sites.

<u>Assumptions on the current status of Well #6:</u>

- The well's rock borehole to a depth of 900' and the 186' of 24" diameter casing at the top of the borehole is reasonably straight and plumb,
- There are no obstructions in the well,
- The low specific capacity of 5.4 gpm/ft. of drawdown is correct, and
- The yield of 6.7 cfs (3,007 gpm or 4.33 MGD), as allowed for in the existing permit, can be developed (drawdown of 557').

<u>Cost estimate for developing Well #6 includes:</u>

Construction of a pump building and pumping equipment.
Metering, electrical equipment and mechanical piping.
One half (1/2) mile of 18" diameter water transmission line.
Pipeline easements, surveying, access road and SCADA system.
Contingencies and engineering.

G. DEVELOPING OF CITY WELL #6 [SHERWOOD WELL] (Continued)

The estimated cost of developing this well is higher than that of Well #11 (McKay/Sewage Treatment Well), and was assigned a lower priority because of the following factors:

- The specialized equipment required for the development of this well such as a 1,000 horsepower motor, 2300 volt service, an approximate 3" diameter line shaft, special transformers, and several other similar costly items for the well pumping system described above.
- The location of this well is not as strategically located as Well #11 to service the additional growth occurring along the Umatilla River floor west of the City. To provide a looped piping system to service the future demands for this area would make this alternative considerably more costly.
- The low Specific Capacity (yield in gpm/ft. of drawdown) makes this well an unlikely candidate for development as an ARR well.
- The higher energy costs in pumping water from this well.

The decision not to develop Well #6 some years ago, may have been based on the then relatively low need for a new water source, the cost of pumping, and that there may be a more productive well field on the Indian Reservation where Well #7 was drilled.

H. SLOW SAND FILTER PILOT TESTING

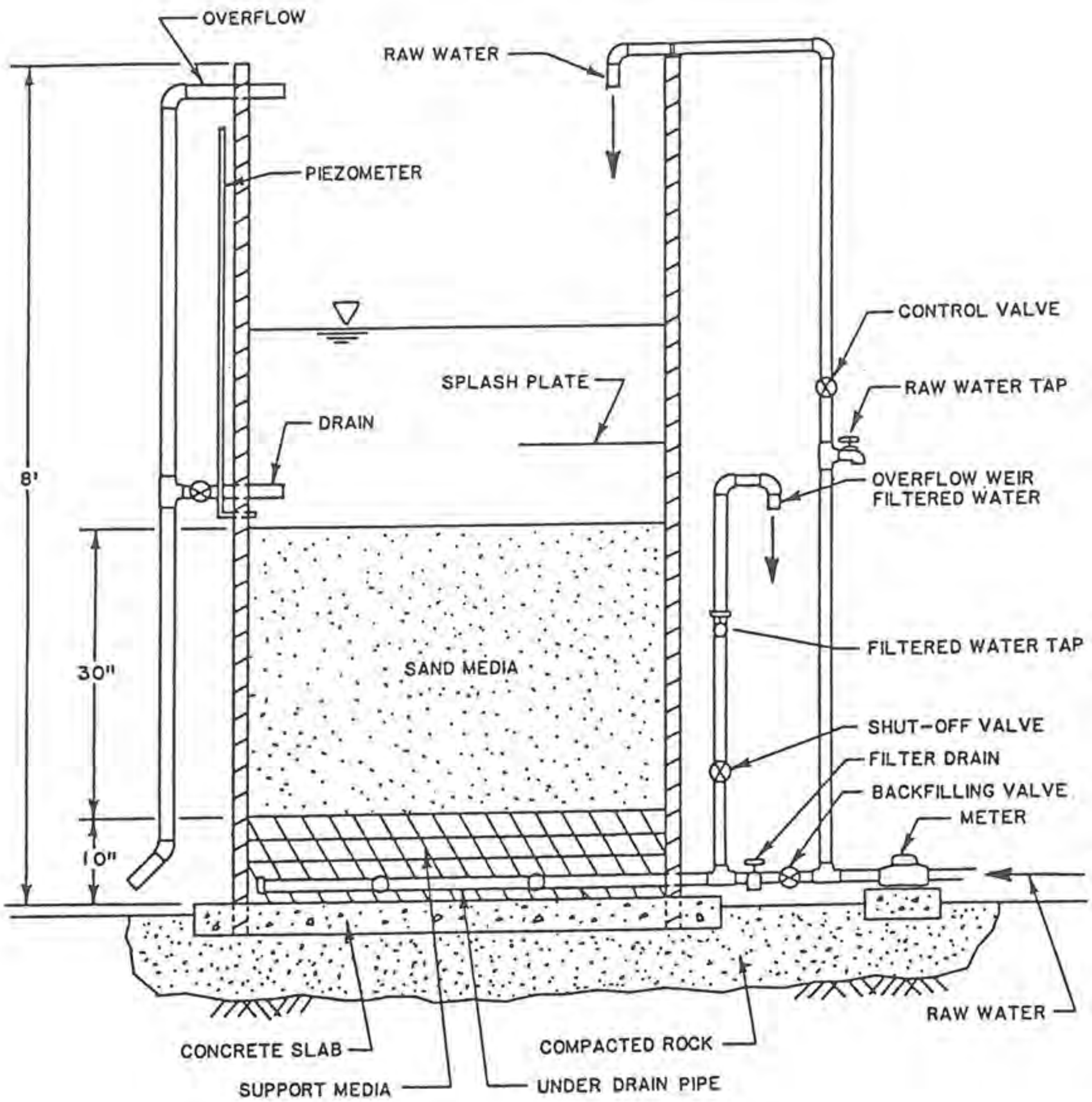
The City will need to develop a pilot testing plan for the Slow Sand Filter (SSF) treatment process and submit it to the OHD staff, with a follow up conference meeting. The springs and the Umatilla River sources are recommended in this report for development. The State's policy is to require pilot testing for a period of one year for each source. The monitoring of the pilot testing units would be an additional manpower requirement of the City.

Dave Leland, Manager of the Drinking Water Program of the Oregon Health Division, presented a working model of a pilot testing unit at the American Water Works Association (AWWA) conference at Spokane, Washington in 1990. Reproductions of some of the printed material presented at that conference are on the following pages VIII-8, VIII-9, VIII-10 and VIII-11.

The recommended pilot testing proposes separate tests for the springs, at the springs Weir House and at a site in the City upstream from Wildhorse Creek for the Umatilla River source. At both of these locations a storage facility would need to be constructed to provide a comparable retention time similar to the 90 MG surface storage facility proposed prior to treatment by the Slow Sand Filter facility. Power and a small centrifugal pump would be required at both locations to pump the water up into the pilot filter plus City forces for monitoring.

EXCERPT FROM DAVE LELAND'S PAPER
GIVEN AT THE AWWA CONFERENCE AT SPOKANE IN 1990

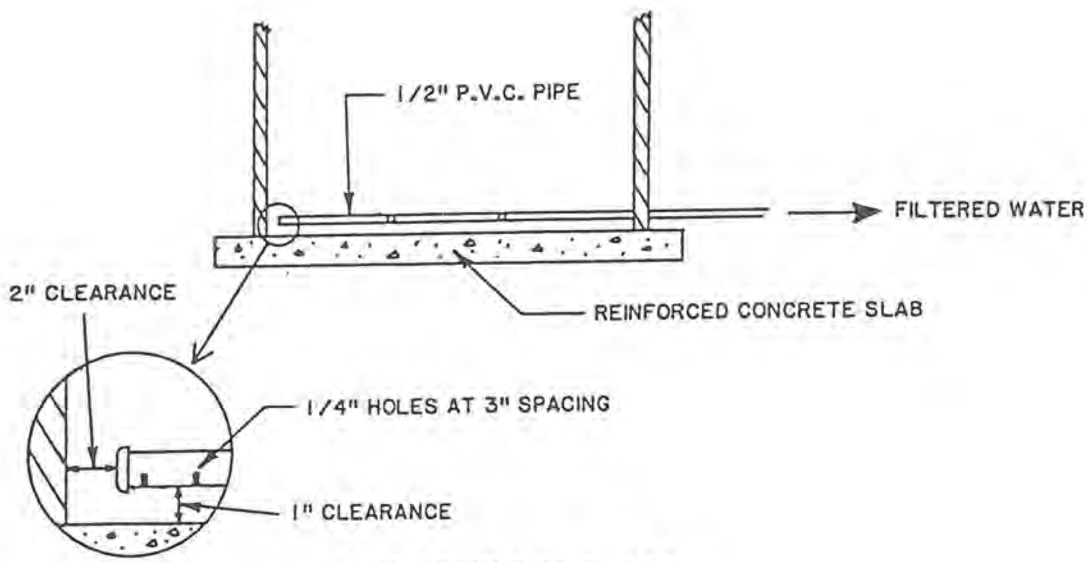
STANDARD SLOW SAND PILOT FILTER



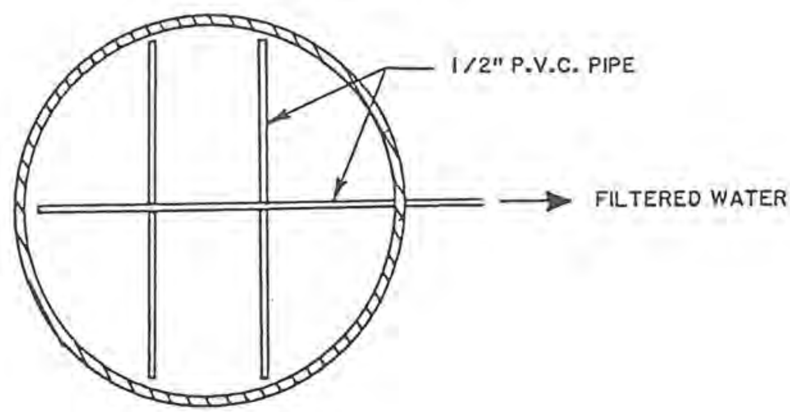
EXCERPT FROM DAVE LELAND'S PAPER
GIVEN AT THE AWWA CONFERENCE AT SPOKANE IN 1990

UNDERDRAIN PIPE DETAIL FOR THE

STANDARD SLOW SAND PILOT FILTER



UNDER DRAIN PIPE DETAIL



TOP VIEW

EXCERPT FROM DAVE LELAND'S PAPER GIVEN AT THE AWWA CONFERENCE AT SPOKANE IN 1990

DATA COLLECTION STRATEGY FOR PILOT STUDIES

(a) ROUTINE MONITORING

PARAMETER	FREQUENCY	PURPOSE
Raw/filtered turbidity	3-7 times/week	Assess particulate removal
Raw/filtered total and fecal coliform	1-2 times/week	Assess biological removal
Head loss	3-7 times/week	Characterize filter run behavior
Flow rate check	3-7 times/week	Keep filter rate constant
Temperature	3-7 times/week	Related to biological removal
THM formation potential/ UV absorbance/TOC	Seasonal/monthly	Assess disinfection by-products
Written notes	Each visit	Documentation
Weather conditions	Each visit	Assessment of raw water quality

(b) SPECIAL PURPOSE MONITORING

Algae (or chlorophyll-a)	Weekly	Assess short filter run lengths
Particle counts	3-7 times/week	Assess high NTU
Microbiological particulate analysis	1-4 times/month	Assess filter efficiency & Giardia removal
Dissolved oxygen	Weekly	Assess biological removal
Color	Weekly	Assess THM precursors
pH	Weekly	Assess corrosion control needs
Iron and manganese filter	Monthly	May shorten runs

EXCERPT FROM DAVE LELAND'S PAPER
GIVEN AT THE AWWA CONFERENCE AT SPOKANE IN 1990

MATERIALS LIST FOR STANDARD PILOT FILTER

ITEM		QUANTITY
Filter vessel:		
	4 ft. diameter fiberglass manhole	1
	Splash plate	1
	Concrete and compacted gravel base	all
Plumbing:		
	1/2 inch schedule 40 PVC pipe	30 ft.
	1 inch schedule 40 PVC pipe	10 ft.
	1/2 inch PVC 90 degree elbows	5
	1 inch PVC 90 degree elbows	2
	1/2 inch PVC tee	10
	1 inch PVC tee	1
	1/2 inch PVC caps	5
	1/2 inch PVC male adapters	6
	1/2 inch PVC couplings	2
	3/4 x 1/2 inch PVC reducers	2
	3/4 inch PVC male adapters	2
	1/4 inch clear plastic tubing	4 ft.
	PVC cleaner and solvent	1
	Teflon thread tape (roll)	1
	Tape measure scale	1
	1/2 inch ball valve	3
	1/2 inch gate valve	1
	1/2 inch hose bibs	2
	1 inch ball valve	1
	Residential water meter	1
Filter media:		
	Bagged sand	32 cubic feet
Support media:		
	Bagged torpedo sand (0.8 -2.0 mm)	3.2 cubic feet
	Bagged gravel (#10 -3/8 inch)	3.2 cubic feet
	Bagged gravel (3/8 inch - 3/4 inch)	4.2 cubic feet

I. ACQUIRING SITES FOR THE PROPOSED WATER FACILITIES

Sites and easements required include:

- Site for the slow sand treatment facility, minimum of 40 acres,
- Site for the 90 MG surface storage pond, minimum of 40 acres,
- Site for subsurface collection gallery and pumping station adjacent to the Umatilla River, probable minimum of 5 acres,
- Easements to connect each of the above sites, plus connections to the existing gravity line from the springs, to the distribution system and South Hill Reservoir(s).

Preferably, more than one site should be optioned for extensive analysis to determine which would best serve the long term interests of the City. The options should contain a clause enabling the City to: conduct soils tests for suitability of earthen embankments, and the depth to basalt rock. The soil analysis may be the deciding factor in determining a site's economic feasibility.

Consideration should also be given as to what route a transmission line from the Umatilla River may have to follow to the site. If the site is on the upper bench south of Freeway I-84, the line may have to cross railroad right of way, County Roads, and the Freeway. The railroad and Freeway crossing will require large size borings. Depending on the site, the routing might include going over nearly vertical bluffs or very long circuitous routing for an easier installation location.

Other factors that should be considered in obtaining options include:

- The proximity to the existing gravity line from the springs,
- The distance to 3 phase electrical power,
- The amount of access road required to reach the site, and
- Visibility of site to the general public to discourage vandalism.

Land acquisition can be one of the first major expenditures in the development of a water facility and should be adequately funded. If the very first major expenditure is under budgeted, it raises a question in the public's mind about the credibility of the estimates for the other proposed facilities. Some of the factors that can dramatically affect the cost of acquiring the needed sites are:

- Conducting soil tests at multiple sites,
- Appraisals and options fees for multiple sites,
- Acquiring oversized tracts to obtain a net usable and developable portion, and
- Being required to acquire an entire economic farm unit on the basis that the remaining portion would no longer be a viable economic unit. This would require land "banking".

J. CONSTRUCTION OF A SLOW SAND TREATMENT FACILITY

The location and the conditions of a treatment site will materially effect the construction costs.

A connecting line from the future treatment site to and from the existing gravity line from the City's springs is provided for in this cost estimate. Even if all of the water from the springs is transmitted via the Umatilla River to the City, the existing gravity line from the springs can serve as an alternative means of supplying the City with water in an emergency condition e.g. power outage and/or mechanical failure at the Umatilla River Pump Station.

<u>The costs for the slow sand treatment facility are premised on the following assumptions:</u>

- The site will be reasonably level,
- That little or no basalt rock excavation will be required,
- Require a relatively short access road, and
- Has three phase power reasonably close by.

<u>Included in the cost estimate are the following:</u>

- Construction of pump stations and 4 filter cells,
- Construction of recirculation pond and pump station,
- On site piping, valving, inlet and control structures,
- Monitoring & control equipment, turbidity, particle counters, chlorine residual, etc.,
- Chlorination and SCADA system structures equipped,
- Site work, fencing, grading, etc.,
- Stand by power and/or fuel powered pumping units for low head pumping,
- Construction of 1/2 mile of 30" pipe from springs gravity line to the site, and
- Construction of 1/5 +/- miles of 30" pipe from treatment site to City South Hill Reservoir, or distribution system and possible low head pump at the treatment plant.

K. CONSTRUCTION OF A 90 M.G. SURFACE POND

A pond depth of approximately 25 feet was assumed in the previous Chapter VII. The results of the soils analysis at the selected site will actually dictate the configuration of the surface dimensions.

It is assumed that at most of the sites to be considered there will be cemented gravels and basalt rock below the surface. The cost of excavation at these depths must be balanced against the net loss of stored water by evaporation for shallower depths with larger surface areas.

Allowing for some loss through a plastic type liner and Pendleton's net evaporation per year, it is estimated that approximately 4 feet of water depth/per year will be lost. This is a significant factor in determining the most cost effective geometrical shape for the surface pond. Any increase in the surface area will require a larger volume of water stored to compensate for the amount of water lost to evaporation and leakage.

It will require a reasonably level site with a limited amount of excavation of basalt rock to confine the limits of this pond to a 40 acre site.

L. A SECOND ARTIFICIAL RECHARGE/RECOVERY (ARR) WELL

This Section assumes that the ARR program at Well #1 (Byers Ave.) has proven that the ARR concept is feasible and a valuable water management tool. It is anticipated that there will always be periods of time during the winter months when the City will be in a position to store large quantities of water in the underlying basalt aquifers.

During winter and early spring periods, the City's water demands have averaged approximately 1,795 gpm (4.0 cfs/2.58 MGD) for months. The Slow Sand Water Treatment facility is designed to produce 6,373 gpm (14.2 cfs/9.17 MGD) with three of the four filters in operation. When all four filters are operating they would produce 8,498 gpm (18.93 cfs/12.24 MGD).

One single ARR well is not anticipated to be capable of accepting inflow rates of 4,578 gpm (6,373 gpm - 1,795 gpm), or 6,703 gpm (8,498 gpm - 1,795 gpm) that the filter plant would be capable of producing for recharge during the low demand months. Two, three or more ARR wells will probably be required to accept the amount that will be available for recharge. Multiple ARR wells are therefor anticipated to be necessary to significantly arrest the rate of decline in the falling water table in the City's deep wells, and maximize the amount of water that will be available for subsequent withdrawal and use during the summer months. It may even possible, the geology permitting, to "bank" water in the underground aquifers for subsequent years.

M. CONSTRUCTION OF A NEW 0.5 M.G. UPPER NORTH HILLS RESERVOIR

The existing Upper North Hills Reservoir (in the wheat field) which is an advanced stage of deterioration and is in need of being replaced as was discussed in Chapter VII.

N. DEVELOPMENT COSTS FOR DEVELOPMENTS COMMON TO TWO ALTERNATIVES

In keeping with the previous sections the costs common to both of the following alternative plans are summarized with a low and high range estimates.

	LOW	HIGH
Obtaining an ARR permit for injection only:	$ 15,000	$30,000
Convert Well #1 (Byers Ave.) to a partial ARR Well:	$ 50,000	$80,000
Testing of Well #11 (McKay/Sewage Plant):	$ 10,000	$15,000
*Development of Well #11 to an ARR & Production Well:	$ 400,000	$ 600,000
Acquisition of Land and Easements:	$ 400,000	$ 800,000
**Slow Sand Water Treatment Facility & Pilot Testing:	$ 5,500,000	$ 7,100,000
90 MG Surface Pond:	$ 4,500,000	$5,500,000
Development of a Second ARR Well:	$ 525,000	$ 675,000
Replacement of the Upper North Hill Reservoir:	$ 400,000	$ 600,000
Total Estimated Costs:	**$11,800,000**	**$15,400,000**

The following is prepared as an alternate solution if the well test at Well #11 (McKay/Sewage Plant) well indicates that the development of this source is impracticable. As recited in the prior Sections, other alternatives should be investigated prior to initiating this alternative.

ALTERNATE WATER SOURCE DEVELOPMENT:

Testing of Well #6 (Sherwood):	$ 40,000	$ 60,000
*Development of Well #6 to a production well:	$ 700,000	$ 900,000
	$ 740,000	$ 960,000

* These items include transmission piping also.

** Includes piping from treatment site to South Hill Reservoir(s)/distribution system, plus low head pumping, if required.

CHAPTER IX

A DEVELOPMENT PLAN BASED ON CURRENT STATE RULES

A. SCOPE

This Chapter presents a development plan that is in compliance with the present State of Oregon's Administrative Rules (OAR). These rules promulgated by the Oregon Water Resources Commission are administered by the Oregon Water Resources Department (OWRD).

Unless the House Bills currently under consideration by the State Legislature pass and provide some relief the City will have to consider a development plan as outlined in this Chapter, or defer any major long term improvements until the next legislature when relief can again be sought from the State.

The House Bills currently being considered by the State Legislature would provide:

- Modification of the OARs, to allow cities to relocate permits without placing the water to beneficial use or having a certificated water right. This would allow the City to relocate the **Points of Diversions** of a 1910 permit and a 1941 water right on the Umatilla River from the North Fork of the Umatilla River to a location within the City. This would eliminate the need to construct 34 +/- miles of pipeline to the City.
- Greatly streamline the water permitting process for the implementation of an artificial recharge and recovery program for Pendleton's deep wells.

[1] The existing OAR makes the cost of implementing a long term development plan prohibitive. The developments and costs presented in this Chapter are additive to those shown in the table of costs in Section N on page 15 in the previous Chapter VIII.

B. RESEARCH STRATEGY

The approach in this Chapter presumes that the City will aggressively pursue the maximum development of all of it's water permits and rights. Achieving the maximum development of the water rights and permits would require, but not limited to, the following research by legal counsel:

- An investigation to determine if the City's springs have been placed to beneficial use.
- Determining whether the City's Umatilla River and spring rights and permits POD's can be individually changed in part or whole.
- Inquire into the feasibility and legality of relocating the existing spring PODs of the upstream water rights and permits to a location on the south bank of the Umatilla River upstream of Wildhorse Creek.

[1] Subsequent to the publishing of the first draft of this Master Plan, the 1955 Oregon Legislature passed legislation enabling the City to relocate these <u>Points of Diversion</u> without requiring the City to make improvements and place the water to beneficial use at the original Points of Diversion. The cost of constructing 34 +/- miles of pipe line from the North Fork in Section E.3, page IX-6 is no longer required.

B. RESEARCH STRATEGY (Cont.)

- Determine what the position of the Oregon Water Resources Department (OWRD) and/or the Oregon Water Resources Commission (OWRC) may be as to whether the Umatilla River is a taking stream (water loss to evaporation and seepage into the river's bed) or a giving stream (receiving inflow from sides of the river's banks). Any reduction in the amount of the water rights/permits (taking stream position) may materially alter or invalidate this development strategy.

- Having legal counsel conduct an investigation and advise the City whether they should, or should not be an advocate for the declaration of a Critical Groundwater Area (CGA) for the Pendleton area. This action has risks, because it could result in the shutting down some of the City's wells, or preclude the option of improving some of the City's undeveloped but permitted wells. The most junior (recent) deep wells may have their rights/permits reduced, or completely phased out of production over a period of a few years. In the most recently declared Critical Ground Areas, "stabilization", as defined by the OWRD, means a zero lowering in the underlying water table. Legal counsel should list all of the possible consequences of a declaration of a CGA for the Pendleton area.

- Explore the feasibility of developing some of the City's permitted, but undeveloped deep wells.

- Investigate the possibility of acquiring more senior surface water and/or deep well rights and/or permits.

- Evaluate the amount of water that may be obtainable from the 1941 State Legislature's withdrawal on the North Fork of the Umatilla River and all of it's tributaries. The investigation should also include a determination as the where the POD was intended and whether the Umatilla River can be utilized as a means of conveying the water to the City proper.

C. OVERVIEW OF EXISTING SURFACE WATER RIGHTS AND PERMITS

Pages III-7 and III-8 in Chapter III, provides documentation that there were several years of high rates of decline of the water table in the Columbia River Basalt aquifers underlying the City. Unless the water table is artificially recharged during the late fall, winter and early spring seasons, when there is an abundance of surface water, the water levels will continue to fall.

Improving any of the City's undeveloped permitted deep wells will further accelerate the depletion of this resource. Therefor, the further development of deep wells as a source of additional supply should be considered only as an interim "fix", until the City can gain legislative relief that will permit the City to develop their surface water rights and permits.

C. OVERVIEW OF EXISTING SURFACE WATER RIGHTS AND PERMITS (Cont.)

The State has recently determined that the City's springs are influenced by the flows of the Umatilla River and therefor are considered as surface sources. The City's rights and permits to surface water are as shown in Table IX - 1 below:

TABLE IX - 1 SURFACE SOURCES

WATER SOURCE	PRIOR-ITY DATE	CURRENT USE IN MGD	PERMITTED RATE IN MGD	UNUSED AND/OR UNDEVELOPED RATE IN MGD
River @ City	11/11/1885	0.00	1.29	1.29
River @ City	12/31/1890	0.00	0.32	0.32
River @ N. Fork	11/12/1910	0.00	5.17	5.17
River @ N. Fork	03/08/1941	0.00	4.10*	4.10*
Wenix Springs	11/28/1910	2.17**	2.59	0.42***
Shaplish Spring	05/20/1912	1.62**	1.94	0.32***
3-Simon Springs	04/22/1929	1.46**	1.74	0.28***
Long Hair Spring	04/22/1929	0.00**	1.29	1.29***
	Totals	**5.25**	**18.44**	**13.19**

* The amount of water available from the 1941 State Legislature's withdrawal of the North Fork of the Umatilla River's drainage basin has not been quantified. To be able to portray graphically the accumulated amount of water permits and rights available to the City and assign some value to this source, we have arbitrarily and without any basis, assigned it a flow rate of 4.1 MGD. **Therefor, the totals shown in the two right hand columns may be considerably in error because of this assumption.**

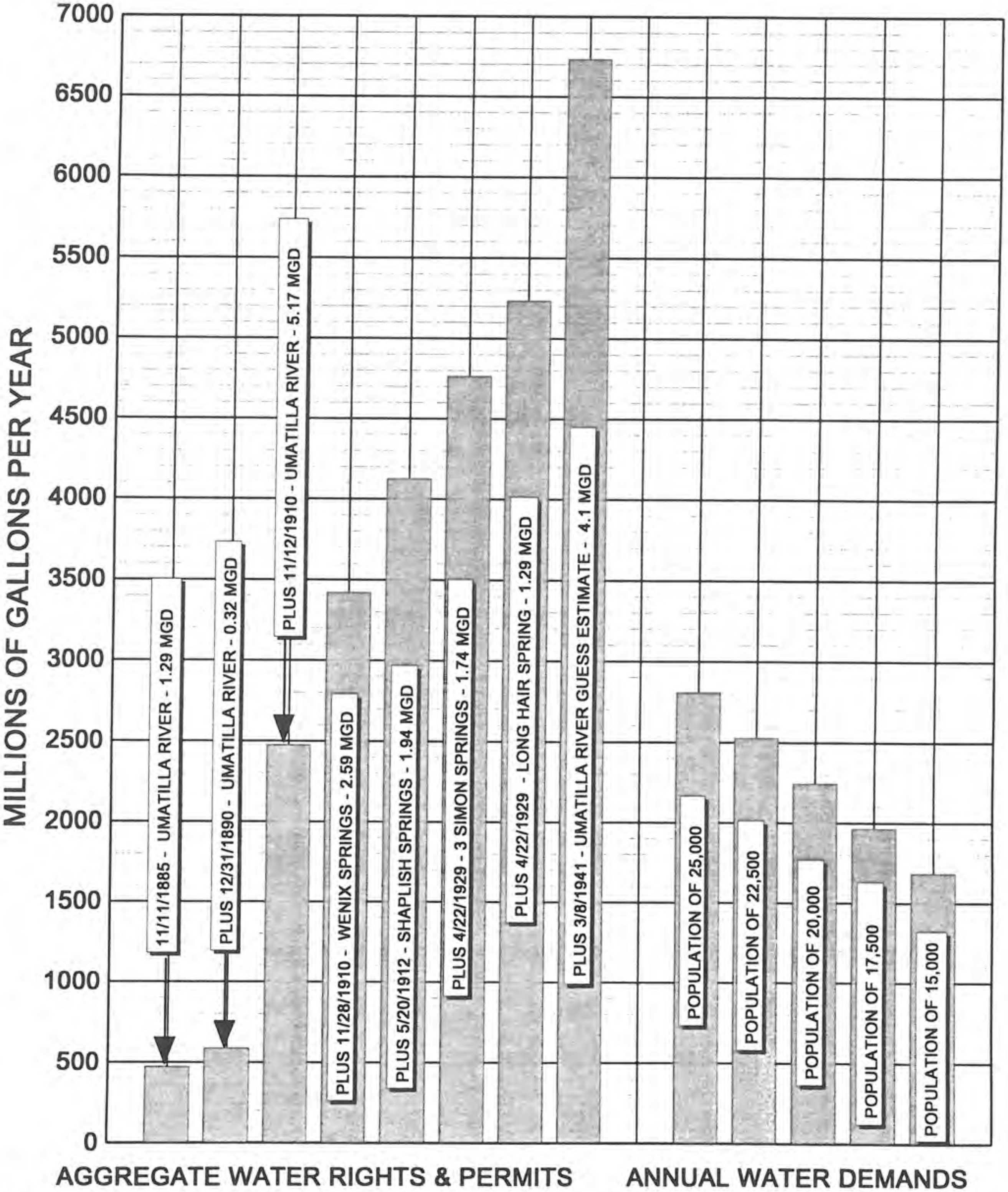
** Flows at above springs are not individually metered, and the 5.25 MGD is a limitation imposed by the line capacity of the gravity line to the City.

*** These quantities total the 2.31 MGD that the present gravity line to the City is incapable of transmitting to the City South Hills Reservoir(s). The Long Hair Springs is used intermittently. Therefor the 1.02 cfs differential (2.31 cfs - 1.29 cfs) was prorated to the other three springs were pro-rated accord with the amount of their respective water rights.

D. UMATILLA RIVER AND SPRINGS VERSUS WATER DEMANDS/POPULATIONS

On the following page IX-4 the vertical bars on the left hand side of the graph shows the permitted quantity of water for each right and/or permit. The vertical bars are cumulative, in that the base of the more junior (later) right or permit starts at the top of the prior more senior (earlier) right or permit. The annual quantities shown are premised on the full amount of the rights/permits being taken every day of the year.

UMATILLA RIVER AND SPRING SOURCES VERSUS WATER DEMAND/POPULATIONS



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D. UMATILLA RIVER AND SPRINGS VERSUS WATER DEMANDS/POPULATIONS (Cont.)

The vertical bars on the right hand side of the graph on page IX-4 depict the amount of water required for different populations. This illustrates that if all of the water from the oldest three water rights and permits (1885, 1890, & 1910), could be legally captured and stored, they could supply most of the demand of a population of 22,500 persons (2,500 million gallons).

The highest vertical bar on the left hand side of the graph indicates that the existing permits and rights total 6,734 million gallons. If the City could fully utilize all their water rights and permits, store and recapture same without any loss, this amount of water could satisfy the needs of a population of 60,000 persons (based on an annual average per capita demand of 307.5 gallons per day).

The City's water rights and permits, however, are subject to more senior water rights. The ability of the City to exercise their water rights and permits will also depend on the flow in the river, which varies with the climate and snow pack. The data and factors that need to be collected and evaluated prior to determining an annual estimated quantity of water available to the City are:

- The quantity of water flowing out of the North Fork basin on a daily and annual basis. This information will be utilized to determine the quantity of water that may be available to the City from it's 1910 water permit and the withdrawal of the North Fork basin by the Oregon State Legislature in 1941.

- The effect that the more senior permits and rights have on the City's water rights and permits. This information can probably best be developed by working with the staff of the local Watermaster. Of particular interest would be the times of the year that these more senior rights would impinge on the City's water rights and permits.

- Explore a Basin Plan Agreement with other entities, whereby the City could agree to forgo the use of their water rights and permits during periods of critical river flow in exchange for larger quantities during times of abundant stream flow.

E. ADVANTAGES AND DISADVANTAGES OF EACH WATER SOURCE

A brief commentary is presented about the attributes of each source as to the advantages and disadvantages that each possesses. The most senior (oldest) rights and permits in this Section are presented first.

<u>E.1 UMATILLA RIVER WATER RIGHT - PRIORITY DATE OF 11/11/ 1885 - 2.0 CFS</u>

This water rights point of diversion is located in Pendleton on the south bank of the Umatilla River in the vicinity of the easterly railroad bridge across the Umatilla River.

E. ADVANTAGES AND DISADVANTAGES OF EACH WATER SOURCE (Cont.)

E.2 UMATILLA RIVER WATER RIGHT - PRIORITY DATE OF 12/31/ 1890 - 0.5 CFS

This water right was obtained by the City through a transfer from a private individual. The water right was for irrigation, stock and domestic use at the Round Up Grounds. Based on preliminary and unofficial discussions with some of the staff at the OWRD, it seems that a case can be made that the transfer to the City, was in effect a transfer which included a change in the type of use.

The point of diversion is not specified and may very well have been the same as the above 1885 water right due to the close historic association of the City and the Round Up Grounds. For the purpose of this report, the assumption is that the point of diversion is the same as the 1885 water right.

E.3 UMATILLA RIVER WATER PERMIT - PRIORITY DATE OF 11/12/ 1910 - 8.0 CFS

The point of diversion for this permit is the North Fork of the Umatilla River. Under current Oregon Revised Statutes and Oregon Administrative Rules, the City would be required to:

- Pipe this water 34 +/- miles from this point of diversion to the City, or
- Construct some kind of improvement at the North Fork of the Umatilla River that could be construed as putting this permit to a beneficial use. It is unlikely that just a minimal improvement at this location would be acceptable to the OWRD.

Based on discussions with the staffs of the Oregon Department of Fish and Wildlife, OWRD and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), it appears that each group would support the City obtaining a change in the location of the point of diversion to a location within the City Limits.

Any change in location of the point of diversion should be made without any sacrifice in the 8.0 cfs (3,590 gpm/5.17 MGD) stated in the permit because of evaporation or seepage into the bed of the stream during transport.

E.4 CITY'S SPRINGS WATER RIGHTS - PRIORITY DATES OF 1910 TO 1929 - 11.7 CFS

The Oregon Health Division has determined that the City's springs are under the influence of the Umatilla River. Permits cite for the springs cite that they are a tributary of the Umatilla River. Some of the OWRD staff are of the opinion that the springs priority dates are no different than the other water rights and permits on the Umatilla River. Each of the City's four springs have points of diversion near each spring.

E.4 CITY'S SPRINGS WATER RIGHTS - PRIORITY DATES OF 1910/ 1929 - 11.7 CFS (Cont)

There are conflicting claims to the jurisdiction over the water rights of the waters on the Umatilla Indian Reservation between the CTUIR and the OWRD. Preliminary discussions with the CTUIR and the OWRD indicate that the determination of jurisdiction may not be resolved for another five (5) to twenty (20) years. The priority dates and amounts of the individual permits are shown in Table IX-1 on page IX-3.

The raw water quality (turbidity) imposes a more significant limitation on the use of this source than that of the gravity pipeline (5.25 MGD). This is because raw water can not be used for extended periods of time for direct municipal use and/or artificial recharge. Federal and state regulations have lowered the allowable amount of turbidity in water to qualify as potable and suitable for human consumption. The higher the turbidity the more difficult it is for a disinfectant such as chlorine to kill any pathogens and viruses present in the water.

Failure of the spring sources time to meet the new turbidity requirements, has resulted in a dramatic reduction in the use of the City's springs and a corresponding reliance on the City's deep wells. The graph on the following page IX-8 shows the diminishing use of the City's springs and the increased reliance on the deep wells to meet water demands.

During the late spring, summer, and early fall periods, the maximum yield from the springs can be as low as 2.0 MGD (1,389 gpm/3.1 cfs). Preliminary observations made during this study indicate that during the late spring, summer and early fall periods that the yield from the springs could be increased by the lowering of the collector pipes and/or the placement of additional collector pipes. This may require trenching down into the bedrock to capture all of the water above the bedrock.

Since all of the springs have been placed to beneficial use, they may by the OWRD's administrative rules, have all or part(s) of their points of diversion (PODs) transferred to a point downstream to the City. The question as to whether the CTUIR or the OWRD has jurisdiction and authority over changes in the PODs needs to be resolved.

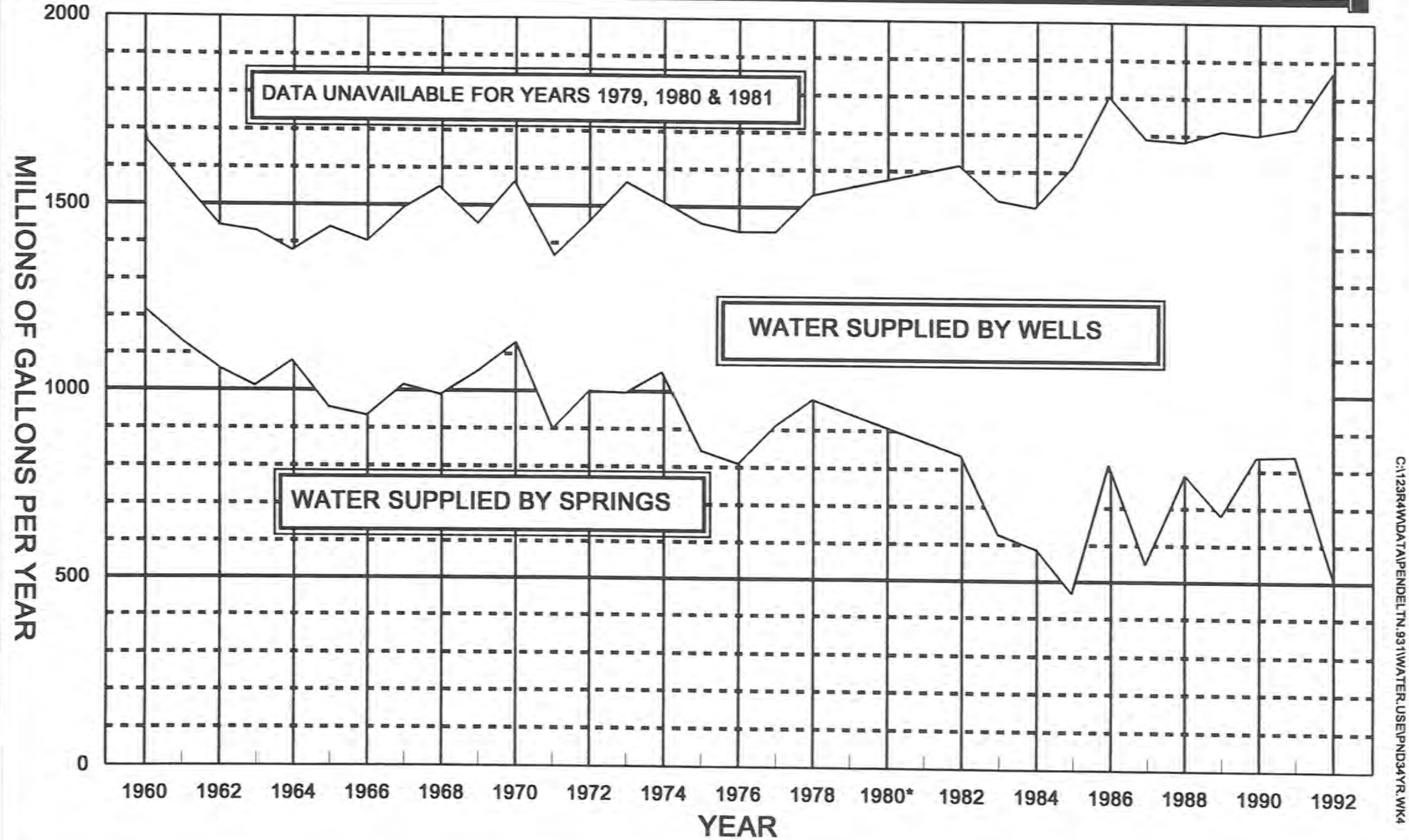
E.5 UMATILLA RIVER WITHDRAWAL - PRIORITY DATE OF 3/8/1941 - ASSUMED 4.1 MGD

The Oregon State Legislature withdrew from future appropriation all water rights of the North Fork of the Umatilla River after March 8, 1941. This withdrawal however is subject to all senior water rights and permits on the Umatilla River.

Several years ago, the federal government set aside the North Fork's watershed as a wilderness area. The constraints that this designation places on the development of these water rights and permits must to be explicitly defined.

As stated in Section C above, a flow rate of 4.1 MGD was arbitrarily assigned to this legislative withdrawal. The assumed 4.1 MGD shall be adjusted after additional research on stream flows and water rights has been developed.

PENDLETON'S SPRING WATER SOURCES VS. TOTAL WATER DEMAND



F. PRIORITIZING DEVELOPMENT OF THE CITY'S RIVER AND SPRING SOURCES

Water rights and permits with the oldest priority dates provide for the securest investment of the City's financial resources. The more recent the water right/permit, the higher is the risk of usage limitations being placed on those sources. The recommended priority for development of water sources are the same as set forth in Table IX-1 on page IX-3, except for the 1910 permit, which would be last because of the expense of 34 mile long transmission line required.

G. DEVELOPMENT OF THE CITY'S SPRINGS

Under present OAR the springs are the only source of a large replinishable supply economically feasible to develop.

Prior to performing any of the work in this Section, the advice of legal counsel should be sought on the present status of the City's springs and what options are available on their future use, e.g. changing of points of diversion. Much of the work and activities set forth in this Section may not be required.

The City Engineering Department has records on the City's springs and the gravity line from the springs to the City. There is an extensive, but very abbreviated as to identification, listing of these records.

Prior to any field investigation of the existing improvements at the City's springs, these records need to be cataloged in more detail, with cross referencing by date and subject matter. Upon completion of detailed cataloging, the material should be reviewed for conflicts, and appropriate commentaries noted in the catalog compilation. This effort will be more than compensated for from savings during the exploratory work in the field.

There is no visible field evidence of the observation wells shown on the City's drawings for the Wenix springs. There may be some documentation on the physical materials used to construct these observation wells. The depth (to rock or not), and whether these pipes are perforated or not is unknown. If such documentation can not be found, they may be located in the field by scaling their location relative to other prominent features (e.g. County Road, railroad tracks, manholes, etc.) on the existing drawings. These observation wells may be able to provide considerable information about the depth of the collector lines, the depth to rock, the water table height, etc.

Additional field investigations will be required to determine the feasibility of constructing new collector lines in trenches down in the bedrock to maximize the collection of water from the City's springs sources. There appears to be an opportunity to increase the amount of water captured at the springs by lowering of the collector pipes (perforated or slotted) down into the bedrock in a bed of filter gravel. A system of this type should be able to entrap almost all of the water flowing above the bedrock and hopefully greatly enhance the yield from these sources. Under the current OAR's this work may be necessary to qualify the water rights points of diversion for relocation downstream to the City proper.

G.1 TELEVISING THE SPRING'S PIPING SYSTEM

A cursory review of some of the old record drawings for the collector and transmission lines at the City's springs revealed some conflicting information. Televising of the collector and transmission lines should be considered, if it is deemed necessary to physically locate and determine what actually exists in the field. Televising is one of the most economical means of verifying these old records and confirm the existence, location, size and condition of the lines. The televising would also provide the following information:

- Where the most productive yields of water are, and
- Where the least productive or dry areas are,
- The location of any collapsed lines that may need repair or reconstruction to allow the televising to continue, and
- The existence of any deep rooted growth impeding the water yield.

The collector and main supply lines for the springs consist of a variety of materials and sizes. The piping at each of the springs and the common transmission line includes newer lines, older lines (excluding abandoned) collection lines and main supply lines of the following estimated lengths:

Wenix Springs	6,765 ft.	
Three Simon Springs	3,585 ft.	
Shaplish Springs	10,770 ft.	
Long Hair/Squaw Creek	2,660 ft.	
Total	23,780 ft.	or 4.5 miles

The most economical method of determining the depths to the surface of the underlying basalt rock is by seismic methods. This is accomplished by digging a few pits to the underlying rock for calibration and verification of the data recorded by the seismic equipment. The amount of the area to be mapped will be somewhat dependent upon the initial data, which will provide some basis for how much of the area should be mapped.

G.2 PIPING IMPROVEMENTS AT AND FROM THE CITY'S SPRING SOURCES

Burying new collector piping down into the basalt bed rock to maximize the yields, may require the construction of a low head high capacity pumping station at the springs to lift the water up into the existing gravity line, or the installation of a larger collector trunk line. As a major source of water for the City, it is proposed to equip this pumping station with auxiliary power, if required, to assure a firm supply of water.

It is anticipated the flows from the springs will be substantially increased as a result of laying the new collector lines down into the bed rock. These new lines laid at deeper depths may render the existing lines useless.

G.2 PIPING IMPROVEMENTS AT AND FROM THE CITY'S SPRING SOURCES (Cont.)

Trench excavation is anticipated to exceed depths of 20 feet to bury new collector lines down into the bed rock. The gravelly soils from the surface down to the bed rock will result in very wide trenches at the surface. Bull dozing of the upper part of the trench may be required to permit excavators to reach the desired depths into the bedrock.

Each collector pipe size would be based on the amount of flow it is anticipated to carry and the slope to which it is laid. Lacking site specific information, the cost estimate will be based on a minimum pipe size of 12", to a maximum size of 36" for collector and transmission lines.

To minimize capitol costs for piping and pumping, it is proposed to continue to utilize the existing gravity pipe line to transmit 5.25 MGD (3,646 gpm/8.12 cfs) from the springs to the City.

The 2.31 MGD (1,604 gpm/3.58 cfs) of water rights at the springs that the existing gravity line is incapable of transmitting is proposed to be conveyed to the City via the Umatilla River. By using the existing bypass line, this will again minimize capital costs. If it is possible to relocate their points of diversion, the 2.31 MGD could come out of the Three Simon and the Long Hair Springs water rights which total 3.03 MGD (2,104 gpm/4.7 cfs).

Another option the City may wish to consider is to utilize only 4.65 MGD (3,229 gpm/7.20 cfs) of the 5.25 MGD (3,646 gpm/8.12 cfs) capacity available in the existing gravity line. This would reserve 0.6 MGD (41 gpm/0.93 cfs) of line capacity to receive water from Well #7 (Mission Well). With this option, 2.91 MGD (2,020 gpm/4.5 cfs) would then come out of the Three Simon and the Long Hair Springs and be transmitted to the City via the Umatilla River.

The continued use of the existing gravity line will eliminate the cost of pumping the 5.25 MGD of water from an intake on the Umatilla River in the City, to the proposed Slow Sand treatment facility, located on the City's upper south bench. The existing gravity line is the only piping from the springs required for conveying of water to the City.

The Cost for developing the spring sources includes:

- Seismic testing at the springs to determine the depth to rock.
- Televising the 4.5 miles of pipe lines and digging of access and inspection pits.
- Surveying and mapping of spring facilities.
- Digging down into the basalt rock for the placement of the collector pipes and transmission lines.
- Construction of a low head, high yield pump station with bypass piping and automated controls.

H. DEVELOPMENT OF THE UMATILLA NORTH FORK 1910 WATER PERMIT

The development of this 5.17 MGD (3,590 gpm/8.0 cfs) water source will be required to meet the average annual demand of 2,516,529,000 gallons for a population of 20,000 persons (see page VII-2). The reasoning for this is as follows:

- Even with the lowering the collector piping at the City's springs, there will be periods when the regional water table will probably be to low to yield the aggregate amount of water rights of the four springs, and/or
- Senior water rights/permits may at times limit the production of water from the City's springs, and
- The additional supply from the North Fork will need to be "banked" in the Columbia River Basalt aquifers for withdrawal during the high summer demand months.

I. DEVELOPING THE 1941 UMATILLA RIVER NORTH FORK BASIN WITHDRAWAL

Both the 1941 water withdrawal of the North Fork Drainage Basin and the Umatilla River Permit with a priority date of 1910, have their POD's at the same general location. With the PODs some 34 miles distant from the City, it would be impracticable to construct two smaller transmission lines to convey the water to the City. Therefor, these two sources shall be considered as a single source in determining their development cost and for the transmission piping to the City.

Water rights and permits senior to the City's permit and right, need to be identified and evaluated. Specifically how senior rights may be impinge on the City's rights/permits at different times of the year needs to be quantified. The State's Legislatures 1941 withdrawal is a very junior source and may in some years provide little if any supply, and conversely in some years might provide the City with large quantities over short periods of time. With the limited amount of a replenishable source available, it is in the City's best interest to maximize the utilization of their water rights and permits, and store the surplus water in the times of abundance for use in the high demand periods.

To recognize this as a source, some quantity had to be given to it. An arbitrary maximum amount of 4.1 MGD (2,847 gpm/6.34 cfs) was assigned to this source. With this assumed quantity and the 5.17 MGD (3,590 gpm/8.0 cfs) in the 1910 permit, the combined quantity of these sources is 9.27 MGD (6,437 gpm/14.34 cfs).

The assumption is made that the 1910 and 1941 North Fork rights and permit can have a common point of diversion. At the point of diversion, there will need to be some type of headworks constructed to measure the flow in the stream to enable the City to divert only the amount it is legally entitled to. This will also require an extension of the Supervisory Control and Data Acquisition (SCADA) control system to monitor the flow at the headworks.

I. DEVELOPING THE 1941 UMATILLA RIVER NORTH FORK BASIN WITHDRAWAL (Cont.)

A 24" diameter transmission line will accommodate a flow of 9.27 MGD (6,437 gpm/14.34 cfs) at a velocity of 4.6 feet per second. However, as stated before, the amount of flow available from the North Fork is an assumed figure without any basis in fact. The cost estimate will therefor be predicated on the next larger sized diameter of 30". The routing of the transmission pipeline is proposed to follow the course of the Umatilla River.

This routing of the pipeline will probably entail county road, railroad and river crossings, plus in narrow valley floor areas, the removal and replacement of paved portions of the county road.

J. CONSTRUCTION OF A RIVER INTAKE AND PUMPING STATION AT PENDLETON

The proposed location of the river intake is on the south bank of the Umatilla River and above the confluence of Wildhorse Creek. This location was selected because it is close to the original 1885 water right, and avoids the highly turbid water which flows out of Wildhorse Creek during localized storms. The amount of water required to be pumped includes the following sources and quantities:

	MGD	GPM	CFS
The November 11, 1885 water right at Pendleton	1.29	898	2.0
The December 31, 1890 water right at Pendleton	0.32	222	0.5
From the springs the additional available rights	2.31	1,604	3.57
Total pumping capacity	3.92	2,724	6.07

The initial pumping system would have pumps sized to pump the above amounts.

However, the building and all the piping would be sized to accommodate the additional 5.25 MGD (3,646 gpm/8.12 cfs) from the springs. This would provide for the possible future abandonment of the gravity line from the springs, whenever it may be deemed to be to costly to maintain. Thirty (30") diameter size piping into and out of the pumping station would be designed to handle the following maximum flows:

MGD	GPM	CFS
9.17	6,370	14.19

The river intake is planned to be a buried pipe gallery system paralleling the Umatilla River with some cross piping to let the underlying gravels do the preliminary screening. The underground gallery system would probably consist of 8 or more perforated, 12" diameter or larger pipes, 200' to 400' feet long (with cross piping) to be capable of collecting 6,370 gpm or more. Similar to the recommended construction at the City's springs, these perforated collectors would be buried down into the bedrock, with specialized filter rock under and over the pipe and wrapped in a geotextile for additional screening.

K. TRANSMISSION LINE FROM PUMP STATION TO 90 MG STORAGE POND

The construction of a transmission line from an unknown location of a Umatilla River for a river Intake and Booster Pumping Station, to an unspecified location for a 90 MG settling/storage pond at the treatment site, over an unspecified route makes cost estimating very difficult. The route for the pipeline may cross: a railroad, city streets, county roads highways and the freeway depending on site selections. Crossings at a railroad and/or freeway will require borings, an expensive operation.

L. WATER RIGHT INVESTIGATIONS, LEGAL SERVICES AND AGENCY INTERFACE

The cost for performing these services will vary depending on the plan, or parts of the two different plans, selected for development of the water sources. It is likely that the plan outlined in this Chapter will encounter a considerable amount of opposition from several entities and result in increased costs over the plan in Chapter X. If the opposition becomes highly contentious and litigious, the estimated cost ranges could be greatly exceeded.

The cost of investigating the existing senior water rights, their status and use patterns, for their effect on the City's water rights and permits are at best "guesstimates". In addition there will be special reports required by State Agencies and the retaining of legal counsel with expertise in water rights.

M. DEVELOPMENT COST RANGES IN ACCORD WITH THE STATE'S CURRENT RULES

The cost summary in this Section includes the Costs developed in Chapter VIII, Section N, on page VIII-15 and are incorporated in Table IX - 2 below.

TABLE IX - 2

DEVELOPMENT COST RANGES IN ACCORD WITH THE STATE'S CURRENT RULES

From Chapter VIII: Costs Common to Both of the Alternative Plans Chapters IX and X	$ 11,800,000	$ 15,400,000
Costs this Chapter:		
Springs - Exploratory plus Development	$ 2,000,000	$ 3,700,000
Transmission Line - North Fork to City	$ 18,700,000	$ 20,300,000
River Intake and Booster Pumping Station	$ 800,000	$ 1,200,000
Pipeline - Pump Station to 90 MG Pond	$ 1,400,000	$ 1,900,000
Water Rights, Legal, agency interface	$ 300,000	$ 500,000
Estimated Cost Range	**$ 35,000,000**	**$ 43,000,000**

CHAPTER X

THE RECOMMENDED DEVELOPMENT PLAN

A. SCOPE

This Chapter is premised on:

- The development of a plan that will be beneficial and acceptable to all entities in the Upper Umatilla River Basin (above Pendleton).

- The City achieving the maximum potential from their existing rights and permits. This, as a practical matter would probably be limited to negotiations with the principal major users of water from the Umatilla River. One such approach, would be the City agreeing to not utilize some of their older water rights/permits during the summer and other critically low flow river periods in exchange for a larger amount during the times when there is an abundance of stream flow in the river.

- Establishment of a hearings process to provide for dissemination of the plan and obtaining public input. There are too many individual holders of water rights to try to contact them individually and gain universal approval.

- That the Oregon Revised Statutes (ORS) and/or the Oregon Administrative Rules (OAR) being be amended to enable the City's relocating their point of diversion (POD) for water rights/permits on the Umatilla River. The most distant points of diversion are approximately 34 miles upstream from the City. A precedent has been established by the recent exchange of water rights on the lower Umatilla River.

- The south bank of the Umatilla River upstream from Wildhorse Creek is the recommended new point of diversion for all or some of the upstream water rights/permits.

Even if all of the entities in the Upper Umatilla River Basin support a City sponsored development plan, this does not necessarily preclude other groups from raising objections and initiating litigation to thwart the implementation of the plan.

The developments and costs presented in this Chapter are additive to those in Chapter VIII.

B. DEVELOPMENT PLAN STRATEGY

From a review of the water rights and permits of record, the City should identify entities impacted by this plan and encourage their support for a basin plan that will maximize the beneficial use of the City's water rights and permits without impairing the others. However, the City's first step should be to have their legal council perform the following research and investigations:

- Confirm that the City's springs having been placed to beneficial use, and are capable of having their Points of Diversion (POD) changed, and

- Investigate the ability of changing the POD's for all or parts of the City's springs rights/permits to a location inside the City Limits upstream of Wildhorse Creek via the Umatilla River.

- Inquire into the status and ramifications of the State legislation that is currently in process, which may allow the City to change their points of diversion without having to have placed the water to beneficial use or certificated as a water right. Of particular interest is the question of whether or not there would be any reduction in the rates or quantities for the Umatilla North Fork Water Rights (1910 water permit the 1941 legislative withdrawal). Unless this is addressed in the new legislation, the Oregon Water Resources Department (OWRD) and/or the Oregon Water Resources Commission (OWRC) may take the position that the Umatilla River is a taking stream (water loss to evaporation and seepage into the river's bed) versus a giving stream. Any reduction in the amount of the water rights/permits may materially alter or invalidate the development strategy proposed in this Chapter.

- Gaining the support of the Oregon Department Fish and Wildlife (ODFW). The ODFW has a water right with a priority date of February 1, 1989 with the following minimum stream flows:

Period	Flows in cubic feet per second cfs	Flows in millions of gals./day MGD	Flows in gallons per minute gpm
October 1st to January 31st	200	129.254	89,760
February 1st to May 31st	240	155.105	107,712
June 1st to June 30th	200	129.254	89,760
July 1st to July 31st	100	64.627	44,880
August 1st to September 30th	60	38.776	26,928

Senior water rights, prior to the November 12, 1910 [City water permit #458 for 5.17 MGD (3,590 gpm/8.0 cfs)], would be another significant group to identify and cooperate with. Prior large rights of record, includes: downstream irrigation districts, the US Bureau of Reclamation and some farms.

B. DEVELOPMENT PLAN STRATEGY (Cont.)

This development plan is based on developing the Umatilla River and the spring sources as the primary water supply. However, it is also essential that the City know it's relative position as a holder of water rights and permits for its deep wells as a secondary source of water.

Parallel with the efforts to develop the best possible plan to maximize the river and spring sources, the City should seek the advice of legal counsel on whether the City should be an advocate for the declaration of a Critical Groundwater Area (CGA) for the Pendleton area. This is a little like playing "chicken", because it could result in shutting down of the most junior deep wells until the groundwater table is stabilized.

In the most recently declared Critical Ground Areas, stabilization as defined by the OWRD means a zero lowering of the underlying water table. It would be advisable for the City to be fully apprised of the possible consequences if the OWRD and/or OWRC determined to declare a CGA for the Pendleton area.

If the City has sufficient senior rights and permits, it may be able to continue to utilize these sources after a CGA has been declared. The City may be entitled to receive some, if not most, of the natural recharge that is occurring in the underground reservoir. If this were the case, it would reduce the amount of development required of the river and spring sources.

C. DEVELOPMENT OF SURFACE WATER FOR DEMAND AND STORAGE

This plan is premised on maximizing the use of the Umatilla River and spring sources for meeting normal demands, plus storing treated water in the underground basalt aquifers for later withdrawal during periods of high seasonal demand. The principal objectives of artificial recharge and recovery (ARR) program of injecting water into the underlying basalt aquifer is to:

- Retard the rate of decline of the water table,
- Arrest the decline, or
- Raise the level of the water table for long term storage.

The level of the water table in the deep wells will continue to fall, unless they are artificially recharged during the late fall, winter and early spring seasons when there is an abundance of surface water that can be treated and artificially injected through an existing or new wells.

C. DEVELOPMENT OF SURFACE WATER FOR DEMAND AND STORAGE (Cont.)

To demonstrate a relationship between the water available from the City's surface water sources and the projected demands for different populations, it was necessary to make some assumptions about the improvements that will be made and the **diminished quantities that may be actually available from the existing spring and river sources**.

- Each source will be improved to yield the maximum amount of water allowed by the water right and/or permit.
- CTUIR's claims on the amount of water, priority dates, and terms that may result from the adjudication are all unknown and not included in this analysis.
- Research has not been performed on the usage patterns (time) of water for different crops by the holders of more senior water rights.
- That some of the very old water rights that are shown on the Oregon Department of Water Resources computer print out may no longer be valid. Some of these water rights may have lapsed because of non use for the previous 5 years.
- To be consistent with the prior Chapter, we have again arbitrarily and without any basis, assigned an available flow rate of 4.1 MGD for the 1941 withdrawal by the State Legislature of all of the North Fork of the Umatilla Rivers drainage basin.

The permitted flow rates as shown on each of the water rights and permit, the amount of production available if the permitted amounts were available all of the time, and an assumed percent of the permitted rate available on an annualized basis for the average year, is shown in Table X - 1 below.

TABLE X -1

FLOW RATE ADJUSTMENTS TO SURFACE SOURCES

WATER SOURCE	PRIOR-ITY DATE	AMOUNT OF PERMIT RATE IN CFS	PERMITTED ANNUAL QUANTITY AMOUNT IN MILLIONS GAL./YR.	THE PERMITTED ASSUMED AVERAGE ANNUAL AMOUNT AVAILABLE IN %
River @ City	11/11/1885	2.00	472	100
River @ City	12/31/1890	0.50	118	75
River @ N. Fork	11/12/1910	8.00	1,887	75
Wenix Springs	11/28/1910	4.00	944	75
Shaplish Spring	05/20/1912	3.00	708	67
3-Simon Springs	04/22/1929	2.70	637	50
Long Hair Spring	04/22/1929	2.00	472	50
*River @ N. Fork	03/08/1941	6.34	1,496	30
	Totals	26.34	6,734	

* Amount of rate assumed as stated elsewhere in this report.

C. DEVELOPMENT OF SURFACE WATER FOR DEMAND AND STORAGE (Cont.)

Based on the assumptions in Table X - 1 on the previous page, the assumed effective annual quantity of water that may be available from each source is shown in Table X - 2 below.

TABLE X - 2

ASSUMED ANNUAL QUANTITY FROM EACH SURFACE SOURCE

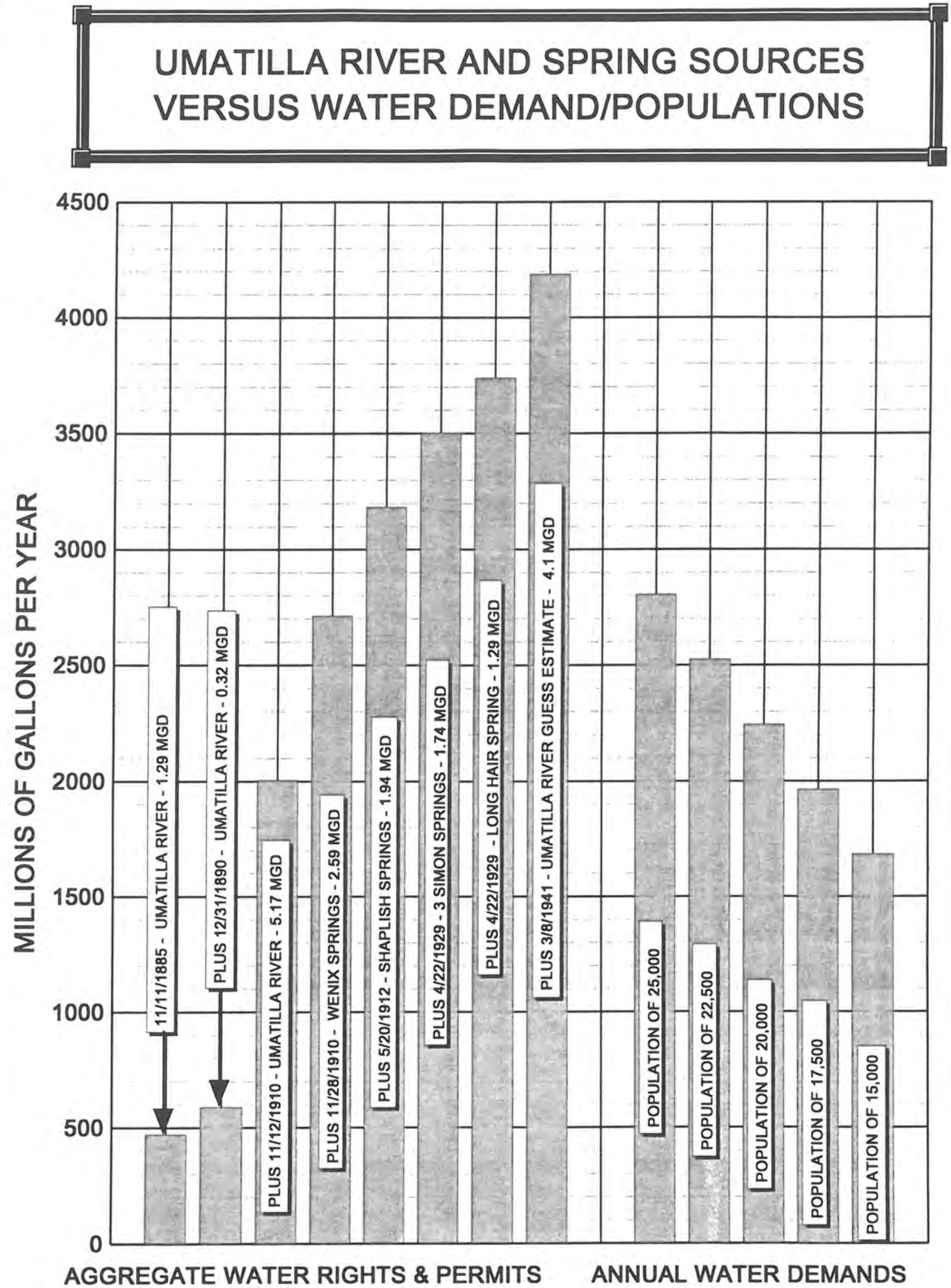
WATER SOURCE	PRIOR-ITY DATE	IN 1,000s OF AC.FT.	IN 1,000,000s OF GALLONS
River @ City	11/11/1885	1,448	472
River @ City	12/31/1890	362	118
River @ N. Fork	11/12/1910	4,344	1,415
Wenix Springs	11/28/1910	2,172	708
Shaplish Spring	05/20/1912	1,448	472
3-Simon Springs	04/22/1929	977	318
Long Hair Spring	04/22/1929	724	236
River @ N. Fork	03/08/1941	1,381	450
	Totals	**12,856**	**4,189**

D. UMATILLA RIVER AND SPRINGS VERSUS WATER DEMANDS/POPULATIONS

On the following page is a graph based on the data in Tables X - 1 and X - 2. This graph is based on the assumed full and diminished yields to give some indication about the ability of the current water rights and permits to meet future projected water demands.

Shown on the left hand side of this graph is the amount of water that each right and permit is assumed capable of providing on an annual basis. The graphical bars are cumulative, in that the base of the more junior (later) right or permit starts at the top of the prior more senior (earlier) right or permit. Water demands for different populations are depicted on the right side of the graph on the next page. This illustrates that the water from the oldest three water rights and permit (1885, 1890, 1910 rights and 1910 permit), could be legally captured and stored (without any loss), they could supply enough water (2,713 million gallons) to meet the demands of a population of 24,172 persons (based on 307.5 gallons per/capita/day average). The graph further shows that the yields from all of these sources could provide 4,189million gallons of water per year, sufficient for a population of 37,323.

An extensive analysis was made of the daily flows in the Umatilla River over the last 19 years. The objective of the analysis was to evaluate the impact of the City not exercising some of the it's older water rights/permits during the low periods of stream flow. A summary of this analysis is shown on page X-7 for when the City would withdraw water only when the minimum stream flows were above either 200, 300, 400, 500 and 600 cfs. This summary at the bottom of the page shows the potential adverse impact the City could bear for the different river flows. The City would need to have an offsetting amount of additional water, to justify the surrendering of the use of these rights/permits. The City should vigorously defend its quantitative rights in any negotiations with other entities.



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UMATILLA RIVER AS A WATER SOURCE

FLOW DATA BASED ON USGS RIVER GAGE STATION #14201000
RIVER GAGING STATION WAS LOCATED AT PENDLETON
COMPLETE YEARS OF RECORD ARE FROM 1936 TO 1988

CITY'S WATER RIGHTS ON THE UMATILLA RIVER:

DATE	AMOUNT IN CFS	CERTIFICATE NUMBER	POINT OF DIVERSION
11/11/1885	2.0	D2604	CITY OF PENDLETON
12/31/1890	0.5	D2582	CITY OF PENDLETON
11/12/1910	8.0	458	APPROX. 450' UPSTREAM OF THE NORTH FORK

ANNUAL AMOUNT OF WATER AVAILABLE FROM THE ABOVE THREE SOURCES = 2,476 MG OR 7,602 AC. FT.

THE AMOUNT OF WATER AVAILABLE FROM THE ABOVE CITY'S 10.5 CFS OF WATER RIGHTS & PERMIT IF THE CITY AGREED WITH OTHERS TO ONLY TAKE WATER AT THE FOLLOWING MINIMUM STREAM FLOWS:

YEAR	UMATILLA RIVER FLOW RANGE ABOVE 200 CFS YIELDS ANNUAL CAPTURE IN M.G. FROM RIVER	UMATILLA RIVER FLOW RANGE ABOVE 300 CFS YIELDS ANNUAL CAPTURE IN M.G. FROM RIVER	UMATILLA RIVER FLOW RANGE ABOVE 400 CFS YIELDS ANNUAL CAPTURE IN M.G. FROM RIVER	UMATILLA RIVER FLOW RANGE ABOVE 500 CFS YIELDS ANNUAL CAPTURE IN M.G. FROM RIVER	UMATILLA RIVER FLOW RANGE ABOVE 600 CFS YIELDS ANNUAL CAPTURE IN M.G. FROM RIVER
1970	1,409	1,266	1,181	1,111	997
1971	1,512	1,364	1,293	1,210	1,014
1972	1,255	1,201	1,140	1,042	926
1973	1,267	1,084	743	499	355
1974	1,355	1,259	1,194	1,154	1,115
1975	1,460	1,326	1,258	1,183	1,120
1976	1,188	1,107	1,025	927	814
1977	927	718	572	430	351
1978	1,209	1,108	1,004	918	817
1979	1,111	917	818	774	740
1980	1,335	1,149	964	875	746
1981	1,393	1,176	998	803	658
1982	1,501	1,280	1,144	1,031	943
1983	1,252	1,107	1,052	942	835
1984	1,628	1,526	1,381	1,241	1,093
1985	1,189	896	821	705	638
1986	1,235	1,124	986	791	679
1987	796	699	692	651	572
1988	1,265	979	804	612	544
MAXIMUM YEAR	1,628	1,526	1,381	1,241	1,120
MINIMUM YEAR	796	699	572	430	351
AVERAGE YEAR	1,278	1,120	1,004	889	787
	PNFLO200.WK4	PNFLOW300.WK4	PN78FLOW.WK4	PNFLO500.WK4	PNFLO600.WK4

SUMMARY:

AMOUNT OF WATER THAT THE CITY WOULD BE UNABLE TO OBTAIN FROM THE RIVER FOR THE: MAXIMUM, MINIMUM, AND AVERAGE YEARS OF THE 2,476 MG IN THE CITY'S RIGHTS/PERMIT IS SHOWN BELOW FOR THE DIFFERENT MINIMUM STREAM FLOWS SHOWN ABOVE.

MAXIMUM YEAR	(848)	(950)	(1,095)	(1,235)	(1,356)
MINIMUM YEAR	(1,680)	(1,777)	(1,904)	(2,046)	(2,125)
AVERAGE YEAR	(1,198)	(1,356)	(1,472)	(1,587)	(1,689)

PN78VALU.WK4 FROM PNFLO1.WK4 CONVERTED TO VALUES.

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E. IMPROVEMENTS REQUIRED FOR THE RECOMMENDED DEVELOPMENT PLAN

E.1 CHANGES IN POINTS OF DIVERSION

The improvements required in this Section are predicated upon a development plan for the mutual benefit of water right holders in the Upper Umatilla River Basin. The improvements in this Section are based on the premise that all of the City's water rights and permits will be consolidated to a single location inside the City Limits upstream of Wildhorse Creek. The needed changes to the existing water rights and permits for this plan are as follows:

- The Umatilla River water permit at the North Fork for 5.17 mgd (3,590 gpm/8.0 cfs) with a priority date of November 12, 1910 will have it's point of diversion changed from the North Fork to a location on the south bank of the river inside the City Limits upstream of Wildhorse Creek.

  The point of diversion would be in the same general location as the City's original 1885 water right for 1.29 MGD (898 gpm /2.0 cfs) and probably also the location of the City's 1990 water right for 0.32 MGD (224 gpm/0.5 cfs)

- The flow from the City's four springs with a combined water right of 7.56 MGD (5,251 gpm/11.7 cfs) would likewise be diverted to the Umatilla River and the points of diversion moved to the same general location as the original 1885 water right.

  This is the second element of the development plan to enhance the stream flows in the river during periods when the City is entitled to utilize their water rights. Recognizing that the City would be faced with the additional energy costs of pumping 5.25 MGD (3,646 gpm/8.12 cfs) that formerly flowed by gravity to the South Hill Reservoir(s) should provide a basis for a consideration of an increase in the permitted amount that will result from the implementation of this development plan.

  The City would benefit from this development plan by not having to expend the funds to construct new collector lines down into the bedrock to maximize the yield allowable in the existing water rights. The City would also not have to face the decision on whether to:

  > Construct an additional transmission line from the Weir House to the South Hill Reservoir(s) to be able to transmit the additional 2.31 MGD (1,604 gpm/3.57 cfs) of existing water rights that the present line can't, or
  >
  > Process a change in the point of diversion(s) of one or more of the springs to the same general location as the original 1885 water right.

E.1 CHANGES IN POINTS OF DIVERSION (Cont.)

A provision should be made as a part of any amendment to changes in the springs water rights points of diversion, to allow the City to divert the spring sources from the Umatilla River, and back into the existing gravity line whenever:

There would be a regional power failure taking the proposed Umatilla River Booster pumping station off line, or

The water in the Umatilla River downstream below the Weir House became accidentally or deliberately contaminated and unfit for human consumption, or

Cloudbursts on the hills above the Umatilla River and below the Weir House result in such a high turbidity that it would not be cost effective to treat the water.

- The third and final element of the development plan is to relocate the point of diversion for the water withdrawn by the State Legislature in 1941 from the Umatilla's North Fork River Basin and it's tributaries to the same location as described above. The amount of this water right is unknown, but it will further enhance the flow in the Umatilla River between the North Fork and the City of Pendleton.

E.2 CONSTRUCTION OF RIVER INTAKE AND PUMPING STATION AT PENDLETON

The anticipated minimum amount of water required to be pumped includes the following sources and quantities:

	MGD	GPM	CFS
November 11, 1885 water right, POD at Pendleton	1.29	898	2.00
December 31, 1890 water right, POD at Pendleton	0.32	222	0.50
North Fork 1910 water right, POD at North Fork	5.17	3,590	8.00
4 springs their full water rights, PODs at springs	7.56	5,251	11.70
*North Fork 1941 Legislative Withdrawal, POD @ North Fork	4.10	2,847	6.34
Total pumping capacity	18.44	12,808	28.54

*Assumed, available flow rates may be considerably higher.

As a result of implementing this development plan the City should be entitled to increase the amount of their rights and permits during times of abundant flow in the Umatilla River. The above pumping rates should therefor be considered as the minimum pumping rates for design purposes.

E.2 CONSTRUCTION OF RIVER INTAKE AND PUMPING STATION AT PENDLETON (Cont.)

A 42" diameter size pipe is recommended the suction and discharge piping to accommodate the flow rate of 18.44 MGD (12,808 gpm/28.54 cfs).

The river intake is planned to be a buried pipe gallery system paralleling the Umatilla River with some cross piping to let the underlying gravels do the preliminary screening.

The proposed improvements for the river intake collection system and pump station includes:

- Installing 6,000 feet of piping 12" perforated piping
- Installing 300' of 42" diameter perforated header pipe
- Installing filter rock type bedding, geotextile and site restoration
- A High head - 12,808 gpm pump station
- SCADA control modifications

E.3 TRANSMISSION LINE FROM PUMP STATION TO 90 MG STORAGE POND

The 42" diameter transmission line proposed improvements that may be required from the river pumping station to the site of the 90 MG storage pond includes:

- 1.5 miles of 42" diameter water line installed
- 3 borings - railroad & freeway (2)
- An allowance for rock excavation
- Fittings, valves, anchorage

E.4 WATER RIGHT INVESTIGATIONS, LEGAL SERVICES AND AGENCY INTERFACE

It is presumed that this development plan is a **WIN-WIN** plan and will encounter less opposition than the development plan in Chapter IX. However, if the opposition becomes highly contentious and litigious, the estimated costs could be greatly exceeded .

The cost of investigating the existing senior water rights, their status and use patterns, for their effect on the City's water rights and permits are at best "guesstimates". In addition there will be special reports required by State Agencies and the retaining of legal counsel with expertise in water rights.

F. SUMMARY OF COSTS FOR THE RECOMMENDED DEVELOPMENT PLAN

As stated in the previous Chapter IX, the construction of a transmission line from an unknown location of a Umatilla River for a river Intake and Booster Pumping Station, to an unspecified location for a 90 MG settling/storage pond at the treatment site, over an unspecified route makes cost estimating very difficult. The route for the pipeline may cross: a railroad, city streets, county roads highways and the freeway depending on site selections. Crossings at a railroad and/or freeway will require borings, an expensive operation.

The cost summary in this Section includes the Costs developed in Chapter VIII, Section N, on page VIII-15 and are incorporated in Table X - 3 below.

TABLE X - 3

ESTIMATED COST RANGES FOR THE RECOMMENDED DEVELOPMENT PLAN

	LOW RANGE	HIGH RANGE
From Chapter VIII: Costs Common to Both of the Alternative Plans Chapters IX and X	$ 11,800,000	$ 15,400,000
Costs this Chapter:		
River Intake and Booster Pumping Station	$ 1,200,000	$ 1,700,000
Pipeline - Pump Station to 90 MG Pond	$ 1,800,000	$ 2,500,000
Water Rights, Legal, Agency Interface	$ 200,000	$ 400,000
Estimated Cost Range	**$ 15,000,000**	**$ 20,000,000**

CHAPTER XI -- RECOMMENDATIONS

A. RECOMMENDED TREATMENT OPTION

In the development of this updated Water Master Plan three treatment options were considered and investigated in Chapter VII. These three were:

- Membrane Filtration. The particular appeal of this method is that it does not require chemicals in the treatment process, except for preventive disinfection. This method of treatment has gained considerable acceptance in the southern states. The colder temperature of northwest waters increases (doubles) the cost of this form of treatment. The cost of this method of treatment resulted in it's rejection.

- Rapid Sand Filtration. This treatment system was first constructed in the United States in 1884 and did not gain broad acceptance until 1902. The process gained popularity because the treatment plants were more compact and provided a high degree of control over the treatment process and could effectively treat higher turbidity waters. Chemicals normally used in this treatment process often remains in solution compromising the quality of the finished water. The effect of the addition of these chemicals was not understood or documented until recent years. Current regulations on the operational practices and disposition of waste sludge (with chemicals) have significantly raised the cost of this type of treatment. The sophistication of this method of treatment requires highly skilled operators, high operational costs (chemicals & power), and regulated disposal of the sludge. Additionally the introduction of chemicals in the treatment process does create post treatment problems in the distribution system. For these reasons this form of treatment was removed from consideration.

- Slow Sand Filtration. This method of treatment was first constructed in England in 1829 and became known as the "English system." The first treatment plant of this type constructed in the United States was in 1870. Slow Sand Filtration process has recently regained popularity because the process does not rely on chemicals in the treatment process, except for preventive disinfection. This treatment process requires more land area than any other type. It does not, however, require additional land for sludge disposal. The London, England facility, originally placed in service in 1839, has been continuously expanded on and continues in service today. Facilities of this type in England are currently treating hundreds (100's) of millions of gallons of water per day. Simplicity in construction, low cost of operation and long life were the deciding factors for recommending this type of treatment facility.

The selection of the Slow Sand Filtration treatment process largely determined the methodology for the other required improvements: interim development of deep well source, land requirements, water sources (by priority dates), mass storage in the underlying basalt aquifer's, surface storage/settlement pond, conventional storage, river intake, transmission lines and pumping facilities.

B. DEVELOPMENT PLAN ALTERNATIVES

Previous Chapters discussed alternate strategies for the different improvements in detail. Two general development strategies evolved from a review of the City's water rights/permits and the present Oregon Statutes and Administrative Rules.

[1] The development plan in Chapter IX, which complies with current Oregon Revised Statutes (ORS) and Oregon Administrative Rules (OAR), is not recommended because of the excessive costs that would be incurred. However, this plan may be the only legal option of choice if the State does not pass the pending legislation to provide the City with relief.

The recommended development plan in Chapter X is premised on the State Legislature passing a pending bill that would amend the ORS and OAR. This bill would allow the City to: relocate the points of diversion at the North Fork of the Umatilla River (34 +/- miles upstream) for two sources, to a location within the City upstream of Wildhorse Creek, without first being required to put these sources to beneficial use.

Pilot testing of the slow sand filter treatment process, developing deep well source(s) for an interim supply, obtaining permits for experimental recharge at Well #1 (Byers Avenue), constructing the upper North Hill Reservoir, researching water rights, legal investigations, etc. can proceed without the desired legislative relief. Legislative relief, if not passed by this current legislature, should surely be obtainable at the next legislature, when an earlier organized effort can be made by the City.

C. OREGON'S APPROVAL PROCESS FOR THE MASTER PLAN

The Oregon Water Resources Commission (OWRC) adopted rules (OAR 690-86) in November 1994. These rules require municipal water suppliers that will be applying for a permit, and/or a change in permit status to prepare and submit a Water Management and Conservation Plan. Previous conditional approvals have had a one year period of time attached to new permits and/or any changes to existing permits, for the applicant to complete the Water Management and Conservation Plan.

Approval of the Water Master Plan by the Oregon Water Resources Department (OWRD) can be time consuming and potentially expensive. The approval process is fraught with the risk of lengthy delays in the OWRD's approving of any draft and/or final plan. The potential for a long delay is a real concern. The balance of this Section will explain in some detail the particular rules that may impede the approval of a draft and/or final plan.

Because the approval process may be very lengthy (over a year), the City should proceed with improvements that do not require a new permit or modification of an existing permit from the OWRD. Specific improvements that should proceed while the plan is going through the approval process will be discussed in the following section.

1 Subsequent to the publishing of the first draft of this Master Plan, the 1955 Oregon Legislature passed legislation enabling the City to relocate two <u>Points of Diversion</u> from the North Fork of the Umatilla River to a location near Pendleton without requiring the City to make improvements and place the water to beneficial use at the original Points of Diversion. The cost of constructing 34 +/- miles of pipe line from the North Fork in Table XI-1, page XI-7 is no longer required.

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C. OREGON'S APPROVAL PROCESS FOR THE MASTER PLAN (Cont.)

The OWRD's process for approval of draft and final Water Management and Conservation Plans is summarized below.

- **The City Council's review and their conditional adoption or amendment to this updated City Water Master Plan as may be required.**

- Schedule hearings on the final draft of the Water Master Plan as conditionally approved. Provide a minimum of 30 days for other effected local governments, appropriate officials, planning bodies for comment and coordination with other plans and/or comprehensive land use plans.

- **At the conclusion of the hearings, conditionally re-adopt or amend the draft of the City's Water Master Plan as released for public hearings and gathering of local input.**

- The plan then should be submitted to the OHD and the OWRD for their review and approval. Review of the updated Master Plan by the OHD will require a fee of $250.

- Schedule a conference with OHD to propose and obtain an agreement on an acceptable one year pilot testing program for a Slow Sand Filter Treatment system for the City's springs and the Umatilla River sources.

- The OWRD shall then notify affected local governments, affected Indian tribes, and all persons on the OWRD's weekly mailing list that a draft water management and conservation plan has been submitted to the OWRD and is available for review.

- Any person may review and comment on the draft plan within 30 days of the date of the OWRD's notification. The OWRD will consider comments that cite specific provisions of concern in the draft plan and describe how each cited provision does or does not satisfy the requirements of the OAR, suggest any modification in each provision that would be necessary to satisfy the relevant requirement, and include information to support suggested modifications.

- The OWRD shall review comments received that conform to the above paragraph and identify any modifications which are needed to satisfy relevant requirements of the OAR.

- During the plan review and approval process, the OWRD may extend the time allowed for implementation of any conservation or metering measures, if the City shows that an extension is necessary to avoid unreasonable and excessive costs.

- The OWRD shall review the following elements in the draft plan for conformance with the rules: conservation measures, curtailment of water use, economic feasibility, any adverse environmental impacts, that proposed implementation measures are available and proven, time needed to carry out measures, soil and climate's effect on the proposed measures, consistency of draft plan with other relevant water management plans and subbasin conservation plans, identification of sufficient availability of water to meet future demands, and the cost effectiveness of conservation versus development of additional sources of water. Upon completing their review, the OWRD shall advise the City of any constraints to implementation of the Water Management and Conservation Plan. The OWRD shall recommend appropriate actions to secure any identified new source of water.

- During the plan review and approval process, the OWRD may, on request of the City, waive the requirements for implementation on any of the measures required by the OAR on Plan Elements and Standards for municipalities. In determining if the implementation of any measure should be waived, the OWRD shall consider whether:

  Implementation of the measure is impracticable or unreasonable;

  The City has an adequate and secure water supply sufficient to serve present and future projected demands, or

  The City is carrying out other, equally effective conservation measures that may include an aggressive leak detection program, anti-waste provisions in the City's ordinances, rules or regulations, or other policies showing a commitment to water use without waste.

- The OWRD will, within 90 days, notify the City after receipt of a draft plan, in writing, the results of their review and include copies of any comments received.

- The OWRD may deny approval of a draft plan if the City does not submit a final plan to the OWRD within 90 days after receipt of the OWRD's review.

- The OWRD shall evaluate the final plan, to determine if the plan satisfies the relevant requirements of the OAR's. Evaluation shall be limited to a review of the modifications in the plan and issues on which the OWRD has commented.

- If the OWRD determines that the final plan does not satisfy the OAR, the OWRD may consult with the City and may provide additional time to correct any discrepancies. The City may also request that the Director of the OWRD appoint a five-member board to review the submitted final design plan. The board would include two individuals from the Umatilla River Basin who are engaged in similar uses of water, the local watermaster and other individuals knowledgeable about the water use practices and/or the environmental impacts of water conservation. After reviewing the final plan and evaluating any additional information presented by the City and the OWRD, the board may recommend that the Department:

Reconsider the decision not to approve the final plan.

Reconsider the decision not to approve the final plan contingent on the water supplier agreeing to specified modifications, or

Re-affirm the original decision not to approve the plan.

- The OWRD shall then notify the City, the board members and any person who submitted comments on any action taken based on the board's recommendations.

- The City or any person who has submitted comments as prescribed by the OAR, may within 30 days of notification, appeal a decision by the OWRD to approve or not approve the final plan to the OWRC. OWRC may deny the appeal or may accept the appeal and remand the final plan to the OWRD to seek resolution of the issues identified in the appeal, and if the issues are not resolved, to initiate a contested case proceeding pursuant to the Oregon Revised Statutes (ORS) and the OAR.

- If the OWRD finds that the plan does satisfy the OAR, or if the City corrects identified discrepancies, the OWRD shall approve the final plan. OWRD shall notify the City and any person who submitted comments of their approval. The approval shall also state when an updated plan shall be required, which shall not be less than 5 years.

- If the Director of the OWRD determines that the City has failed to submit a plan as required by the OAR, or has failed to satisfactorily implement an approved water management and conservation plan, the Director may proceed with one or more of the following actions:

  Provide an additional, specified amount of time for remedy,

  Initiate an evaluation of the City's water management practices and facilities to determine if the use of water is wasteful,

  Initiate regulation of water use as prescribed in the OAR to eliminate waste,

  Rescind a previous approval of a water management and conservation plan, and

  If the submittal of the water management plan is required under a permit condition, assess a civil penalty as prescribed in the ORS, or cancel the permit.

D. PROPOSED IMPROVEMENTS, ACTIONS AND SCHEDULING

In the summers of 1992 and 1994, the City experienced the need for requesting voluntary curtailment of yard irrigation. A few calls, requesting voluntary reductions in water use to a few large consumers of water, averted the need for rationing. Subsequent additional growth and the potential for another hot summer, dictates that the City should not wait for an approval of the updated Master Plan from the OWRD, before proceeding with some of the improvements.

Proposed improvements and their estimated costs were discussed in the previous Chapters and are summarized in Table XI - 1 on page XI - 7. Depending on the fate of House Bills in the State Legislature this session, a third plan blended from the two shown in table, may have to be adopted. Financing is discussed in more detail in Section E below. The City should initiate an information program to inform the electorate of the need to upgrade the existing water facilities.

Even if current ORS and OAR are not changed to accomplish the recommended development plan, the carrying out of the primary elements will place the City in a posture to meet the future water demands for a sufficient period of time to continue to seek legislative relief from future legislatures. Construction of 34 +/- miles of pipeline from the North Fork of the Umatilla River to the City as required by the current OAR, would be an extremely wasteful commitment of local financial resources, and antithetical to the highest and best use of the available resource. Changing the point of diversion from the North Fork to the City proper and the use of the Umatilla River as the means of conveyance, should engender support from all other users of water in the upper Umatilla River Basin (above Pendleton). The following recommended specific improvements and actions to be carried out by the City, should follow the sequence shown and authorized as soon as they can be funded from budgeted funds and/or funds from a general obligation bond issue.

D.1 CONSERVATION

The City should abandon the present policy of providing water free of charge to some entities. In lieu of the present policy, the City could subsidize some users with an annual monetary credit ($) equivalent to the annual consumption of other similar users, plus a charge rate the same as others have to pay for usage above the annual amount. **Freewater** can easily become very costly water to the City without some incentive to conserve. Metering and payment of water has been proven historically to be an incentive to conserve water.

D.2 DEVELOPMENT OF AN ADDITIONAL DEEP WELL SOURCE AS AN INTERIM STEP

The loss of Well #1 (Byers Ave.) and the declining water table dictates that the City Council act expeditiously to provide an ample replacement supply of water for current and future needs.

Well #11 (McKay Creek/Wastewater Treatment Plant) seems to be the likely candidate for development of an interim source. This well could be constructed as a production well or a combination production and recharge well depending on the results of a well test.

Authorize testing of Well #11 (McKay Creek - Wastewater Treatment Plant) plus a second possible well test at Well #6 (Sherwood Well) if the test at Well #11 shows the well is a low producer.

TABLE XI - 1

COST SUMMARY OF ALTERNATIVE DEVELOPMENT PLANS

COST ITEMS FROM CHAPTER VIII	RECOMMENDED PLAN COST RANGE $		PLAN AS PER CURRENT OREGON STATE RULES COST RANGE $	
	LOW	HIGH	LOW	HIGH
Test & Develop Well #11 (McKay Creek) to an ARR Well	410,000	615,000	410,000	615,000
Obtain Permit & Convert Well #1 (Byers) to a Partial ARR Well	65,000	110,000	65,000	110,000
Land and Easement Acquisitions	400,000	800,000	400,000	800,000
90 MG Surface Storage and Settlement Pond	4,500,000	5,500,000	4,500,000	5,500,000
* Slow Sand Filtration Treatment Facility	5,500,000	7,100,000	5,500,000	7,100,000
Replacement of Upper North Hill Reservoir (in wheat field)	400,000	600,000	400,000	600,000
Development of a Second ARR Well	525,000	675,000	525,000	675,000
Sub Totals:	**11,800,000**	**15,400,000**	**11,800,000**	**15,400,000**

COST ITEMS FROM CHAPTERS IX AND X	CHAPTER X		CHAPTER IX	
Water Rights Research, Legal and Agency Interface	200,000	400,000	300,000	500,000
Exploratory Work and Development of City's Springs	0	0	2,000,000	3,700,000
Transmission Line North Fork of Umatilla River to City	0	0	18,700,000	20,300,000
River Intake and Booster Pumping Station	1,200,000	1,700,000	800,000	1,200,000
Pipeline from Booster Station to 90 MG Pond (above)	1,800,000	2,500,000	1,400,000	1,900,000
Sub Totals:	**3,200,000**	**4,600,000**	**23,200,000**	**27,600,000**
Grand Totals:	**15,000,000**	**20,000,000**	**35,000,000**	**43,000,000**

* Includes Pilot Testing & Transmission Lines to the South Hill Reservoirs

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D. PROPOSED IMPROVEMENTS, ACTIONS AND SCHEDULING (Cont.)

D.3 PILOT STUDIES FOR SLOW SAND FILTRATION TREATMENT

The first step will be to schedule conferences with OHD. The purpose of the conferences is to obtain an agreement on an acceptable one year pilot testing program for the Slow Sand Filter Treatment system.

Two pilot testing units are proposed for each of the following sources: the Umatilla River at Pendleton and at the City's springs. This will provide for two different gradations of sand to be tested at each source to learn which gradation of sand will provide the most cost-effective treatment.

D.4 ARTIFICIAL RECHARGE AND RECOVERY EXPERIMENTAL PROGRAM

Schedule conferences with the staff of the OWRD for a permit to convert Well #1 (Byers Ave.) to a partial Artificial Recharge and Recovery (ARR) well. Initially the well would be a partial ARR in that it would be designed to only accept injected water. If the water table is sufficiently raised, it may become a full ARR well. If the recharge indications are very positive, a new replacement well designed specifically to function as a recharge/production well could be drilled near existing Well #1.

A conference with the OWRD is required to find out what documentation and reports may be required for the City to obtain a permit to do an Artificial Recharge and Recovery (ARR) project. Previous requirements for a permit have required the applicant to provide extensive testing and documentation. There currently is a House Bill under consideration for passage that would streamline the application process and reduce the testing, documentation, and report requirements.

Upon arriving at an acceptable agreement with the OWRD, the City should proceed with plans and specifications for a construction contract to convert Well #1 (Byers) to a partial ARR well.

D.5 REPLACEMENT OF THE UPPER NORTH HILL RESERVOIR

Authorize the design and the construction of a 0.5 MG reservoir approximately 1/4 mile north of the City's Limits. This new reservoir will replace the 0.3 MG reservoir that is in its last few years of useful life. The new reservoir would also increase the pressure for upper north hill customers.

D.6 TREATMENT, SURFACE STORAGE AND RIVER INTAKE SITES

Options for alternate sites should be obtained for: the treatment facility, the 90 MG storage pond, river intake system and the booster pumping station. Options for easements should also be obtained between these sites.

D.7 RETAINING OF LEGAL COUNSEL WITH EXPERTISE IN WATER RIGHTS

There are several issues on which legal counsel with expertise in Oregon's statutes, and administrative rules on water rights should investigate and advise the City. The issues that need to be monitored and/or opinions rendered on, include but are not limited to:

- Research, evaluate, and offer opinions on the validity, and viability of the City's existing water permits/rights, and potential consequences of:

  The Oregon Water Resources Commission (OWRC) declaring a Critical Groundwater Area (CGA) in and around Pendleton, plus

  Whether the State of Oregon or the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) has legal jurisdiction over the Reservation. Counsel should also advise on the possible ramifications to the City's springs water rights and the earlier 1885 and 1890 river rights for 2.0 and 0.5 cfs respectively.

- Investigate the possible use of the Umatilla River to convey all or part of water in the City's permits/rights from the City's springs and the North Fork of the Umatilla River. This will probably involve negotiations with the local Watermaster's office in Pendleton and/or the OWRD staff at their Salem office.

- Determine if the OWRD would reduce the quantity/rate in water permits/rights by using the Umatilla River for conveyance, because of evaporation, seepage, and/or other losses. If losses are claimed, the times of the year such losses would be applied should be established. A substantial reduction in the amount of water rights and permits would probably preclude using the Umatilla River as a means of conveyance.

D.8 TENTATIVE PROJECT SCHEDULE

There are several opportunities for the project to be derailed on its path to completion. With this caveat, a tentative schedule is provided below. As stated in the second and fourth paragraphs from the top of page 3, the City is required to hold hearings. The schedule in Table XI-2 on the following page starts with the City Council's first formal adoption of the draft plan and/or as the Council modifies.

TABLE XI - 2

TENTATIVE PROJECT SCHEDULE

ACTION OR ACTIVITY	MONTHS TO START	MONTHS FROM START TO FINISH
Council adopts draft plan - sets hearing	0	1
Retaining of special legal counsel	0	24
Adopt new policy on Freewater	0	1
Council close hearings consider public input, re-adopt draft plan	1	2
Retain agent to acquire land and easement options	1	7
Submit re-adopted draft plan to the OHD and OWRD	2	4
Apply to OHD for & perform approved pilot sand filter pilot test	2	15
Apply for and perform ARR experiment at City Well #1 (Byers)	2	15
Testing of Well #11 (McKay Creek/Sewage Plant)	2	6
Review comments from OHD and OWRD on draft plan	4	5
Evaluate actions of State Legislature on project scope.	4	5
Interface with OHD and OWRD & re-submit plan, if req'd.	5	6
Final plan approval by OHD and OWRD	6	7
Development of Well #11 (McKay Creek/Sewage Plant)	7	17
Review results slow sand filtration pilot tests & ARR experiment	16	17
Apply to OWRD for permanent ARR permit	17	20
Place Bond Issue before the electorate	18	19
Acquire Land for Sites and Easements for Lines	20	21
DESIGN/CONSTRUCT		
New North Hill Reservoir	20	36
ARR well for interim source & storage in winter months	20	36
90 MG Storage Pond and River Intake	22	38
Booster Pumping Station & Transmission Line to Reservoir	35	48

E. PROJECT FINANCING AND WATER RATES

E.1 PROJECT FINANCING

In Table XI - 2, Tentative Project Schedule, we have structured a schedule that will allow evaluation of the success of each significant activity that a subsequent activity is either dependent upon or related to (e.g., pilot testing before treatment plant construction, river intake design before booster station construction, experimental recharge prior to construction of 90 MG pond and second ARR well, etc.). This approach has a dual purpose of finding out both the cost and success of each project element before proceeding with the next activity. As stated repeatedly throughout this report there are several unknowns in the estimated costs. For example: if rock excavation can be avoided in the construction of the 90 MG pond and at the treatment site, the proposed interim well, and the second ARR well does not require as much depth as estimated, etc., the total project costs may be as low as $10,000,000.

To address and meet the many needed pressing improvements, it will be necessary for the City to ask the electorate to support and pass a general obligation or revenue bond issue. Traditionally the City has submitted general obligation bonds to the voters because the funds can be obtained at a lower rate of interest. The City, in all probability, has as good a credit rating as any other public entity in the State, and can probably secure financing at a lower rate than the State programs discussed below.

The OWRD has a Water Development Loan Fund for projects related to the Safe Drinking Water Act with interest rates pegged at the States Interest Rate on general obligation bonds of approximately 6 to 6.5% plus an additional administration fee of 0.5%. This loan fund is limited to $50,000,000 without an approval from the Governor to increase the amount. Maximum term for this loan is 30 years. There are no grants available through this loan fund.

The Oregon Economic Development Department (OEDD) has available funds from the States lottery proceeds. This fund has a $10,000,000 dollar cap on the amount of a loan. There is a possibility of a grant for up to $500,000 for applicants that can meet the OEDD's eligibility requirements. This funding program is open to water, wastewater, airports, roads, bridges and almost all kinds of infrastructure. The interest rates on loans from this agency are the same as the one administered by the OWRD with the same term of 30 years. To obtain a grant from this agency the applicant's project must be keyed to a local economic development accompanied by job creation.

The advice of experts in the financial community should be sought on which option will serve the City's best interest.

E.2 WATER RATES

Water rates will need adjusting to:

- Compensate for the reduction in revenue resulting from the conservation program,
- Service the debt of the general bond issue, and
- For operational and maintenance cost's for the new facilities.

It is assumed that the City will retire the debt from the metered sales of water to customers.

F. EMERGENCY PLANNING

Some of the City's springs are situated along the Union Pacific Railroad and County Road right of ways. These sources are vulnerable to contamination from oil, gas, and chemical spills. On one previous occasion, a train derailment spilled diesel oil over the area of the springs rendering this source useless for a considerable length of time.

This Master Plan proposes the use of the Umatilla River as a source from all of the drainages above the City. This will expose the upstream water sources to a higher degree of risk from pollutants and contaminations.

It is recommended that the City develop ongoing communications and coordination between the City Water Department's staff and: the Union Pacific Railroad, the Confederated Tribes of the Umatilla Indian Reservation, the County Sheriffs Department, and whichever public or private entities the City can recruit. The City may wish to consider setting up an early warning system. This could be accomplished by having an ongoing public awareness program enlisting cooperation from individuals along the Umatilla River upstream from the City to advise of any spillage or other threat to the potability of the river source.

G. CONCLUSION

Good quality water was once considered a plentiful and inexhaustible resource in the State of Oregon. This is no longer true, even in the higher rainfall areas such as the Willamette Valley, cities are struggling to develop the supplies needed for growth and the quality requirements imposed by the "Safe Drinking Water Act".

Several cities in the Willamette Valley are exploring the use of Artificial Recharge and Recovery (ARR) as a vital water management tool in meeting seasonal irrigation demands. This Firm is currently serving on the technical advisory committee for the city of Salem's Water Study. The City of Salem is investigating the feasibility of constructing 20 to 30 artificial recharge and recovery deep wells in the Columbia River Basalt. The era of "cheap" potable water has been relegated to the past in Oregon.

The capital improvements, proposed in this updated Water Master Plan, feature a treatment process that generally has proven to be applicable to almost every source water. The Slow Sand Filtration process is a facility that requires very little operational supervision and no chemicals, except for preventive disinfection. The periodic removal of scrapings off the top of the sand filter beds can be added "as-is" as a soil amendment or cleaned (washed) for later reuse.

The earlier the City embarks on the improvements and constructs a treatment facility, the sooner the City can enjoy the full amount of their water rights and permits.